Co-products Compendium

Meat & Livestock Australia

Locked Bag 991

North Sydney, NSW 2059

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contents

1 Overview

1.1 Background

When cattle and sheep production started to grow in Australia during the 19th century, there was a market for hides and wool in the UK but only salted meat could be exported. With no ready market for meat, sheep and cattle carcases were boiled down to make tallow after hides were recovered or animals were culled[1]. At the time, what are now considered to be some of the co-products of meat production were the primary products of cattle and sheep production and were more valuable than the meat.

Meat is now the most valuable product from sheep and cattle production. But co-products also make a contribution to the revenue generated by meat production. For example for prices in July 2009[2], co-products represent about 14% of the total value of saleable product from cattle.

A typical grass fed steer of 465 kg live weight steer produces about 190 kg of boneless meat. About 6 kg is lost in evaporated moisture as the carcases chills. The remaining 269 kg, including about 36 kg of gut fill, comprises the co-products of meat production. (For the purpose of MLA project investigations and this compendium, edible offal are classed as co-products).

Figure 1.1 summarises the yield of the major categories of products from a 465 kg steer. The breakdown in Figure 1.1 is derived from a spreadsheet tool developed by MLA to examine co-product yields and values.

Resource: Co-products values spreadsheet tool available from MLA

In the example in Figure 1.1, the yield of boneless meat from live weight is about 41% leaving about 59% of the live weight to be handled as co-products. Part of this is gut fill and 6% is hide which has a specific use without much option for different applications. This leaves about 45% of the live weight which typically can be divided in varying proportions between edible offal, rendering and pet food.

In general the highest value can be obtained by packing co-products for edible use. Pet food has the second highest value and rendering is the least value. However, handling and packing costs for edible offal and pet food can make recovery of these items less profitable than rendering outlets. To maximise returns from co-products meat processors need a strategy that will:

- identify the most profitable use of co-products taking into account processing costs;
- maximise the recovery of the more valuable co-products, particularly edible offal;
- where possible, improve quality where modified or upgraded quality can improve returns;
- take the opportunity to recover higher value specialty co-products such as foetal blood, low ash ovine meal and blood plasma bearing in mind that the market size may be limited and high prices can collapse if there is over-supply.
- look for opportunities to value add to co-products through further processing.

Figure 1.2 summarises the yields of some of the co-products options from the non-carcase parts of a 465 kg steer.

Figure 1.1 Typical breakdown of products from 465 kg steer

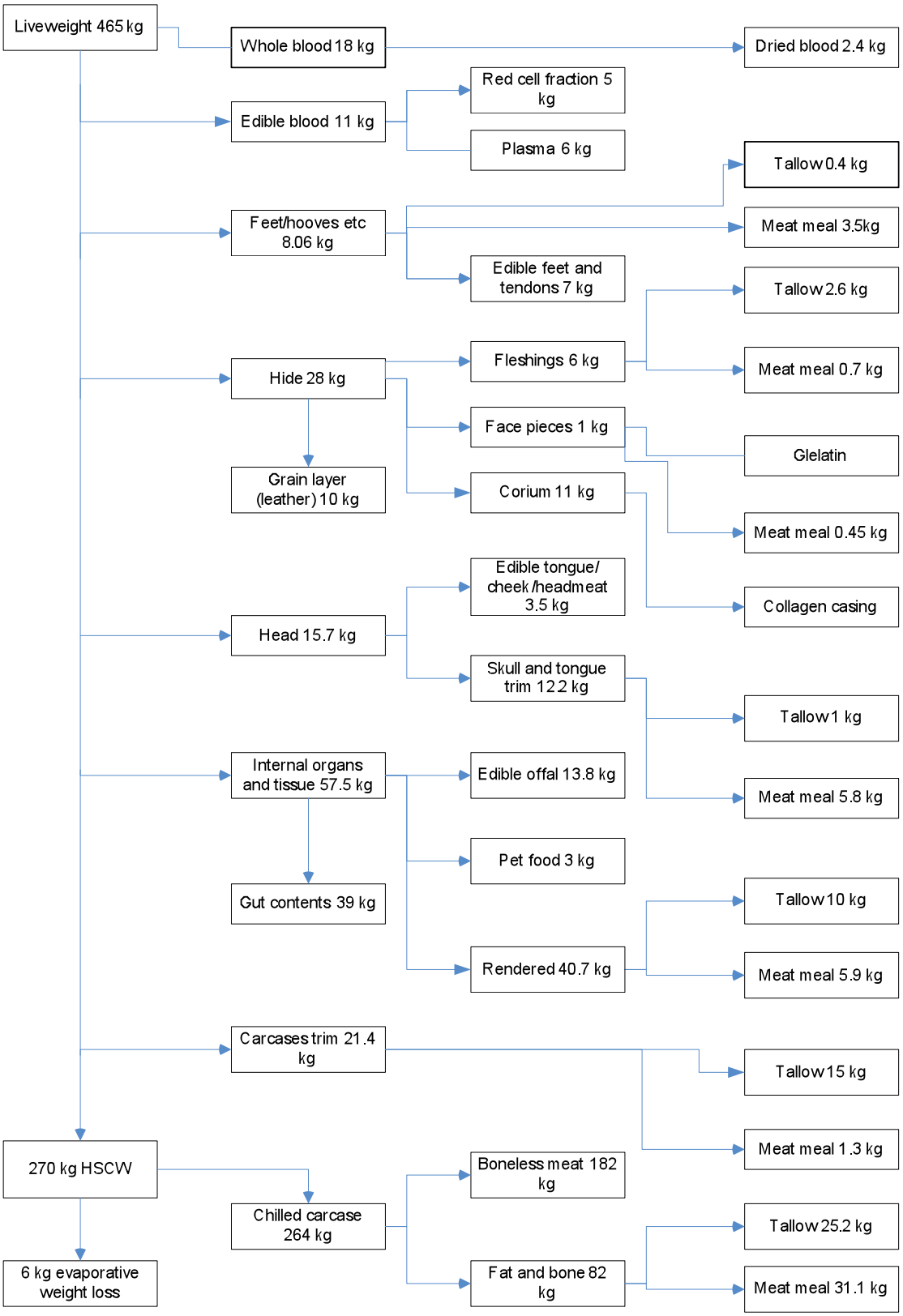


Figure 1.2: Summary of co-products yields from a 465 kg steer

1.2 Comparative value of co-products

Some co-products have several alternative uses. Table 1.1 give examples of the value of selected products and typical processing costs. The prices shown in Table 1.1 are taken from the MLA Co-products monitor for July 2009[2]. The value of rendered products is based on yields shown in Table 3.4.

The costs involved in producing different types of co-products vary between plants but examples of operating costs (i.e. excluding capital, depreciation and interest) included in MLA reports are:

- bulk-packed edible offal 50 cents per kg including transport;
- fresh pet food negligible costs[3];
- frozen pet food 25 cents per kg[3]
- rendered products 4 cents per kg of raw material if rendered on-site[4].

Costs are from MLA reports and are discussed in more detail in the relevant sections of this compendium.

Table 1.1: Examples of relative returns from individual co-products items (July 2009)

Co-product item	**Margin after deduction of operational costs from price ($ per kg of raw material)**			
	Edible	Pet food fresh	Pet food frozen	Tallow and meat meal
Kidney	0.45	0.22	0.40	0.16
Liver	0.60	0.22	0.40	0.16
Lung (non Halal)	0.20	0.22	0.40	0.13
Heart	1.00	0.22	0.40	0.18

Although directing co-product items to edible use is usually the most profitable outlet, followed by pet food, constraints such as lack of facilities and labour may limit recovery of edible offal[5]. Similarly recovery of offals as pet food ingredients may more profitable than rendering but it requires dedicated collection facilities that may not be available. 1.3

1.3 Maximising recovery

Maximising the recovery of edible offal is likely to be a priority for improving co-product yields. Some offal is unavailable for edible use due to condemnation and some is not collected for operational or quality reasons. MLA has investigated offal recovery rates[5] and summaries of typical recoveries are presented in Tables 2.3, 2.4 and 2.6 in the Edible Offal section of the compendium.

The investigation of offal recovery identified structural impediments; shortage of labour and lack of information about offal recovery rates as reasons for lower than expected recovery rates. A spreadsheet tool has been developed to help track offal recoveries and measure improvements in recoveries

It was estimated that there is scope for improving recovery of edible offal to the extent that on average, revenue could be increased by:

- $1,051 per 500 head of cattle;
- $447 per 4000 head of sheep and lambs.

Resource: MLA Offal yield analysis tool – an Excel spreadsheet on CD

1.4 Improving quality

Most customers for co-products expect consistent product quality based on supply according to a specification. Regular supply of consistent quality product supply does not necessarily attract a premium but it can help improve the status of suppliers and maintain sales in falling markets. It is also part of forming relationships with customers which could lead to premium prices, particularly if supplying to the pet food market[3].

Premium prices are available for products supplied according to premium product specifications. Supply of premium product is likely to incur higher production costs and suppliers have to assess whether additional costs are justified by higher costs. Some examples of premiums are shown in Table 1.2.

Specification	Average premium
1% FFA tallow as opposed to 2%	$20 per tonne
2% FFA tallow as opposed to 4%	$40 per tonne
50% protein meat meal as opposed to 48%	$23 per tonne
IW sheep liver as opposed to bulk backed	60 cents per kg
Halal offals as opposed to non-Halal	lips.55 ¢/kg; heart 39 ¢/kg; liver.16 ¢/kg

1.5 Higher value co-products

Opportunities to market higher value co-products may be available from time-to time. Examples are:

- foetal calf blood , the price of which was about $400 per litre in 2004 and is currently about $70 per litre
- low ash ovine meal which has been reported at up to $1800 per tonne in 2009.

High prices are due to strong demand and limited supply. The limited supply may be a result of only a small number of suppliers being able to access the market. The experience is that these high prices tend to fluctuate because high prices encourage the use of alternatives and reduction in demand, or supply increases because more suppliers access the market.

Supplying high value co-products may require investment in equipment and infra-structure and suppliers should take into account that apparently high prices may not be sustained, particularly if more suppliers access the market.

1.6 Added value co-products

Apart from edible offal, most co-products are sold with minimum added value to customers who further process the products. MLA has investigated various opportunities to add value to co-products some examples which are discussed further in the compendium are:

- Separation of meat meals into low ash and high ash fractions;
- Blending high fractions of meat meal with other ingredient to make fertiliser;
- Sorting, trimming and inspection of pet food offal
- Extraction of bovine serum albumin and other components from blood plasma
- Recovery and concentration of stick water from continuous wet rendering plants;
- Preparation of bone stock;
- Fleshing of hides to recover tallow and meat meal;
- Fellmongering of sheep skins.

The examples of value-adding to co-products require capital investment and market development to sell product. The value-adding opportunities are outside the core business of meat companies but some of the value-added co-products listed above are produced by some companies. Meat companies have also identified other opportunities for value adding to co-products.

1.7 Value of co-products

MLA has developed a spreadsheet to estimate the potential value of co-products from different types of stock. The potential value of co-products is based on prices reported in the MLA co-products report[2] and uses yields and returns of edible offal in an MLA report on best practice for offal collection[5]. Potential values of co-products estimated from the spreadsheet and based on prices reported in the July 2009 MLA co-products monitor are shown in Table 1.3.

Co-product	Cow 180 kg HSCW ($ per head)	Yearling 200 Kg HSCW ($ per head)	Steer 270 Kg HSCW ($ per head)	GF Steer 350 Kg HSCW ($ per head)
Edible offal	43.19	47.15	59.09	101.24
Meat meal	25.79	27.05	34.61	40.55
Tallow	21.43	23.55	33.83	58.45
Blood meal	1.74	1.93	2.42	3.14
Hide	10.47	13.00	13.00	19.5
Pet food	1.95	1.30	1.95	1.95
Total	105.47	113.98	144.90	224.83

Based on values shown in Table 1.3, co-products represent about 13 to 15% of the total value of saleable products from cattle.

Resource: Co-products values spreadsheet tool available from MLA

1.8 References

1. Bill Spooncer (1999). A history of rendering in Australia. In Proceedings of Fifth International Symposium. Australian Renderers Association Inc.
2. Co-products Market Analysis Project Report. MLA Monthly report available at http://www.mla.com.au/TopicHierarchy/MarketInformation/DomesticMarkets/Processing/Coproducts/Co-products+monitor.htm
3. Cost benefit analysis of pet food in red meat processing. MLA Project PRCOPVA.014, January 2006
4. The costs of rendering. MLA Project PRCOPIC.035, 2006
5. Best Practice for offal collection. MLA Project A.COP.0037, February 2008.

2 Edible offal

2.1 Background

Edible offal usually provides the best return for non-carcase components. But this is not always the case because processing and packaging costs may make recovery of edible offal unprofitable, or less profitable than other outlets. However, where recovery of edible offal is the most profitable outlet for non-carcases parts, it is in the interests of abattoirs to maximise the recovery of edible offal rather than allow the offal to slip through to lower value uses such as rendering and pet food.

Constraints to maximum recovery of edible offal start with inspection. Inevitably, a proportion of offal is not available for edible use because of pathological conditions.

For those offals that are available for edible use, a decision about whether to collect an item can be affected by:

- likely profitability compared with other uses;
- available facilities;
- inspection or regulatory requirements;
- size of market;
- access to markets and available labour.

Typically, export beef abattoirs recover from 8 to 25 or more offal items, not including specification and packaging variations for particular items.

In view of variations in the number of offal items collected for edible use, variations in condemnation rates and variations in recovery rates, the value of edible offal can be very different from plant to plant. Examples of the variations in value that might occur are shown in Table 2.1. The values in Table 2.1 are based on prices reported in the July 2009 MLA Co-products monitor[1].

In view of the variations in the value of edible offal that can arise, MLA has conducted projects to investigate losses during inspection, losses in collection and to expand the range of offal collected for edible use.

2.2 Typical uses

Edible offal covers a wide range of products which have different uses in different markets. Figure 2.1 illustrates the total exports of selected beef offals and the major destinations for these offal items. Figure 2.2 shows export markets for sheep offal. Clearly demand for certain offal items is concentrated in particular countries. Exporters should be aware of these markets, how the offals are used in these markets and the preferred specifications in the markets.

Table 2.1: Variations in the value of edible offal collected in different circumstances

Collection conditions	Value of edible offal from 270 kg steer
Collection of 24 items including Halal product at typical recovery rates	$60.80
Reduced collection of 10 major items at typical recovery rates	$41.24
Typical collection of 24 items but at low end of range of recovery rates	$50.00

Figure 2.1: Variations in the value of edible offal collected in different circumstances

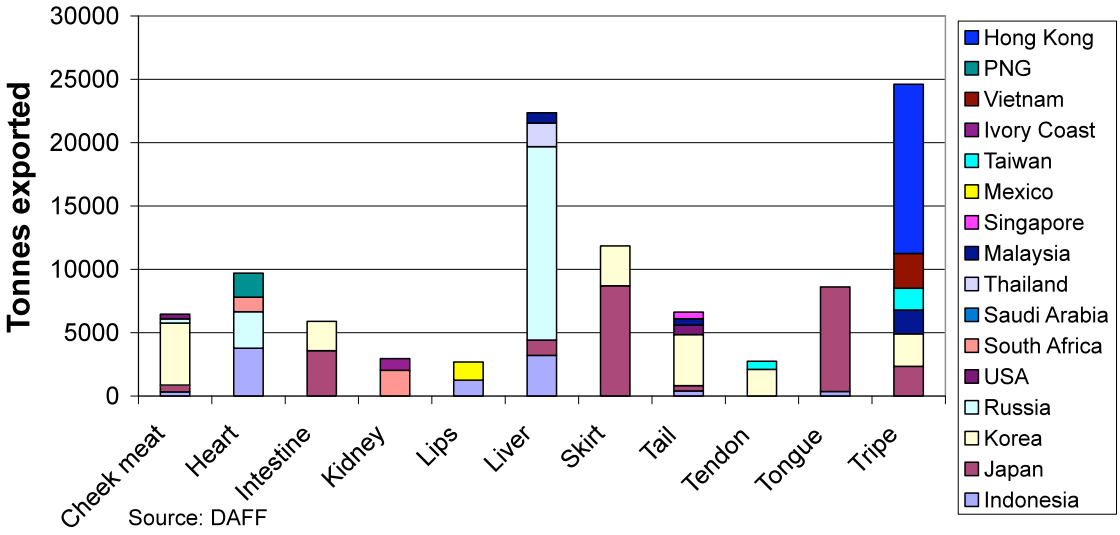
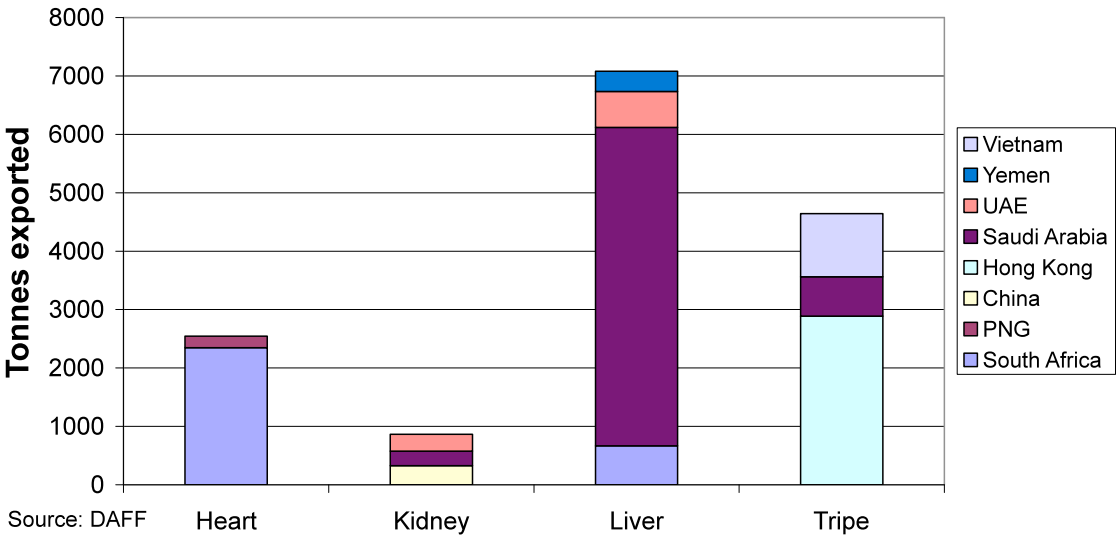


Figure 2.2: Major export destinations for sheep offal in 2008



Resource: Market destinations for offal are available at: http://www.mla.com.au/TopicHierarchy/MarketInformation/DomesticMarkets/Processing/Coproducts/Offal.htm

In 2001 a delegation of meat industry representatives and MLA visited China to investigate what offal products were in demand and to asses Australia's ability to deliver the required products. A hand book has been produced which describes the products in demand in China, how the products are used and the regional variations in demand for products[2]. The delegation reported that in general the required specifications for offal in demand in China match the specification in

Resource: MLA Handbook "Beef and Lamb Offal Specifications for China"

Other markets have not been examined in the same detail but some general observations are:

- High value offals such as tongue and rumen pillars are directed at the Japanese market. These offals are used in the barbecue-restaurant trade and there is peak demand in January at the time of the New Year Holiday, and during the Golden Week holidays at the beginning of May. Japan is also a major market for thick and thin skirt, intestine and weasand.
- The main demand for cheek meat and tails comes from Korea. The demand for tails is usually at a peak in winter months. Korea is also a market for thick and thin skirt, intestine, and tendon.
- Russia is the main market for liver and also takes hearts and a small amount of cheek meat. Peak demand in Russia is typically towards the end of the year. In December and January exports to Russia may slow down due to holidays and reduced access to ports that are affected by ice.
- Halal markets in Indonesia, Malaysia and Singapore take a range of offal including liver, hearts, lungs (excluding Indonesia), lips and tongue roots. The peak season for export demand tends be approaching the month of Ramadan although demand may continue throughout the year.
- Large volumes of beef and sheep tripe are exported to Hong Kong. A range of other offals are exported to mainland China when prices are favourable.
- High demand for sheepmeat offals comes from the Middle East, with shipments of sheep liver and tripe particularly popular.

2.3 Quantities

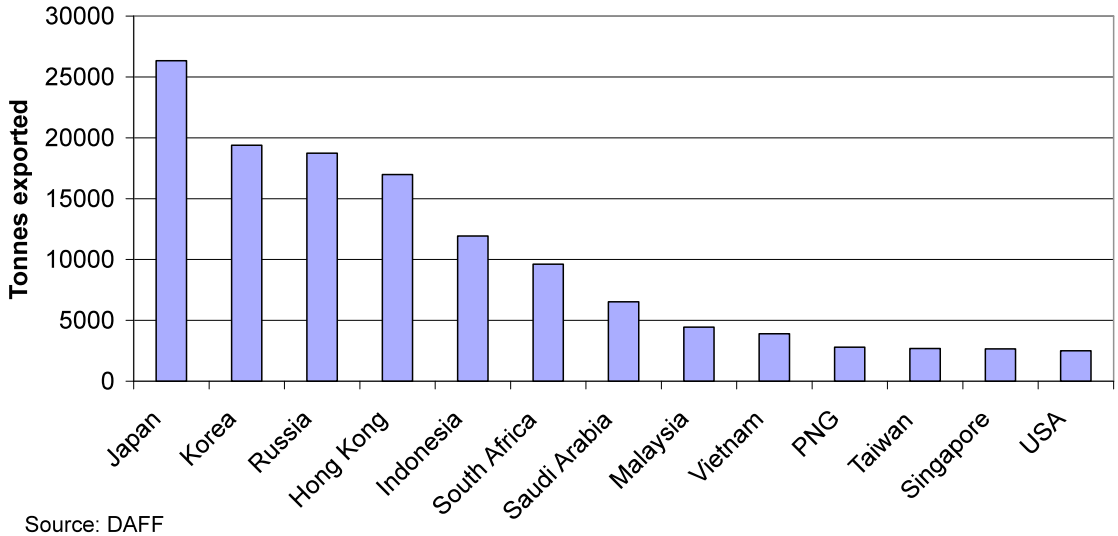
The majority of edible offal is exported but a proportion is also consumed in the domestic market. While the volume of offal exported is known, it is difficult to assess the amount offal utilised in the domestic market.

In 2008 the volume of offal exported was 138,032 tonnes including:

- 119,672 tonnes beef offal;
- 18,360 tonnes sheep offal.

The major export destinations for Australian edible offal in 2008 are shown in Figure 2.3.

Figure 2.3: Major export destinations for edible offal in 2008



Source: DAFF

2.3.1 Quantities per head

The quantity of edible offal available per head of sheep and cattle has been studied in an MLA project[4] and is discussed in more detail below.

2.4 Values

MLA tracks prices monthly in the Co-products price monitor[1]. Prices reported in the Co-products monitor are derived from surveying export plants and traders. Offal prices from the monthly survey are maintained in a data base dating from 1992.

Figure 2.4 shows an example of prices tracked by the monthly co-products monitor.

From the average price of offals reported in the co-products monitor in calendar year 2008 and the volume of offal exported as reported by DAFF, the value of offal exported in 2008 was:

- $451 million for beef offal;
- $34 million for sheep offal.

The value of edible offal per head of cattle and sheep is a notional value since processors select different offals to collect, rates of recovery are variable and orders are not always available. However the potential values of offal from different types of stock are shown in Figures 2.5 and 2.6. The values in Figures 2.5 and 2.6 are derived from the typical yield of edible offal as determined in the MLA project "Best Practice for Offal Collection"[3] and the average price of offal items reported in the MLA Co-products monitor in 2008. The values assume that export market access is available to all markets including Halal. The offal from grain-fed steer includes values of chilled tongue and thick and thin skirt.

Figure 2.4: Historical prices of selected offals

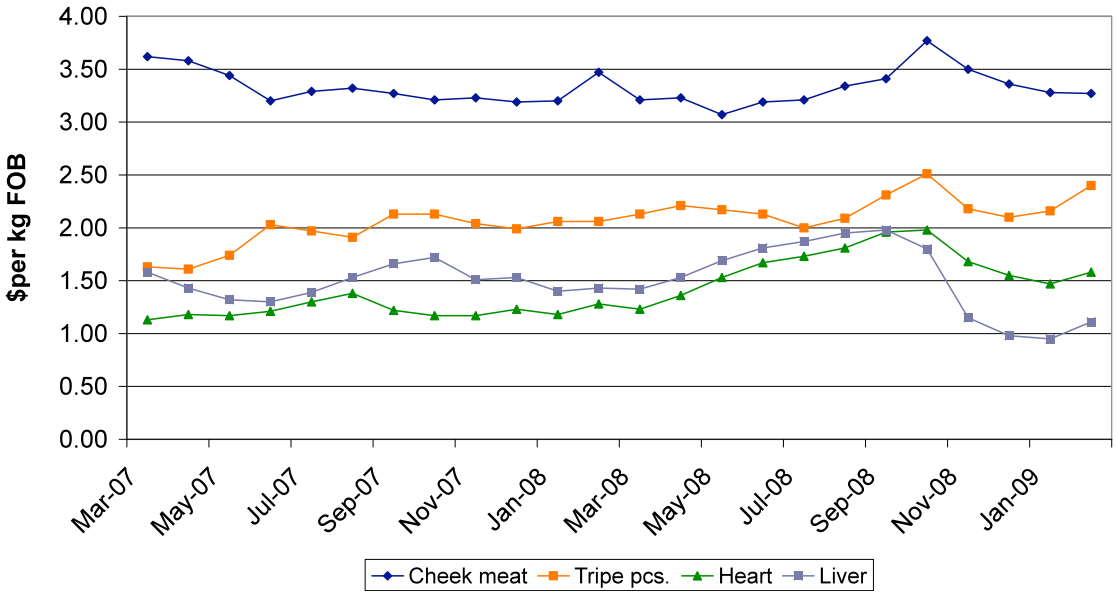


Figure 2.5: Potential value of edible offal from cattle

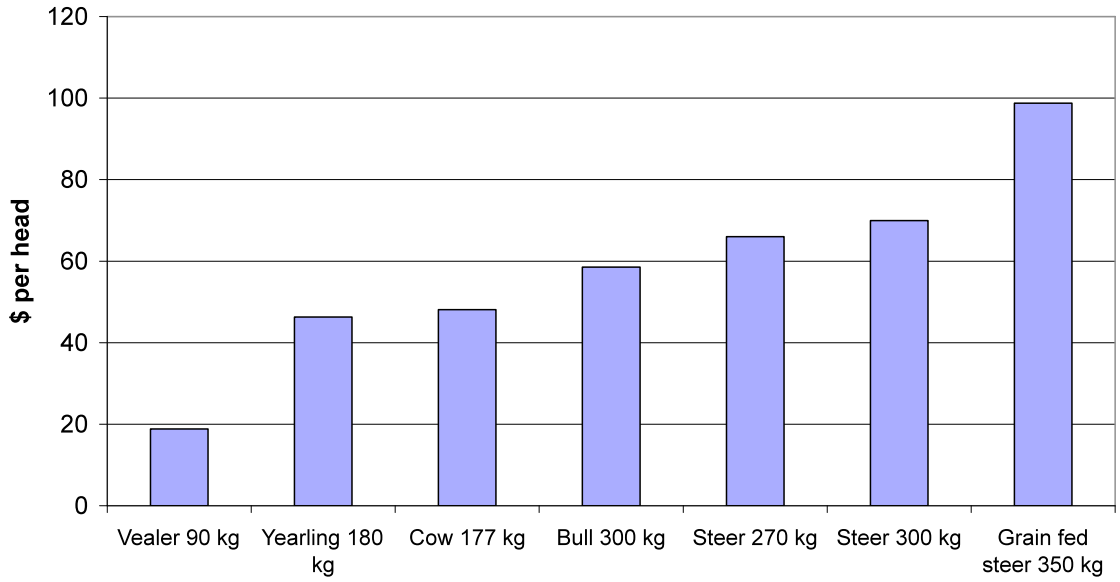
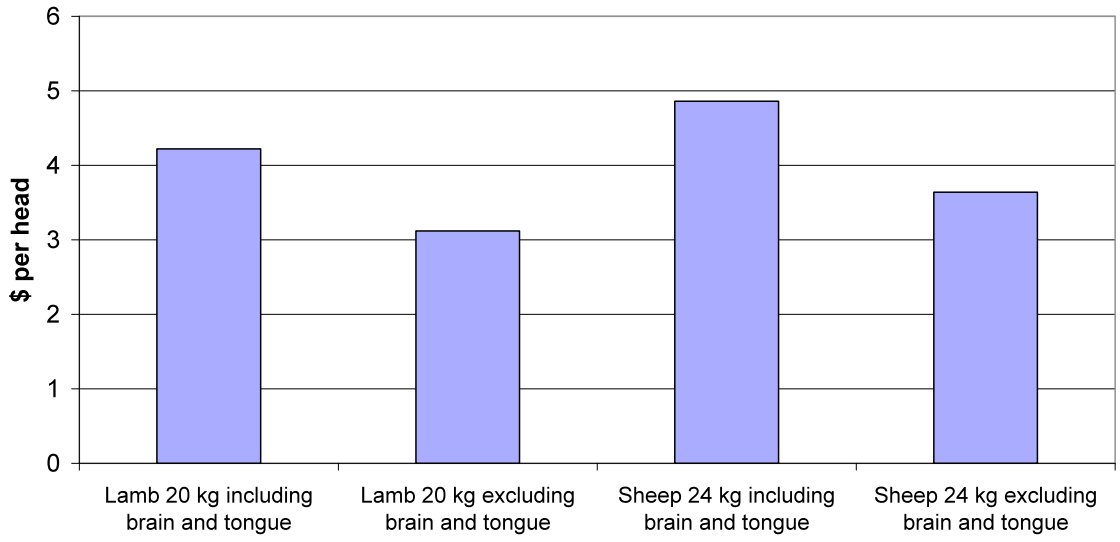


Figure 2.6: Potential value of edible offal from sheep and lambs



2.5 Opportunities to increase value

Apart from prices, the value of offal depends on recovery rates and the range of offals recovered. Rates of recovery are affected partly by condemnation of offal due to pathological conditions

The amount of offal that is condemned as unfit for human consumption is generally not recorded.

Two MLA studies have assessed the condemnation rates of sheep offal[3, 4]. Figure 2.7 summaries the estimated condemn rates in the two studies.

One study has assessed condemnation rates of beef offal[3]. Results from this study are shown in Figure 2.8.

Figure 2.7: Estimates of sheep and lamb offal condemnation rates

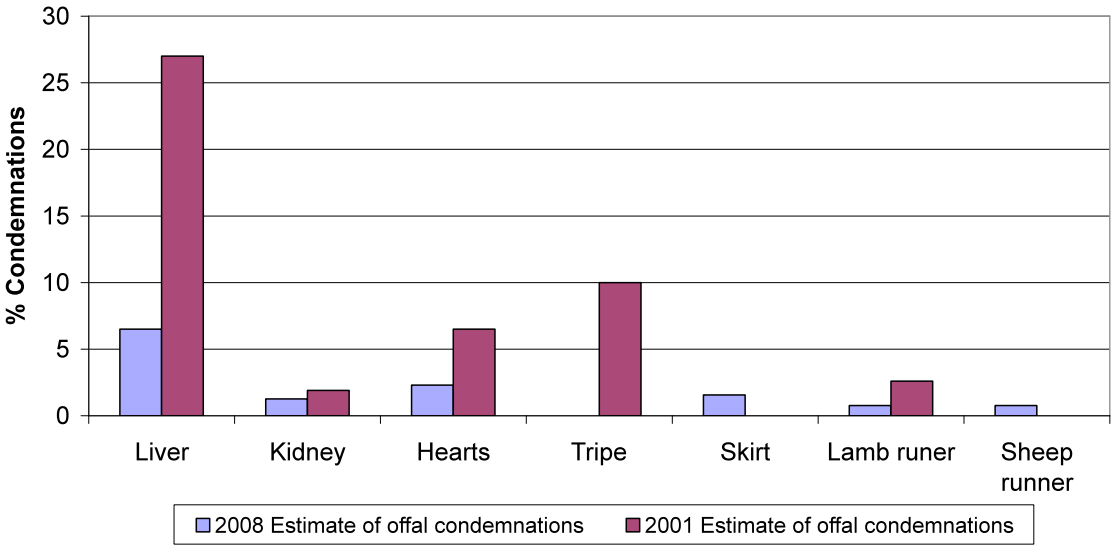
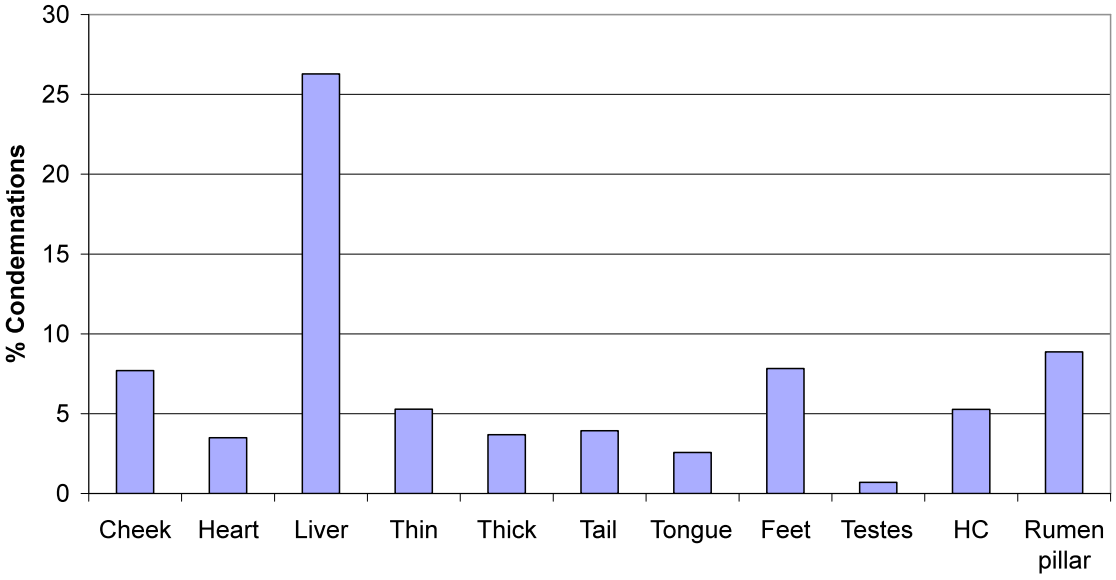


Figure 2.8: Estimates of beef offal condemnations



Another MLA study looked at beef liver and kidneys that had been condemned at on-line inspection[5]. Of 602 livers either condemned or graded by inspectors as suitable only for pet food, 144 (24%) were classified as fit for human consumption on the basis of detailed laboratory examination by the researchers. Of 749 kidneys condemned by inspectors or graded as suitable for pet food only, 188 (25%) were considered to be suitable for human consumption after detailed examination.

Downgrading of product that might have been recovered for human consumption translated into losses of $372 and $576 per 100 head for liver and kidney respectively[7].

Apart from condemnations at inspection, other regulatory issues may affect the recovery of edible offal. MLA projects have investigated the recovery of offal that might otherwise be unavailable for edible use[7, 8]. Studies have resulted in the approval of processes to recover edible product from burst paunches. These investigations also resulted in AQIS notice 2001/21 which allows for the recovery for edible use of green offal which otherwise would be condemned due to contamination.

At one abattoir, recovery of edible product from burst paunches was estimated to result in an improved yield of 12% valued at $100,000 per year[9].

Another project resulted in approval to recover brains and tongues from sheep heads removed immediately after bleeding[10]. There is a potential value of about $1 per head for recovery of sheep brains and tongues. Reports on the recovery of edible product from burst paunches and recovery of sheep brains and tongues include templates that can be followed to validate alternative collection procedures for offal, examples of procedures and other information required for the approval of alternative procedures.

MLA investigations have also shown that reduced collection of edible offal is related to availability of staff, levels of training and supervision[3]. These findings are discussed below. The main finding of these investigations is that abattoirs should have good recording systems to track offal recovery rates. From tracking offal recovery rates, it is estimated that there are opportunities to improve recovery of beef offal to the value of about $1000 per 500 head of cattle and $450 per 4000 head of sheep[3].

Resource: MLA Offal Yield Analysis Tool – an Excel spreadsheet on CD. Report: "Best Practice for Offal Collection"[3]

MLA has also supported work on processing offal products according to market specifications. For example, work on producing beef feet to Korean specification is discussed below. It is estimated that the margin on producing beef feet is $0.38 to $1.9 per kg[11].

Quality issues may affect the value of offals and the ability to recover offal for certain markets. MLA projects have considered the microbial quality of offal and while the microbial quality is good, improvements could be made by additional washing of offal and by plate freezing of offal. Although plate freezing is an advantage, reports indicate that offal cooled and frozen according to refrigeration index criteria are satisfactory quality[3, 12].

2.6 MLA work

2.6.1 Offal recovery rates

Recovery rates for sheep and lamb offals were investigated by MLA in 2001[4].

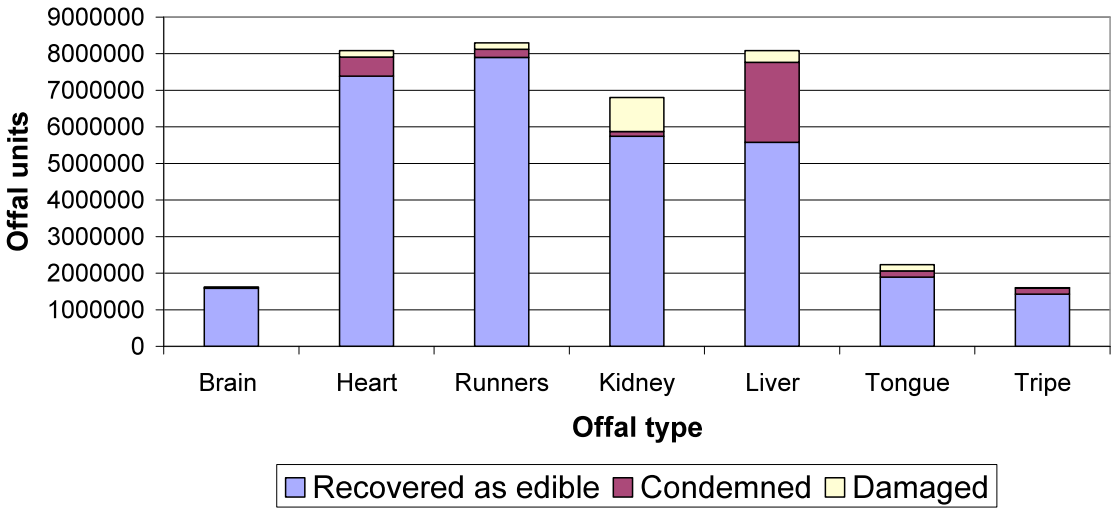
Table 2.2 shows the percentage of offal collected for edible use at eight abattoirs. The table also shows how much of the offal that was intended to be collected for edible use was lost through condemnation and damage.

Figure 2.9 shows the quantities of offal collected, condemned and damaged at the eight abattoirs surveyed.

Table 2.2: Recovery of sheep and lamb offal and losses due to damage and condemnation

Offal	% available offal processed for edible use at 8 abattoirs	% condemnation of offal intended for edible use	% of offal intended for edible use lost due to processing damage
Brain	19.8	0.9	1.3
Heart	97.4	6.5	2.1
Runners	100	2.6	2.1
Kidney	82.0	1.9	13.7
Liver	97.4	27	3.9
Tongue	26.9	7.6	7.6
Tripe	20.3	10	5.0

Figure 2.9: Volume of sheep offals recovered as edible, condemned or damaged ar eight establishments



Based on offal values at the time, the value of sheep offal lost due to condemnation and damage was about $3 million per year. Figure 2.10 shows the estimated value of loss of potentially edible product due to condemnation and damage.

The major loss of offal value is from liver condemnation and the main cause of condemnation is liver fluke with about 6% of lambs and 18% of hogget and mutton affected by liver fluke. The main cause of losses due to processing damage was gut spillage which affected offal, particularly heart, liver, kidney and runners from about 1.3% of the total kill.

Further work on offal recovery rates for cattle, sheep, goat and veal production was conducted in 2007. In this study the researchers measured recovery rates at eight abattoirs rather than rely on surveys of abattoirs[3].

Tables 2.3 and 2.4 show the range of yields of offal packed for edible use as a percentage of hot standard carcase weight

Table 2.3: Yields of offal from cattle

Offal item	Range of yields as % of HSCW	Range of recoveries as % of pieces recovered.
Aorta	0.032 - 0.06	
Cheek meat	0.224 - 0.568	92
Head meat	0.174 - 0.287	
Heart	0.594 - 0.782	93 - 95
Kidney	0.214 - 0.304	
Lips	0.073 - 0.277	
Liver	0.758 - 2.258	45 - 73
Lung	0.364 - 0.899	
Membrane	0.019 - 0.343	
Thin skirt	0.268 - 0.457	
Thick skirt	0.226 - 0.472	74 - 97
Tail	0.364 - 0.483	80 - 97
Tendon	0.172 - 0.202	
Tongue root	0.103 - 0.131	
Tongue root fillet	0.054 - 0.135	
Tongue swiss cut	0.436 - 0.586	86 - 98
Honeycomb	0.187 - 0.239	79 - 91
Rumen pillar	0.095 - 0.236	71 - 91
Tripe pieces	1.34 - 1.869	
Omasum	0.044 - 0.260	

Table 2.4: Yields of offal from lamb and sheep

Offal item	Range of yields as % of HSCW	Range of recoveries as % of pieces recovered.
Aorta	0.032 - 0.06	
Cheek meat	0.224 - 0.568	92
Head meat	0.174 - 0.287	
Heart	0.594 - 0.782	93 - 95
Kidney	0.214 - 0.304	
Lips	0.073 - 0.277	
Liver	0.758 - 2.258	45 - 73

Table 2.5 shows the typical weights of offal items from cattle and sheep. The average weights shown in Table 2.5 are based on measurements of the weight of 15 to 78 individual offal items.

In this study estimates of condemnation were made by observing a sample of offals at inspection. The estimates of the number of condemnations are shown in Table 2.6.

Table 2.5: Average offal weights

Beef offal		**Sheep offal**	
Offal item	**Average weight (kg)**	**Offal item**	**Offal weight (kg)**
Aorta	0.134	Heart	0.251
Cheek meat	0.813	Liver	0.707
Heart	1.835	Kidney	0.149
Kidney	1.027	Skirt	0.135
Lips	0.786	Spleen	0.112
Liver	6.448	Tripe	0.57
Lung	2.37		
Thin skirt	0.653		
Thick skirt	0.867		
Tail	1.169		
Tendon	0.195		
Tongue root	2.355		
Tongue root fillet	0.166		
Tongue swiss cut	1.342		
Weasand	0.127		

Table 2.6: Estimates of condemnation of beef offal

Offal item	**Estimated condemnations (%)**
Cheek meat	7.7
Heart	1.9 - 5
Liver	1.0 - 55
Thick skirt	0.3 - 7
Tail	0.3 - 18
Tongue swiss cut	0.3 - 5
Honeycomb	1.5 - 10
Rumen pillar	8

Condemnation of offal followed a pattern according to the type of stock processed. In general there were few rejections of lamb offal except for grain-fed lamb when liver abscesses were noted. Ecchymosis in hearts and thick skirts were also a cause of rejection.

In sheep, liver were rejected for C. tenuicollis and hydatids. Livers were also rejected for fluke when stock were from irrigated areas. Hearts were rejected for C. ovis.

There was no significant rejection of calf offal. Similarly there was little rejection from yearling cattle unless the animals were grain fed in which case livers were rejected for abscesses.

Liver from cows from irrigated areas were rejected for liver fluke. Lungs were also affected. Liver disease caused by fluke resulted in other offal being condemned due to adhesions in the peritoneal cavity and subsequent burst viscera and contamination. In Queensland, hydatids was the main cause of liver condemnation.

In grain-fed cattle, there were high levels of abscesses in livers. Other conditions related to geographical regions, e.g. in Queensland livers were affected by hydatids and in stock from irrigated areas fluke infestation was found in livers.

Across all species and ages, a small percentage of kidneys were rejected for white spot.

Apart from condemnations, other reasons for non-collection of available offal are structural impediments, shortage of labour and lack of information about offal recovery rates.

Structural impediments may limit the ability to inspect offal, for example head offal from sheep and lambs, and may prevent collection of processed items such as scalded tripe.

Labour issues are the main cause of reduced offal collection. At the time of the investigation, labour shortages resulted in non-collection of the lower value items which require high labour input such as head meat.

There are opportunities to increase the recovery of offal. The first step in collecting more offal is to measure recoveries and have good records of recovery rates. To help achieve this, the project generated a spreadsheet-based offal yield analysis tool. This tool facilitates data input about offal and carcase production and provides reports of offal recovery rates in terms of percentage of HSCW.

Accurate yield performance data should allow processors to increase yields on a consistent basis Tables 2.7 and 2.8 show the potential average offal yield increases that are available and the value of the increased yield based on September 2007 prices.

Table 2.7: Typical potential offal yield increase for beef offal

Offal item	Range of yields (% recovery of available offal after inspection)	Estimated potential yield increase (%)	Daily value of yield increase per 500 head ($)
Heart	89.5 – 99.7	5	215
Liver	92 - 100	5	197
Thick skirt	81.6 - 100	5	95
Tail	87.8 – 99.6	5	186
Tongue	89.7 - 100	1	86
Honeycomb	86.7 – 96.4	5	167
Rumen pillar	78 - 100	2	105
Total			1,051

Table 2.8: Typical potential offal yield increase for sheep offal

Offal item	Range of yields (% recovery of available offal after inspection)	Estimated potential yield increase (%)	Daily value of yield increase per 4000 head ($)
Liver	86.9 – 95.1	5	175
Skirt	91	5	Unknown
Kidney	88	5	10
Heart	88 - 96	3	57
Tripe	96	5	Unknown
Runners	80 – 95.6	10	205
Total			447+

Resource: MLA Report "Best Practice for Offal Collection"[3]

2.6.2 Offal quality

Projects on best-practice for offal collection have commented that the microbiological quality of offal is controlled through the use of the refrigeration index to verify adequate cooling rates for chilled and frozen product[3].

Other projects have assessed the microbial quality of offal and provide benchmarks for microbial counts on offal.

Table 2.9 shows the microbial contamination on selected offal at the time of packing and after freezing[12]. This project investigated methods of improving the microbial quality of offal. The methods included improved cleaning of the viscera table, additional washing of liver and improved cleaning of rumen pillars. It was found that a final wash of livers for five or ten seconds with water at ambient temperature significantly reduced the total counts and coliform counts on livers. Table 2.10 shows the changes in microbial counts on liver and rumen pillars due to alternative processing procedures

Table 2.9: Microbial counts on beef offal

	Mean counts log10/100cm2					
	On viscera table		In packing room		After freezing	
	Total count	Coliform	Total count	Coliform	Total count	Coliform
Liver	3.140	2.067	3.724	2.211	3.614	1.744
Kidney	4.253	2.036	3.871	2.198		
Heart	3.149	3.430	1.996	1.639		
Rumen pillar	4.556	2.527				

Table 2.10: Effect of washing liver and additional trimming and cleaning of rumen pillars on microbial counts

	Mean counts log10/100cm2	**Estimated potential yield increase (%)**	**Daily value of yield increase per 4000 head ($)**	
	Before washing/ additional cleaning	After washing/ additional cleaning	175	
	Total count	Coliform	Total count	Coliform
Liver (5 sec wash)	3.387	2.506	3.078	1.557
Liver (10 sec wash)	4.228	2.667	3.139	1.418
Rumen pillar	4.556	2.527	4.194	1.979

Resource: MLA Report "The Microbiology of Variety Meats"[12]

The study of the microbial quality of offal has led to other work to investigate the safe recovery edible product. A project on the recovery of edible tripe from burst paunches and dry-dumped paunches has shown that appropriate evaluations can validate the safety of alternative offal collection techniques[7]. AQIS notice 2001/21 allows for the recovery for edible use of green offal which otherwise would be condemned due to contamination.

Table 2.11 summaries the microbial counts on tripe and rumen pillars recovered from burst paunches and dry-dumped paunches. These data show that edible product can be safely recovered from contaminated paunches and dry-dumped paunches but the appropriate processing methods must be used. The processing methods must be developed at individual establishments and quality-assurance programs amended to reflect the specific processing procedures. The procedures must be validated to demonstrate that they are effective. The report of the MLA project provides guidelines for validation processes and the development of modified procedures.

Table 2.11: Microbial counts on tripe and rumen pillars recovered from burst paunches and dry-dumped paunches

Process	**Mean count log10/cm2**			
	Aerobic plate count		**Coliforms**	
	Tripe	**Rumen pillar**	**Tripe**	**Rumen pillar**
Standard baseline	3.5	3.3	1.3	2.1
Dry dumped	3.1	3.9	1.0	2.7
Burst paunch	3.5	3.5	1.5	2.6
Dry dumped and burst paunch	4.1	3.6	1.3	2.3

Resource: MLA Report "Enhanced Recovery of Co-products – Mountain Chain and Tripe"[8].

2.6.3 Expanded offal collection

2.6.3.1 Sheep Brains and Tongues

The safe recovery of offal products by alternative methods has been investigated in projects to recover tongues and brains from sheep and dehaired feet from cattle[10, 11].

Recovery of sheep brains and tongues requires hygienic collection and handling of the offals and maintaining a correlation between offals and carcases until inspection is completed. Hygienic recovery of brains and tongues usually means skinning heads on the carcase and then recovering the head offal after the head and viscera have been inspected. With inverted dressing systems, the head may be removed from the carcases before it is skinned to protect the hygienic condition of the carcases.

In an MLA supported project, heads were removed from the carcase after bleeding and transferred to a purpose built head processing room. The heads were partly skinned and tongues and brains recovered. The microbiological condition of the brains and tongues was examined and compared with product from a conventional collection system.

The results of microbiological analysis are shown in Table 2.12

In addition to the processing procedures developed for hygienic collection of brains and tongues. Procedures were developed to retain heads in batches of 25 until carcase and viscera inspection was complete.

The validation work supported by MLA resulted in SafeFood NSW and AQIS approving the alternative procedure for collection of sheep brains and tongues.

Resource: MLA Report "An Alternative Procedure for the Recovery of Brains and Tongues from Lambs fit for Human Consumption"[10].

2.6.3.2 Beef Feet

In a project designed to expand the range of edible offal recovered from abattoirs. MLA has investigated the recovery of beef feet for the Korean market. The project focussed on production of dehaired beef feet with comparable characteristics to the product produced in Korea from Hanwoo cattle. Beef feet are usually rendered with a product value of about $270 per tonne. The potential value of edible beef feet is about $2000 per tonne.

Beef feet for the Korean market are generally full leg with no hair and no toe nail. Toe colour should be pink (not grey); there should be no damage to the joint, nail or toe and the skin colour should be pale and almost white. Fig 2.11 shows beef feet produced in Australia.

Figure 2.11: Example of processed beef feet

Table 2.12: Summary of microbiological condition of sheep brains and tongues

	Mean count log10/cm2			
	Total viable count		E. coli	
	Brain	Tongue	Brain	Tongue
Standard baseline	2.4	3.53	0.23	0.41
Alternative procedure	2.58	3.58	-0.05	0.05

Beef feet are produced by scalding and dehairing in a dehairing machine. This takes about 30 minutes for a batch of 100 feet. After dehairing, toenails are removed by machine. Modifications may be required on the slaughter floor, for example it may be necessary to remove feet by knife rather than shears and a transfer system to the processing room will be required.

The cost and performance of equipment used to produce dehaired beef feet was evaluated in the project. The dehairing equipment was modified by adding abrasive pads and a processing additive was used in the scald water to make sure that satisfactory dehairing was achieved without excessive use of manual cleaning of the feet.

The cost of processing including amortisation of equipment was estimated to be about $1.32 per kg. The value of the product was assumed to be $1.70 to $2.50 per kg depending on the grade of the product.

Resource: Report: "Dehairing of Cattle and Sheep Heads and Hooves – Pilot Technology Evaluation"[12]

2.7 References

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3 Rendered Products

3.1 Background

The largest volume, if not value, of non-carcase parts is rendered

As an example, Table 3.1 shows the volume of material for rendering and the value of rendered products that is typically available from a 270 kg steer.

From Table 3.1, raw material for rendering, including slaughter floor and boning room material, has a value of about 40 cents per kg based on product value. The cost of rendering is $130 to $265 per tonne of finished product[2].

In view of the relatively low value of rendered products it is generally more profitable to maximise alternative uses of co-products, such as edible offal and pet food, and minimise the amount of raw material that is rendered. However, rendering provides a means of dealing profitably with the bulk of co-products which otherwise have no value and could face a disposal cost.

Rendered products are traded as commodities in competition with similar materials. For example tallow competes with palm stearine and to a lesser extent other vegetable oils. Meat meal competes with vegetable protein meals such as soy meal. The value of rendered products takes a lead from the other commodities but values also depend on the number of different uses and markets that are available.

To maintain and potentially improve returns for rendered products, MLA's focus has been:

- to protect the existing uses and markets;
- seek to develop wider market opportunities for traditional uses;
- look at developing new applications and uses.

Table 3.1: Example of quantity and value of rendered product from 270 kg steer

Material available for rendering (excludes added water and intestinal contents)	Yield of meat meal	Yield of tallow	Value of tallow and meat meal*
165 kg	48 kg	52 kg	$68.7

** Values based on July 2009 prices reported in MLA Co-products market analysis report[1]*

3.2 Rendering systems

Discussions about rendering issues include what can be expected from different rendering systems. MLA has not investigated the performance of different rendering systems but the following general comments provide a guide to different systems.

The main point of differentiation between rendering methods is whether the system uses wet rendering or dry rendering principles. These systems are also referred to as low temperature (wet rendering) and high temperature (dry rendering). Most wet rendering systems are continuous. Dry rendering is done in continuous and batch systems. In Australian, about 20% of rendering systems are continuous wet, 40% are continuous dry and 40% are batch dry rendering[3].

3.2.1 Dry rendering

In dry rendering, materials are boiled in their own juices until most of the water has been evaporated. Heating continues but the solids are fried in tallow until the water content is reduced to about 5%. At this point the temperature is about 130°C. The tallow and the dried solids are then separated. Since the tallow extraction occurs when the material is dry, the term dry rendering is used.

3.2.2 Wet rendering

In wet rendering, raw materials are heated in their own juices, with or without steam injection and added water. The temperature could be 60°C to 100°C but in Australian conditions the temperature is usually about 95°C. Only a small amount of water is evaporated from the materials in the wet rendering process. After the initial heating stage, liquid including tallow and free water is separated from the wet solids by centrifugation or draining and pressing. The wet solids (at about 55% moisture) go on to be dried separately from the tallow. The term wet rendering is used because tallow and solids are separated while the total material is still wet.

3.2.3 Blood meal production

Blood meal is produced by continuous coagulation of whole blood at about 85 to 95ºC followed by centrifugation to separate coagulated solids from stick water. The solids are about 60% moisture. They are usually dried to 4 to 8% moisture either in batch cookers, disc driers or rotary air driers.

Resource: Rendering Systems and Blood Recovery brochures in MLA Advisory Package “Rendering” 1997

3.3 Typical uses

The products of rendering beef and sheep material are tallow and meat and bone meal. Blood meal produced by drying blood is also regarded as a rendered product.

There are many different uses for tallow and meat and bone meal and specifications vary according to how the customers use the products. Renderers should be aware of how usage affects the required product quality and what specifications are important in different uses.

The major uses of tallow are:

- **Soap making**

  The major use of tallow is to make soap. About 70% of Australia’s tallow is exported and is mainly used for soap making in export markets. There are many export markets for tallow but the principle markets are China and Taiwan.

  For tallow used to make soap, low levels of free fatty acid, moisture and impurities are required so that yield losses are minimised. The tallow must be bleachable so that it will produce a white soap.

- **Oleo-chemicals**

  Tallow derivatives such as fatty acids, mono and di-glycerides and glycerol are used in the manufacture of a wide range of products. They are used as lubricants in metal working, in cleaning products and fabric softeners, plastics, rubber compounding, cosmetics and personal care products and food emulsifiers[4].

- **Edible applications**

  Edible tallows derived from edible material such as fat and bone are used to make bakery ingredients, such as shortening margarine, and frying fats.

- **Pet food**

  Tallow is used in dry pet foods, both in formulations and coatings. Tallow is a flavour attractant and it must have a fresh smell. Light colour is also important to maintain the product colour.

- **Biodiesel production**

  About 30,000 tonnes of tallow per year is used to make biodiesel in Australia and volumes are increasing[5]. Important quality issues for the use of tallow in biodiesel are plastics, moisture, impurities and unsaponifiables.

- **Stock feed**

  Relatively small amounts of tallow are used in the stock feed industry as an energy supplement in feeds and as a dust suppressor. Tallow may be used in ruminant feeds provided that the total moisture and impurities content is less than 2%.

The major use of meat and bone meals and blood meal is in intensive animal production, particularly poultry and pig feeds where it is used as a protein, phosphorus and calcium supplement. There is also some use of meat and bone meals in aquaculture. Meat and bone meal may not be used in feeds for ruminant animals.

The other major use of meat meal is in dry pet-foods.

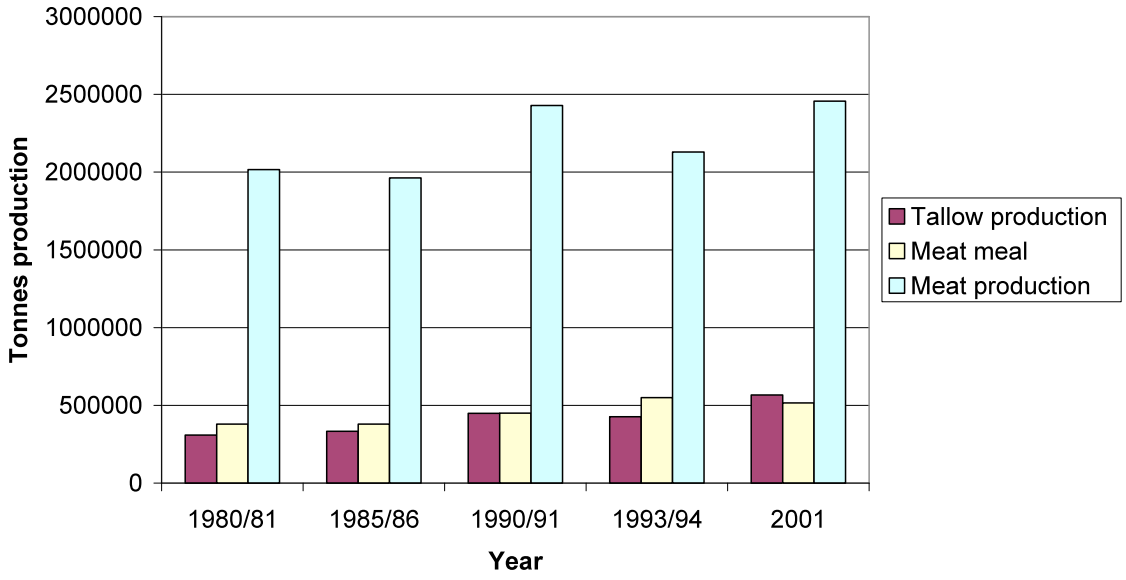
Small amounts of meat and bone meal are used as fertiliser.

3.4 Quantities

Production of rendered products is not closely tracked. Until 1994, production of tallow and meat meal was collated by the Australian Bureau of Statistics. ABS production figures from 1980 to 1994 are reported in two MLA projects[6, 7]. In 2001 the Australian Renderers Association conducted a survey of production of rendered products and published the findings in a Fact Sheet[8].

Figure 3.1 shows production of rendered products in selected years[6, 7, 8]. The total production of beef, veal and sheep carcase meat for the same periods is also shown. Obviously production volumes of tallow and meat meal are related to production of meat. The production of tallow as reported by the ARA from the 2001 survey is higher than expected compared with previous years but in 2001 the average carcase weight was 258 kg, up from 232 kg in 1991.

Figure 3.1: Production of meat and rendered products



3.4.1 Export

About 60 to 70% of tallow is exported and about 30 to 45% of meat and bone meal is exported. Total exports in 2001 when the production survey was conducted by the ARA are shown in Table 3.2.

The major export markets for tallow are China, Taiwan, and Pakistan.

Major export markets for meat and bone meal are Indonesia and China.

Table 3.2: Exports of meat meal and tallow in 2001

	Production	Export	Domestic use
Tallow	567,000	390,000	267,000
Meat meal	517,000	214,000	303,000

3.4.2 Yields

The volume of production of rendered products per head depends on the type of stock slaughtered, the extent of boning operations and the amount of co-products that are diverted to uses other than rendering.

Rendering processes can also have an effect on yields. For example increasing the moisture content of meat meal will increase the yield of meat meal. Reducing the fat content of meat meal will increase tallow yields but reduce meat meal yields. In wet-rendering systems yield may be reduced due to loss of product in stick water but in dry-rendering systems there should be no product losses.

MLA has not investigated rendering yields but has developed some tools that assist in estimating yields. From the point of view of abattoir renderers, yields are of interest in order to assign a value to the rendered products available per head. Yields per head are also used for benchmarking purposes.

Yields of rendered product from individual co-product are used to compare the rendered value of items with other uses. Abattoir renderers may have an interest in the potential yields from raw material collected from outside sources such as other abattoirs, boning rooms and butcher shops.

Rendering yields can be estimated from the expected yields from individual items and the available quantities of these items. Estimated yields of rendered product from different types of stock based on this approach are shown in Table 3.3. The yields in Table 3.3 are from the MLA co-product values spreadsheet tool. They are based mainly on a CSIRO Meat Research Laboratory report[9]. The yield estimates involve assumptions about the quantities of edible offal collected for edible use based on the findings of the MLA report on Best Practice for Offal Collection[10].

Resource: Co-products values spreadsheet tool available from MLA

Table 3.4 shows the estimated yield of meat meal and tallow from individual products.

Table 3.3: Estimated yields of rendered product from different types of stock

	Cow 180kg HSCW	Yearling 200kg HSCW	Steer 270kg HSCW	Grain fed steer 350kg HSCW
Meat meal from slaughter floor offal (kg)	13.8	12.5	16.7	18.1
Tallow from slaughter floor offal (kg)	16.9	19.1	26.6	38.8
Meat meal from boning room (kg)	21.7	24.8	31.1	37.7
Tallow from boning room (kg)	15.8	16.9	25.2	50.5
Total meat meal (kg)	35.5	37.3	47.8	55.8
Total tallow (kg)	32.7	36.0	51.8	89.3

Table 3.4 Yield of tallow and meat meal from individual items

Item	Meat meal yields (%)	Tallow Yield (%)
Meat 85 CL	22.1	12.5
Meat 50 CL	12.2	48.6
Boning room fat	9-15; typically 12	50-65; typically 58
Boning room bone	42-55; typically 45	16-24; typically 20
Head	50	8
Feet	44	5
Cheek (full cheek)	20	15
Heart	20	10
Kidney	25	3
Liver	22	5
Lung	22	1
Trachea and trim	17	14
Spleen	21	3
Tail	25	14
Thick skirt	22	6
Thin skirt	22	1
Caul Fat	2	89
AUSMEAT trim	6	70
Paunch	19	6
Bible & reed	15	17
Intestine	14	24
Tongue	20	15

Yields of rendered products from bulk raw materials such as slaughter floor material and boning room material are difficult to predict because the composition is highly variable. In particular added water and full paunches can reduce yields. However some guides to yields from miscellaneous bulk raw materials shown in Table 3.5

Resource: Rendering Yields Brochure in MLA Advisory Package "Rendering" 1997

Table 3.5 Yields of meat meal and tallow from miscellaneous raw materials

Material	Meat meal (%)	Tallow (%)
Slaughter floor material with 10% added water	18	28
Slaughter floor material 25% added water	16	25
Hide fleshings.	7.1-9.5	40-46

3.4.3 Blood

The yield of blood depends on the efficiency of collection and losses in blood stick water. Added water at the time of collection dilutes the blood and reduces the yield of dried blood as a percentage of raw blood. In addition, added water in the raw blood results in increased volume of stick water and increased losses of blood solids in stick water.

The yield of recoverable whole blood is about 2.4% to 2.9% of live weight[11]. For a 270 kg steer the yield of whole blood should be about 12 kg at about 20% solids content. The theoretical yield of dried blood at 6 % moisture content is about 2.6 kg. However losses of solids in the stick water will reduce the yield to about 2.5 kg per head.

If there is 20% added water in the blood, about 6% of the blood solids will be lost in the stick water resulting in a yield of about 2.4 kg per head. If there is 50% added water about 9% of blood solids will be lost in the stick water resulting in a yield of about 2.3 kg.

Resource: Blood recovery in MLA Advisory Package "Rendering" 1997

3.5 Values

MLA tracks prices monthly in the Co-products price monitor[1]. Prices reported in the Co-products monitor are derived from surveying renderers and traders. Rendered product prices from the monthly survey are maintained in a data base dating from 1992.

Figure 3.2 shows an example of prices of rendered products tracked by the monthly co-products monitor.

Figure 3.2 illustrates the variations in prices of rendered products. In addition the volume of production of rendered product is not accurately known. Thus it is difficult to estimate the total value of rendered products.

Assuming an annual production of about 516,000 tonnes of meat meal, 567,000 tonnes of tallow and 30,000 tonnes of blood meal as reported by the ARA in 2001[8] and the average prices of these products for 5 years from 2004 to end 2008[1], the total value of rendered products from cattle and sheep are:

- $257 million per year for meat meal
- $346 million per year for tallow
- $20 million per year for blood meal

The value of rendered products per head is also variable due to price fluctuations. From the estimated production per head shown in Table 3.2 and the five year average prices from 2004 to 2008, the potential value of rendered products per head is shown in Figure 3.3

Figure 3.2: Historical prices of tallow, meat meal and blood meal

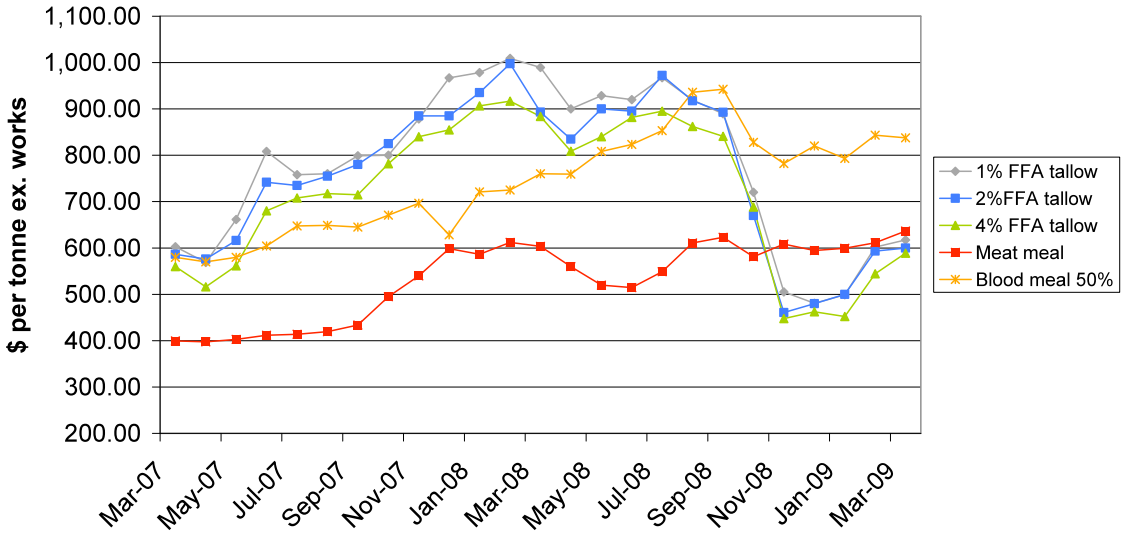


Figure 3.2 illustrates the high level of variation in prices of rendered products. In addition the volume of production of rendered product is not accurately known. Thus it is difficult to estimate the total value of rendered products.

Assuming an annual production of about 516,000 tonnes of meat meal, 567,000 tonnes of tallow and 30,000 tonnes of blood meal as reported by the ARA in 2001[8] and the average prices of these products for 5 years from 2004 to end 2008[1], the total value of rendered products from cattle and sheep are:

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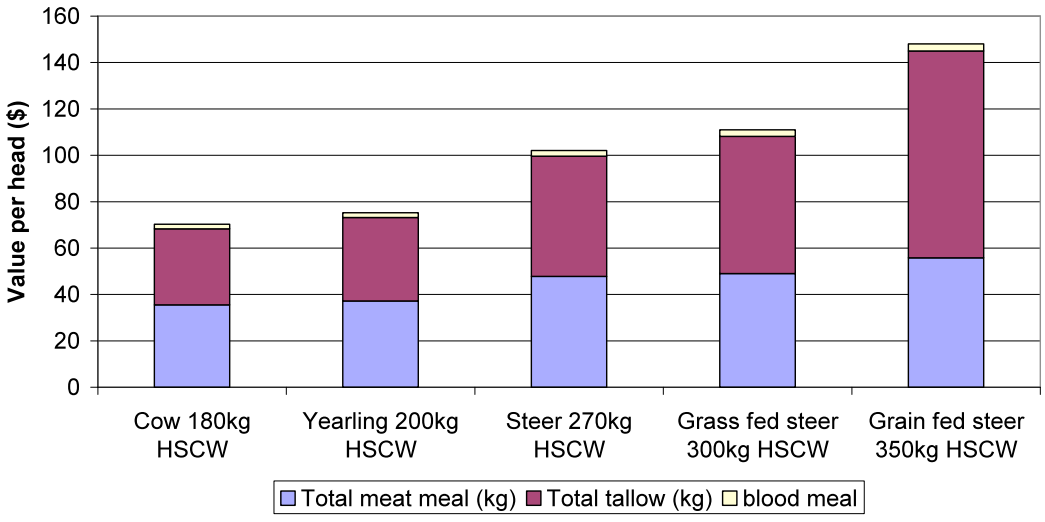
The value of rendered products per head is also variable due to price fluctuations. From the estimated production per head shown in Table 3.2 and the five year average prices from 2004 to 2008, the potential value of rendered products per head is shown in Figure 3.3

Figure 3.3: Sample values of rendered product from cattle



3.6 Opportunities to increase value

Rendered products compete with other commodities in international markets. For example meat meal competes with other protein meals and tallow competes with other fats and oils, particularly palm stearine. World production of vegetable protein meals and vegetable fats and oils is considerably greater than meat meal and tallow. Prices for vegetable proteins and oils generally dictate the price trends of meat meal and tallow. This is illustrated in Figure 3.4 which compares prices of soy meal with meat meal and Figure 3.5 which compares the price of palm stearine FOB Malaysia with tallow.

Figure 3.4: Comparison of prices of meat meal with the price of soy meal

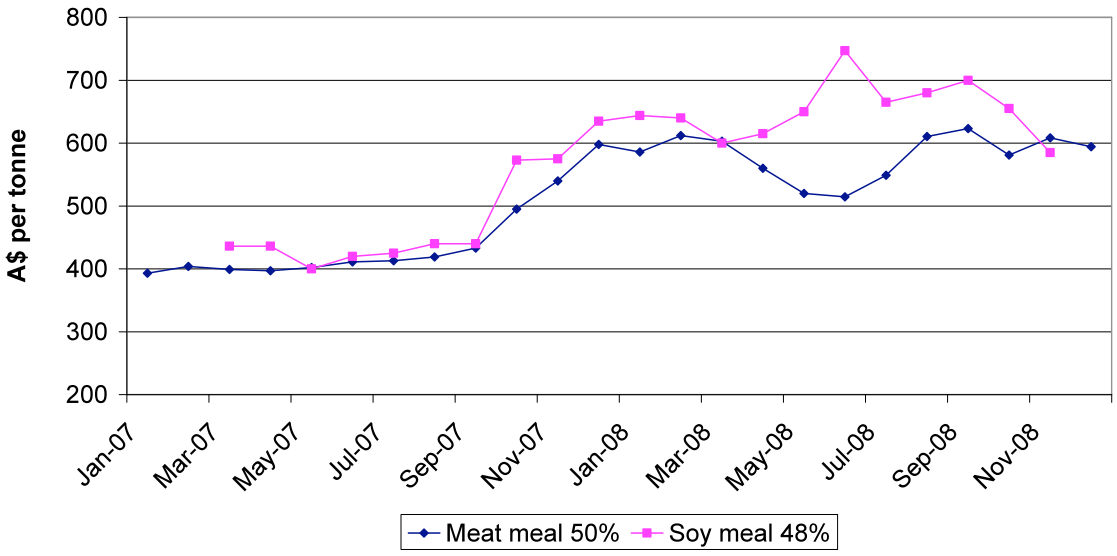
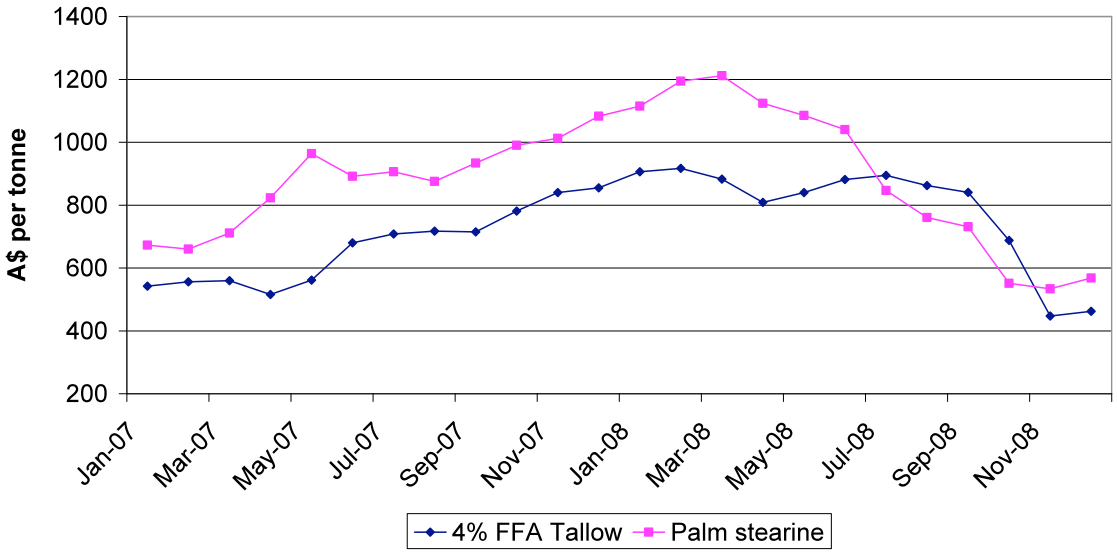


Figure 3.5: Comparison of price of tallow with the price of palm stearine



Since prices of rendered products tend to follow prices trends of other commodities, one option for improving values is to distinguish rendered products from other commodities. An example of this is the demand that has been created for the use of ovine meal in pet food. Ovine meal is in limited supply and it cannot be substituted in pet food applications. The price can be two or three times higher than conventional meat meals because it is regarded as having properties that cannot be replaced by other protein sources.

A second option for improving returns is for producers to differentiate their products from competitors' products. MLA has investigated this option and has identified meat meals that would be suitable for inclusion in aquaculture products. For a meat meal to be used in aquaculture products to the fullest extent its composition should be:

- >60% protein;
- <20% ash;
- <8% fat.

Meals that do not meet this specification could be used in aquaculture products at lower inclusion levels. If meals with the above specifications are produced they would receive a price premium in line with other high protein meals such as fish meal and poultry meal but would not receive any premium for unique or special properties associated with meat meal.

3.6.1 Quality

There are opportunities for improving returns from rendered products by controlling product specifications. For example, the average premium for 1% FFA tallow compared with 2% FFA in 2007 and 2008 was $25 per tonne; the average difference between 2% and 4% FFA tallow was $39 per tonne.

In the case of meat meal, price differences between grades are pro rata according to protein content. For example if 50% protein meat meal is $550 per tonne. The protein is valued at $1100 per tonne and a 48% protein meat meal is worth $528 per tonne.

Other quality characteristics such as tallow colour and ash content of meal may be associated with price premiums. Conversely quality defects such as moisture in tallow may attract penalties. Quality characteristics such as biogenic amines or Salmonella in meat meal and polyethylene in tallow may not be associated directly with price but may affect the range of customers a renderer can supply.

MLA has investigated quality issues such as biogenic amines in meat meal and Salmonella in meat meal. These projects are discussed below. While other quality issues have not been investigated, the following general comments apply:

3.6.1.1 Tallow

Free fatty acid

The main determinant of tallow quality and price is free fatty acid (FFA). Free fatty acid is a measure of the amount of breakdown of the main component of tallow, triglyceride. High levels of free fatty acid result in loss of yield when the tallow is processed to make soap or biodiesel and may incur higher processing costs.

Breakdown of triglyceride in tallow and increases in FFA can occur in raw material before rendering and after rendering in stored tallow. Free fatty acid levels are not usually affected by the rendering process.

In raw material, FFA develops in fat due to bacterial action. Any conditions that promote bacterial growth will accelerate increases in FFA in raw material. Conversely, conditions that inhibit microbial growth will slow the rate of FFA increases. The following points are important in controlling FFA increases:

- **Particle size;** the more finely the raw material is cut, the greater will be the surface area that can be colonised by bacterial. In particular, any pasty fatty material that might result from over-working of material in grinders, hoggers, gut cutters or transfer screws is subject to high rates of microbial growth and increases in FFA.
- **Contamination by gut content;** the gut content is a source of large numbers of bacteria and if it spreads through the raw material the resulting bacterial activity will result in increases in FFA.
- **Water;** there is usually enough water for microbial activity but excessive amounts of water will help spread microbes through the material.
- **Temperature;** the ideal temperature for the bacteria that are likely to breakdown fat in raw material is about 37ºC. Temperatures above 45ºC or below 25ºC will slow the rate of increase in FFA.

The above points explain why sheep material generally produces tallow with a higher FFA than beef material (smaller particle size of the raw material) and tallow from fat and bone has low FFA (large particle size, material is chilled and little or no contamination from gut contents).

To limit increases in FFA in raw material:

- avoid working material to create pasty material;
- leave size reduction as late possible and store material in whole pieces;
- cut and wash gut material to remove intestinal content but make sure that washing is efficient and does not leave the material smeared with gut contents;
- all raw material handling equipment should operate on a first in, first out basis to prevent delays in processing any part of the raw material.

Acid stabilisation

In some circumstances addition of acid to raw material can help prevent increases in FFA. Acid addition may be useful in cases where finely divided material is held for several hours and the FFA in tallow is more than 4%.

Application of about 27 litres of 10% solution of sulphuric or hydrochloric acid per tonne of raw material should reduce surfaces of the raw material to about pH4 and provide some stabilisation of the raw material[12].

Tallow refining and storage

After rendering, further increases in FFA occur if there is water in the tallow. Water causes hydrolysis (breakdown) of triglyceride to produce FFA, but the rate of hydrolysis is affected by bacterial action. The main points for control of increases in FFA in rendered tallow are:

- gut materials should be cleaned to remove paunch and intestinal contents which can destabilise tallow ;
- tallow polishers of separators should be regularly cleaned and maintained to clarify tallow effectively;
- tallow must be 90 to 95ºC when clarified by centrifugation;
- stored tallow should be drained regularly. The frequency of draining depends on how much residual water is in the tallow after centrifuging but could be a daily requirement;
- tallow tanks should be cleaned regularly;
- leaks in heating pipes in tallow tanks must be repaired.

Adjusting FFA

In theory, free fatty acid can be removed from tallow by addition of alkali such as sodium hydroxide. Alkali reacts with free fatty acid to form a soap which is not soluble in the fat and can be separated by settling or centrifugation. Removal of FFA from tallow by neutralisation with alkali results in loss of yield. In addition, the effluent from the process may be difficult to dispose of.

Colour

Tallow colour may be measured in the raw state or after bleaching. Raw colour is usually specified in the FAC colour scale. The FAC scale was devised by the Fats Analysis Committee of the American Oil Chemists' Society (AOCS). Other scales such as Lovibond are also used. Bleached colour is usually specified in red units of the AOCS/Tintometer scale. Bleached colour is important when tallow is to be used in applications where the processing includes bleaching to produce a white product such as soap making. Raw colour is important in applications where the tallow is not bleached such as in pet food. Figure 3.6 shows the bleached and unbleached versions of the same tallow.

Figure 3.6: Raw and unbleached versions of a tallow sample

Raw colour relates to the cleanliness of the raw material. For example, fat and bone should produce tallow with FAC colours of 1 to 7. Tallow from washed beef gut should have FAC colour of 11 A. A tallow colour of more than 21 indicates a high proportion of gut contents in the raw material.

The bleached colour of tallow usually relates to processing conditions. High temperatures during cooking produce fixed pigments that are more difficult to bleach out of the tallow.

Keeping the rendering temperature below 128ºC should ensure good tallow bleachability. Tallow from continuous wet-rendering systems should have good bleachability even when the raw colour of the tallow is high,

Moisture, impurities and unsaponifiables (MIU)

The MIU in tallow represents a loss of product yield to customers and could increase processing costs. Moisture and insoluble impurities can make the tallow unstable and result in increases in FFA during transport and storage.

If the M&I is greater than 2%, tallow is restricted animal material and must not be fed to ruminants.

Residual moisture and impurities in tallow is controlled by effective tallow refining and storage.

Unsaponifiables are naturally occurring fats in tallow that cannot be converted to soap or biodiesel. The main unsaponifiables are phospholipids and cholesterol. Lanolin, which may be present in tallow derived from sheep material, is also unsaponifiable.

Resource: Tallow and Tallow Washing and Storage brochures in MLA Advisory Package “Rendering” 1997

3.6.1.2 Meat meal

Crude protein

The main quality specification and determinant of value for meat meal is crude protein. The crude protein content of meat meal is determined by raw material composition. Raw materials with a high proportion of soft tissue and low proportion of bone will produce meat and bone meal with higher protein content. For example, meat meal from beef slaughter floor material has a protein content of about 55% while meat meal derived from slaughter floor material combined with boning room material typically has a protein content of 50% or less.

There is little scope for adjusting protein content other than changing the raw material mix. MLA has investigated removing bone from meat meal to increase protein and this is discussed below.

The components of meat meal are protein, ash, moisture, fat and fibre. By reducing the residual moisture and fat content of meat meal, the proportion of protein can be increased. For example, meat meal with protein of 50%, moisture 5% and fat 12% would be almost 53% protein if the moisture content were reduced to 3% and the fat reduced to 10%.

Pepsin digestible protein

The digestibility of protein in meat meal is measured by treating meat meal with the enzyme pepsin under specific conditions. Crude protein that is not digested by pepsin under the conditions of the test is the undigestible portion of the protein. The typical specification for meat meal is that at least 80% of the crude protein must be digestible. Although the digestibility test may not relate directly to what is digested by animals, it gives an indication of how much of the protein is nutritionally available in diets.

Some of the protein in raw material such as the keratin in horns, hooves, hair and wool is not digestible and will contribute to undigestible protein if it is not hydrolysed by pressure or alkali treatment. Other protein may become undigestible in the rendering process due to over cooking

Ash

The ash content of meat meal may affect pricing, particularly for meals sold for pet food. Low ash meat meal is more attractive for use in pet food and aquaculture diets. The ash in meat meal is mainly calcium and phosphorus derived from bone in the raw material. The percentage ash in meat meal is directly related to the proportion of bone in the raw material. Because of this, a high protein meat meal has low ash content.

Ash content can be adjusted by reducing the bone content of raw material or by separating the bony fraction of milled meal as discussed below.

Moisture

The typical specification for moisture in meat meal is 4 to 10%. If the meat meal is too dry it is very dusty and can cause handling problems. If it is too moist it can support mould growth. It is in the interest of renderers to produce meat meal at the high end of the moisture specification in order to maximise yield.

The moisture content of meat meal is controlled by the cooker end-point temperature or dryer temperature. Although higher moisture contents provide higher yield, high moisture content meat meal creates more steamy conditions in equipment and can make Salmonella control more difficult.

Fat

The residual fat in meat meal is a useful energy source but too much fat can make meat meal cake and become difficult to handle. The typical specification for fat is 8 to 13%. In general, the value of tallow is higher than the value of meat meal and it is better to extract as much fat as possible from rendered product to maximise tallow yield. Tallow extraction from rendered solids is affected by cooking temperature and press operation. Overcooked product is likely to have a high fat content.

Biogenic amines

The level of biogenic amines in meat meal does not necessarily have a direct influence on the value of the product but may make a meat meal more, or less attractive to certain customers. Some customers that use meat meal in pet food and poultry rations require biogenic amines to be less than 100 or 150 mg per kg for the total of the four main amines[12]. Biogenic amine levels are affected by the condition of the raw material. Fresh raw material (i.e. less than 6 hours old) usually produces meat meal with biogenic amines less than 100 mg per kg. MLA has investigated biogenic amine levels on meat meal and the subject is discussed below.

Salmonella

The price paid for meat meal is not necessarily affected by Salmonella but meat meal that is contaminated by Salmonella is excluded from certain export markets. Some domestic customers may avoid buying meat meal that is contaminated by Salmonella. MLA has investigated the incidence and causes of Salmonella in meat meal and the subject is discussed below.

Resource: Meat and bone meal brochure in MLA Advisory Package “Rendering” 1997

3.7 MLA work

The traditional uses of rendered products, particularly meat meal, have been threatened by the spread of BSE through the use of contaminated meat meal in ruminant feed. In some countries, meat meal cannot be used in animal feed. In response, MLA work on rendered products has focussed on:

- maintaining meat and bone meal’s position as a valuable animal feed;
- alternative uses for meat meal so that meat meal can be channelled to useful outlets if there are restrictions on the use of Australian meat meal in animal feeds;
- supporting and expanding the use of meat meal in feeds.

3.7.1 Salmonella in meat meal

Production of meat and bone meal and other animal protein meals that are free from Salmonella is a continual challenge for renderers. Both domestic and export customers expect that meat and bone meal should be free from Salmonella. Meat meal may be excluded from certain export markets if it is contaminated by Salmonella and may be unsalable to some domestic customers.

An MLA project looked at Salmonella in meat meal from three points of view[13]. In the first part of the project, the serotypes isolated from meat meal were compared with Salmonella serotypes isolated from poultry and humans. The purpose of this work was to assess any links between Salmonella in meat meal and human cases of Salmonella via feed and poultry.

In the second part of the project, environmental and product samples from four rendering plants were examined to determine potential sources of Salmonella contamination. As a result of these surveys, rendering plants were offered advice on how to reduce Salmonella contamination and after implementing the advice, the plants were re-sampled in the third stage of the project.

The investigation of Salmonella serotypes isolated from meat meal show that the main serotypes isolated from humans do not occur in meat meal. Meat meal in poultry feed is probably not a major source of Salmonella contamination of poultry and people. However there are serotypes that are common to meat meal, poultry and people and the possibility of Salmonella in meat meal being passed to poultry and people via feed cannot be ruled out.

Table 3.6 shows the top ten Salmonella serotypes in meat meal, poultry and humans in 2002, 2003 and 2004 according to data published by the National Enteric Pathogens Surveillance Scheme.

Table 3.6: Top 10 Salmonella serotypes in meat meal, chickens and humans for 2002 -2004

Serotypes in meat meal (n= 530)		Serotypes in chickens (n = 816)		Serotypes in humans (n = 10,779)	
Serotype	**% of all isolations**	**Serotype**	**% of all isolations**	**Serotype**	**% of all isolations**
S. Anatum	18.1	S. Typhimurium	27.5	S. Typhimurium	55.4
S. Orion	11.1	S. Infantis	26.8	S. Saintpaul	7.8
S. Infantis	5.9	S. Virchow	9.9	S. Virchow	6.9
S. Agona	5.4	S. Kiambu	4.6	S. Birkenhead	5.5
S. Tennessee	5.3	S. Mbandaka	4.6	S. Chester	4.3
S. Senftenberg	5.1	S. Singapore	4.4	S. Infantis	2.8
S. Ohio	4.1	S. Agona	3.2	S. Aberdeen	2.7
S. Cerro	4.0	S. subsp1 ser 16:1, v:-	3.0	S. Hvittingfoss	2.6
S. Singapore	3.8	S. Zanzibar	2.0	S. Mississippi	1.8
S. Mbandaka	3.5	S. Ohio	1.8	S. Muenchen	1.5

In the second part of the project, 163 sponge samples from equipment surfaces, 69 scrapings from equipment and 48 samples of products collected from four plants were tested for *Salmonella* and *Enterobacteriaceae*.

Salmonella was detected in sponge swabs and scrapings at the four plants but there were no points of concentration of contamination and it was not possible to identify primary sources of contamination. In plants where *Salmonella* was not detected in products, there was a low incidence of *Salmonella* in equipment samples. In plants where *Salmonella* was detected in product there was a high incidence of *Salmonella* in equipment samples indicating that by the time *Salmonella* is detected in product there is probably widespread contamination throughout meal handling equipment.

Some observations were:

- Sponge and scraping contamination rates of equipment pre- and post-press or dryer are similar;
- The first product produced for the day may be more heavily contaminated;
- *Salmonella* contamination occurs along the process chain with possibly less towards the end of the chain.

It was considered unlikely that *Salmonella* contamination that occurred pre-press would carry over to product post-press and that action to control *Salmonella* contamination should concentrate on post-press equipment.

As a result of this work, MLA has published a *Salmonella* Problem Solving Guide. The Guide provides a systematic approach to reducing *Salmonella* contamination

Resource: *Salmonella* Problem solving guide. MLA 2007

3.7.2 Biogenic amines

Biogenic amines are a product of the degradation of protein, for example by bacterial activity. It has been noticed that when meat meal with high levels of biogenic amines are used in poultry feed, the growth rate of the birds can be affected. There are indications that the biogenic amines cause irritation and possibly inflammation of the crop.

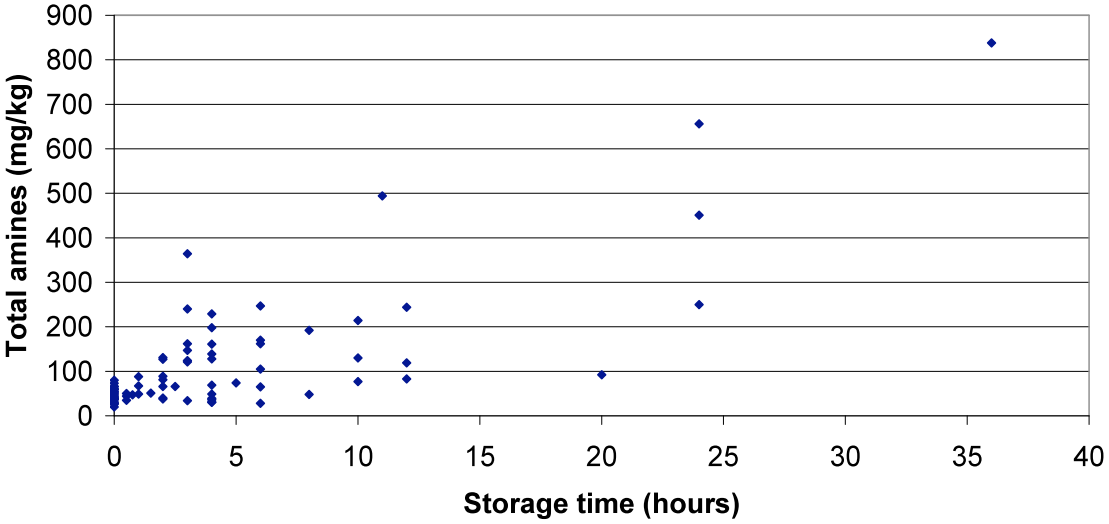
High levels of biogenic amines in meat meal have threatened the continued use of meat meal in poultry rations with some poultry producers being particularly concerned. MLA has conducted a project to determine the typical levels of biogenic amines in meat meal and to identify ways of reducing the level of biogenic amine[13].

The total amines (the sum of putrescine, cadaverine and histamine) in 81 samples ranged from 20 to 838 mg per kg. About 65% of samples had total amines

less than 100 mg/kg; about 20% of samples were in the range 100 to 200 mg/kg and 15% of samples were greater than 200 mg/kg.

Several factors that could affect amine levels were considered but the time of storage of raw material before rendering is probably a major factor. Figure 3.7 shows the relationship between estimated storage time of raw material and biogenic amines levels in meat meal. This figure indicates that to produce meat meal with biogenic amines levels less than 100 mg/kg, renderers should aim to process raw material within 3.5 hours of collection.

Figure 3.7: Relationship between storage time of new material and biogenic amines in meat meal



3.7.3 Validation of heat treatments

Some importing countries specify heat treatments that must be applied to rendered products. Australia uses a wide range of rendering equipment and processing equipment and it is difficult to apply a standard set of heat treatment conditions. Instead, the Australian Standard for Hygienic Rendering of Animal Products allows flexibility in the equipment and conditions used to render raw materials provided that the conditions are validated.

An MLA study has examined the requirements for validating rendering conditions as specified in the Australian Standard for Hygienic Rendering of Animal Products[16]. The objectives of this study were:

- to evaluate the biological hazards associated with raw material for rendering in Australia;
- assess whether rendering processes validated according to the requirements of the Australian Standard for Rendering adequately control the hazards.

Potential hazards in rendered products were identified as Salmonella, Newcastle disease virus, Bacillus anthracis, Clostridium botulinum and Clostridium perfringens. Transmissible spongiform encephalopathies such as BSE are also a hazard but are a negligible risk in Australia.

Experiments have demonstrated that Salmonella and viruses such a ND are eliminated in relatively mild rendering conditions. Spore-forming bacteria such as Clostridium spp. and Bacillus spp. may not be eliminated by rendering heat treatments.

Since Clostridium perfringens is expected to occur in raw material at levels of 300 to 600,000 per gram, testing cooked product gives an indication of the heat treatment's ability to kill this type of organism. The Australian Standard's requirement to validate heat treatments based on elimination of naturally occurring bacteria in raw material is an appropriate method of demonstrating the effectiveness of heat treatments. The requirements of the Standard should be more specific e.g. they should nominate the test method to be used and the required result.

Since this project was completed, the Australian Standard for Hygienic Rendering of Animal Products has been amended and prescribes the use of AS 5013.16 to test for Clostridium perfringens, as recommended in the report. The Standard has not adopted the recommendation to test the whole aliquot of a 1 gram in 10 dilution so that results can be reported as "absent in 1 gram". The Standard allows a reporting level of <10 per gram.

Validation of rendering heat treatments does not replace specific requirements for heat treatments prescribed by some importing countries, particularly the EU. However, AQIS has negotiated access to other countries based on compliance with the Australian Standard for Rendering.

3.7.4 Disposal of Specified Risk Material

In order to retain markets for meat meal in feeds and even to retain markets for beef, it has been suggested that it may be necessary, to exclude BSE-risk materials from the animal feed chain. This could mean separating risk material from other raw material for rendering so that meat meals free from BSE-risk material can be produced for the feed industry.

MLA conducted a project to assess the financial impact of the removal of BSE-risk material from animal feed and to consider options for handling the risk materials[15].

The amount of BSE-risk material and therefore the cost handling and treating the material depends on how the risk material is defined. The project used the EU definition of specific risk material (SRM). This definition includes heads and small intestines from all cattle over 12 months of age and it is assumed that all Australian cattle except bobby calves would produce SRM. Using this definition, the total amount of SRM would be 448,000 tonnes per year.

The cost of removing SRM from other raw material for rendering and treating it separately was estimated to be $136 million per year or about $19 per head of slaughtered cattle.

The capital cost for establishing equipment to treat the SRM was estimated to be $130 million.

The options for disposing of the SRM have been considered. Incineration is the main method of disposal in the EU. Incineration is not an option in Australia because there is insufficient capacity and to create capacity would have a severe environmental impact. A range of other disposal methods designed to inactivate BSE infectivity has been evaluated. However alternative disposal technologies were not fully developed and the most appropriate method of disposal was considered to be hypobaric rendering (i.e. pressure cooking) to recover tallow followed by disposal of solids by land fill. The estimates of the capital costs to set up equipment to dispose of SRM are based on this method of disposal.

3.7.5 Expanding the traditional markets for rendered product

One of the most promising options for expanding the use of rendered products in animal feed is increased use of meat meal in aquaculture feed. Initial work on the use of meat meal in aquaculture feeds identified that for maximum inclusion of meat meal in aquaculture diets, the meat meal should have high protein (>60%) and low ash (<20%). To produce meat meal with this specification requires either segregation of raw materials or separation of bone from finished meat meal. Consequently MLA investigated methods of producing low ash meat meal by fractionation of finished meal.

If low ash meals are produced for aquaculture there would be corresponding production of high ash meals. Further investigations by MLA have looked at options for utilising high ash meals.

3.7.6 Aquaculture

MLA projects have assessed a range of different types of meat meal in aquaculture diets for different types of fish and crustacean species. Table 3.7 summarises the meat meals examined and the target species.

Table 3.7: Summary of projects on the use of meat meal in aquaculture feeds

Meat meals tested			**Target species**	**Inclusion rate**	**Project**
Protein	**Ash**	**Fat**			
83.5%	9.4%	17.1%	**Tiger prawns – *Penaeus monodon***	**25% and 50% replacement of fishmeal protein**	**CS.233**
46.7%	38.6%	7.4%			
51%	36.9%	6.3%			
53% DM	35% DM	7.4% DM	**Silver Perch – *Bidyanus bidyanus***	**15% and 30% of diet**	**M.561**
80% DM	3% DM	11.6% DM			
49% DM	36% DM	9.2% DM			
60% DM	12.1% DM	17.2% DM			
>65%	<10%		Rainbow trout Tiger prawns – *Penaeus monodon*	30% and 50% of feed	M.744
80% DM	3% DM	11.6% DM	**Silver Perch – *Bidyanus bidyanus***	**15, 22, 27, 37% of diet**	**M. 783**
55% DM	35% DM	7.4% DM			
52%			**Barramundi – *Lates calcarifer***	**55% of dietary crude protein**	**M.783**
60%	12.1%	17.2%			
“High quality meat meal”			Silver Perch – *Bidyanus bidyanus*	29% and 30% of the diet	PRCOP.009
59%	21.2%	10.9%	Tiger prawns – *Penaeus monodon*	15% and 30% of diet	PRCOP.011

The findings of the MLA projects listed in Table 3 are summarised below:

CS.233 Preliminary evaluation of meat meal in aquaculture diets for prawns[18]

This project was a small scale evaluation of prawn feeds made with meat meal. The trials were carried out in 100 litre tanks. The digestibility of meat meal in the diets was less than the replaced fish meal but the growth rate of prawns fed with diets containing meat meal were not different to growth rates of prawns fed with the fish meal based diet. The low-ash meat meal was more digestible than the higher ash meal and was rated as a ‘good’ ingredient. The other meals were rated as ‘useful’ ingredients.

In view of the growth rates of prawns in this study, it was concluded that meat meal could replace 50% of the fish meal in diets for juvenile prawns. Meat meals were included in diets at up to 29% of the whole diet. However, the low digestibility of the meat meals would result in significantly more faecal waste and this could have an adverse effect on water quality.

M.561 Preliminary evaluation of meat meal in aquaculture diets of silver perch[19]

This project was also conducted on a small scale in 160 litre tanks with 7 juvenile silver perch in each tank. Diets containing 15 or 30% meat meal were readily accepted by the fish. Digestibility coefficients for amino acids, dry matter, protein and fat in the diets were determined. The dry matter digestibilities of the two high protein meat meals were better then the digestibilities of the low protein meals and were equivalent to low quality Peruvian fishmeal. Digestibilities of energy and protein in meat meals were lower then for fishmeal but similar to oilseeds and grain legumes.

The cost of digestible protein in meat meal was $1 to $1.3 per kg and compared favourably with $1.2 to $2 per kg in imported fishmeal.

Some problems with meat meal were excessive wool and hair, high fat content and inconsistent quality.

M.744 Processing of meat meal for utilisation in aquaculture diets[20]

This project used a high protein, low ash meat meal in diets for trout and prawns.

In the case of trout, meat meal could be used to replace 30% of the protein content of the feed (50% of the total feed) without affecting feed conversion rate, growth factors, environmental parameters or eating quality of the fish. In the case of prawns, feeds containing 30% meat meal performed similarly to standard fishmeal based diets but at 50% inclusion of meat meal there were performance penalties.

The high-protein, low-ash meat meal can be successfully used in trout feed at 50% of the diet and in prawn feed at 50% of the diet. For meat meal to be used in place of fishmeal, meat meal has to be priced at a discount compared with fish meal.

M.783 Potential of meat meal to replace fishmeal in commercial diets for silver perch[21]

In trials conducted at commercial stocking rates, two meat meals were used in combination to progressively replace fishmeal. One of the meat meals was a speciality meal containing 80% protein. This meal appeared to inhibit the performance of feeds when included at more than 9% of the diet. In trials using the other meal alone (a 55% protein ovine meal), feeds containing 37% of the meat meal and 5% of fishmeal performed better than a feed containing 27% fishmeal.

M.783 Potential of meat meal to replace fishmeal in commercial diets for barramundi[22]

In these trials, a high protein (60%) meat meal and conventional meat meal (52% protein) were used to replace fish meal in feeds for barramundi. Experiments with feed made with different proportions of meat meal and fish meal were carried out. Diets in which the meat meals contributed 55% of the crude protein content performed well and achieved growth rates equivalent to fishmeal based diets.

The conventional meat meal was more economical to use and was further investigated in diets which contained 50% meat meal and no fishmeal. The growth rate of fish fed these diets was equal or better than for fish fed fishmeal based diets. The eating quality of the fish fed meat meal based diets was good and it was concluded that fishmeal in the diet is not necessary to produce fish with good eating quality provided that fish oil is added to the diet.

In these experiments, the low-ash meat meal did not perform better than the conventional meal although there are potential environmental benefits of using the low ash meal. The conventional meat meal reduced the cost of diets in terms of food cost per kg fish gain by 18 to 23% compared with fishmeal based diets.

PRCOP.009 Consumer sensory evaluation of silver perch cultured in ponds on meat meal based diets[23]

This project focussed on the eating quality of silver perch fed diets containing meat meal. A diet containing 29% meat meal and 10% poultry meal produced fish with the best all round sensory characteristics. This diet had an ingredient cost $0.74 to produce 1 kg of fish compared with a cost of $1.76 for a commercial soybean-based diet.

PRCOP.011 In-pond evaluation of high meat meal diets for the black tiger prawn[24]

In this project, prawns were grown in conditions that resemble a commercial prawn pond. A premium quality meat meal was used to make feeds containing 15 or 30% meat meal and these feeds were compared with a commercial feed and an experimental diet containing 30% fish meal and no meat meal.

The growth rate of prawns fed the four diets was not significantly different. Feed conversion rates and prawn survival rates were similar for all diets. The high meat meal diets did not create greater amounts of sludge under cages.

This work showed that large scale production trials using a premium meat meal at up to 30% of the diet can be undertaken with little risk to production or pond environments.

3.7.7 Using meat meal in aquaculture feeds

Projects to investigate the performance of meat meal in aquaculture feeds have shown that a range of different meat meals can be used successfully in feeds for trout, silver perch, barramundi and tiger prawns.

Some of the main points are:

- Meat meals in aquaculture feeds are well digested by silver perch, barramundi and tiger prawns;

- The digestibility of low-ash meat meal is similar to that of fish meal;
- Meat meal could replace two-thirds of the fish meal in silver perch and prawn feeds and all the fish meal in barramundi feeds;
- High dietary inclusion of meat meal (>30%) does not detract from the taste of silver perch, prawns, or barramundi;
- Replacement of fish meal with meal meat in feeds would result in 10% reduction in ingredient costs for prawn feeds and at least 25% reduction in the ingredient cost of silver perch and barramundi feed;
- There is no advantage in using low-ash meat meal in terms of production costs but there are potential environmental concerns. The increased use of meat meal in aquaculture feeds can only be advocated if low ash products are available;
- The protein in meat meal must be competitively priced with high quality vegetable protein meals;
- To achieve maximum inclusion rates in aquaculture feeds, meat meals should be >60% protein, <20% ash and <7% fat;
- To be price competitive, meals with less than 55% protein need to be no more expensive per unit of digestible protein than high quality vegetable protein meals such as soy meal;
- Meals containing more than 60% protein could attract a price premium from 15 to 20% per unit of digestible protein basis, but only if the fat content is low (less than 10%).

PRCOP.008 Survey of the nutrient content of meat meals and meat co-products with respect to their use as ingredients in aquaculture feeds[25]

MLA work on the use of meat meal in aquaculture feeds identified that high-protein low-ash meals are more suitable than high ash meals, particularly in prawn feeds. There is an arbitrary limit of 15% ash in prawn feeds. Feeds with higher ash content are considered to have excessive undigestible material leading to increased faecal waste and the potential for environmental problems in ponds. In view of the limit on ash in the total feed, meat meals with high ash content can be used only at low inclusion rates.

Similarly, prawn feeds have an upper limit for fat content of about 10%. Some of the fat must be highly unsaturated marine oil and if there is too much saturated fat contributed from meat meal, there is no room left for addition of unsaturated fats within the limit for total fat.

To keep the ash content of feed below 15%, 30% of a 25% ash meat meal could be included but there is only room for 15% of a 35% ash meat meal in the feed. To maintain the fatty acid balance, 30% of an 8% fat meat meal could be used in a feed but only 20% of a 14% fat meat meal could be included in the diet.

In view of the preferred requirements for meat meals used in aquaculture feed, MLA conducted a survey of the composition of Australian meat meals. Twenty-seven samples of meat meal were tested for dry matter, ash, gross energy, crude protein, total lipid, cholesterol, phospholipids and fatty acids. Crude protein ranged from 47 to 76% of dry matter and ash was from 11 to 37% of dry matter.

No meat meals matched the ideal specification but some of the meals could still be used in prawn feeds at inclusion levels less than 30%. The meat meals also contained a small amount of cholesterol (up to 0.4%) which is an advantage compared with vegetable protein meals.

Resource: K.C Williams, G.L. Allan, D.M. Smith and C.G. Barlow “Fishmeal replacements in aquaculture diets using rendered protein meals”, MLA 1997. Reprinted from proceedings of the Fourth International Symposium, Australian Renderers Association 1997

3.7.8 Markets for meat meal in aquaculture feed

There is a potential market for the use of meat meal in prawn, silver perch and barramundi feeds in Australia. One report estimates the domestic market for meat meal in aquaculture feeds to be 2,500 tonnes provided that the meat meal is a suitable specification[20]. If meat meal were included in aquaculture feeds at 20%, the Asian aquafeed market alone would absorb 500,000 tonnes of meat meal.

MLA has investigated the markets for meat meal in aquaculture in several countries in the Asia region.

COPR.013 The prospects for marketing meat meal for inclusion in Indonesian aquaculture diets[26]

An MLA study group visited Indonesia to review the aquaculture industry. About 120,000 tonnes of prawns are produced using about 240,000 tonnes of feed. The total production of aquaculture feeds is estimated to be about 400,000 to 500,000 tonnes per year. At the time of the study, a small amount of meat meal had been used in fish feeds but not in prawn feeds.

If meat meal were included in prawn feed at 20%, there would be a demand for 48,000 tonnes of meat meal. It was estimated that 80,000 tonnes of meat meal could be used in the whole aquaculture industry.

Ideally meat meal aimed at the prawn industry should be at least 55% protein, less than 4% phosphorus and less than 10% ash. BSE-free status and the price of protein in meat meal should be used as selling points. The cholesterol content of meat meal could also be a useful selling point. Meat meals for use in aquaculture must be treated with anti-oxidant.

PRCO.015b Opportunities for use of meat meal in aquaculture rations – Taiwan[27]

The Taiwanese aquaculture industry produces prawns, eels, milk fish and tilapia. In 1996, 421,000 tonnes of fish feed and 36,000 tonnes of prawn feed was produced. No meat meal is used in prawn diets. Fish feeds may contain up to 5% meat meal. The nutrient requirements of prawns and fish are not well understood and there is a reluctance to change successful feed formulations. In addition, meat meals imported from the USA and Canada have been poor quality and inconsistent. In view of this experience coupled with concerns about BSE, there is suspicion of meat meal.

Research has shown that meat meal could replace up to 30% of fishmeal in prawn feeds. The meat meal should be good quality i.e. >55% protein; <10% fat and <22% ash with antioxidant added and should be consistent. These requirements will add to costs of production of the meat meal. The amount of meat meal likely to be used in rations will depend on cost and figures are presented to show potential inclusion of meat meal in different feeds for a range of meat meal costs relative to a range of soy meal costs.

Standard quality meat meal at US$225 per tonne and higher quality meat meal at US$265 per tone could constitute 25 to 50% of fish feed. Premium meat meal at $US490 per tonne could constitute 4% of prawn diets.

PRCO.015c Opportunities for use of meat meal in aquaculture rations – Thailand[28]

The Thai aquaculture industry produced 244,000 tonnes of prawns and 228,000 tonnes of fish in 1996. About 470,000 tonnes of prawn feed and 200,000 tonnes of fish feed are produced per year. No meat meal is used in prawn feed. Fish feeds may contain up to 5% meat meal. The market for prawn feed is dominated by CP Feedmill Public Co Ltd. There have been variable experiences with meat meal in aquafeeds. There are also concerns about BSE.

It is not likely that much meat meal would be used in prawn diets. A minimum 35% of the protein in the diet must come from fish meal. The remainder of the protein could come from meat meal or soy meal. Premium meat meal priced at A$700 per tonne FOB could be used in prawn diets at an inclusion of about 4%. Tilapia rations are not constrained to use fish meat and can use lower quality meat meal. Inclusion rates of meat meal in tilapia diets could be 30-40% for a meat meal cost of A$300 per tonne for standard meat meal.

3.7.9 Modification of meat meal specifications

MLA work on the use of meat in aquaculture feeds has highlighted that for maximum inclusion in feeds, meat meal should be high protein, low ash and low fat. To produce high protein, low ash meal, the options are to use predominately soft offal (i.e. reduced bone) in the raw material, or fractionate the finished meal by partially removing the ash fraction of the meal.

High protein, low ash meals used in some of the MLA experiments on the use of meat meal in aquaculture feeds were produced from predominantly soft offal. For example, two meals produced from soft offal had proximate analysis of:

- 83.5% protein; 9.4% ash; 17.1% fat
- 60% protein; 12% ash; 17.2% fat

A rendering plant may have access to predominantly soft offal material or may be able to segregate soft and bony materials and process the segregated materials separately.

MLA has developed a spreadsheet tool that estimates the protein and ash content of meat meals made from segregated raw materials. Table 3.8 gives examples of the estimated protein and ash contents of meat meals made from different raw materials.

Table 3.8: Estimated composition and yield of meat meal from selected raw material from 100 head of 270 kg steers

Raw material	Protein %	Ash%	Fat%*	Yield of high protein meal (kg)	Yield from residual material (kg)	Protein in residual meal %
Slaughter floor soft offal (excludes head and feet)	72.5	5.5	15	940	4,046	45.3
All slaughter floor material	56.4	23.6	13	2,000	2,980	46.6
Slaughter floor plus boning room soft material	59.1	20.3	14	2,349	2,625	43.0
All available material	50.0	31.9	10	5,036		

**Fat content is an assumed value. Meals are also assumed to contain 5% moisture and 2% crude fibre.*

The spreadsheet tool is shown in Figure 3. It can be used to estimate the yield, and protein and ash content of meat meal from different raw material mixtures from a mix of different cattle.

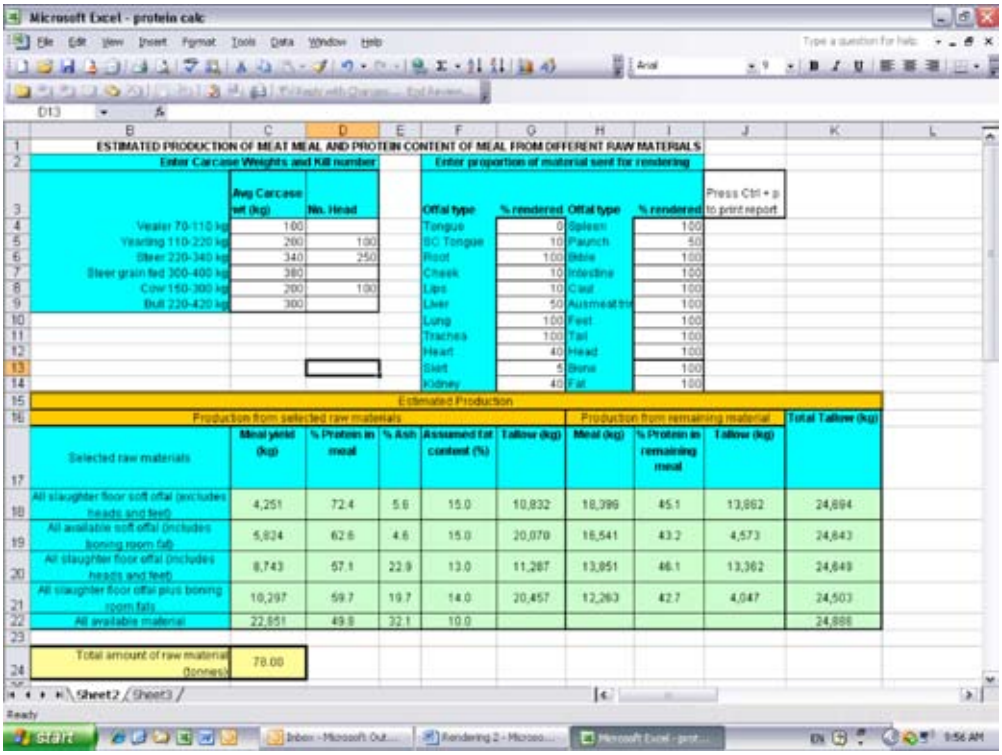


Figure 3: Example of spreadsheet tool for estimating the protein content of meals from segregated raw materials.

Resource: Protein calculation spreadsheet tool available from MLA and web site http://www.meatupdate.csiro.au/

High-protein, low-ash meals can be produced by separating bone particles from finished meals. MLA has investigated separation of meat meal into high and low ash fractions and there are also commercial techniques in use in the Australian rendering industry.

In an MLA study to characterise the fractions from separated meat meals, the techniques of air tabling and air classification were used to fractionate meat meal and press cake[29]. In air classification, particles separate in an upward flow of air. Separations of 16:83 to 63:36 of coarse material to fine material were achieved. However there was little difference in the ash and protein contents of the coarse and fine fractions and the original meat meal.

The air table separated meal into three fractions. About 15% of meat meal was separated as bone containing 58% ash and 29% protein.

With all methods of separation, fat was concentrated in the finer (low ash) particles. Fat also caused problems by blinding screens, coating the inside of the air classifier and causing balling of the fine fractions on the air table.

Air tabling equipment is used commercially to separate bone chips for gelatin production from other particles. The technique is used with un-milled dried solids from continuous wet-rendering plants. The particles that are processed through the air table are about 17mm as determined by the mincer plate used to grind raw materials. Clearly air tabling equipment is effective in removing bone chips from wet-rendered dried-solids before milling. It can be assumed that the milled low-bone fraction will produce a high-protein low-ash meat.

A type of commercial air classification is used to separate milled meals into high-ash and low-ash fractions. Table 3.9 gives an example of the separation that can be achieved using a Gayco centrifugal separator[28].

Resource: Techniques for the separation of meat meal into its components brochure in MLA Advisory Package "Novel co-products from the meat industry"

3.7.10 Use of high-ash meals

If low-ash high-protein meat meals are produced for specialised uses such as pet food or aquaculture feed ingredients, the corollary is that high-ash meal will be produced. Some high-ash meal can be used in the traditional use of feeds for poultry and pig production but prices would be discounted commensurate with the protein content of the meals. If the volume of high-ash meals increases due to production of low-ash meals, alternative uses of the high-ash meals should help maintain values.

MLA has investigated possible alternative uses of high ash meals[29]. The ash component of meat meal is similar if not equivalent to a bone meal. Some of the historical uses of bones, have been:

- extraction of gelatine and concomitant production of phosphate by-products used in dental fillings;
- production of bone char mainly used for bleaching sugar. This use has been phased out. Bone char has also been used to make ink pigments and for carburising of steel;
- production of bone china.

These uses are more suited to cleaned degreased bones rendered separately from other raw materials. However, bone chips separated from wet rendered mixed material have been successfully used as a raw material for gelatin production. In addition these uses have been largely replaced by other technologies and demand for bone in these uses is small.

High-ash fractions of separated meals, for example high-ash fractions from centrifugal separation, are suitable for use as fertiliser and feed supplements. High-ash fractions are similar to traditional blood and bone fertiliser. When ash fractions are used as fertiliser the phosphorus and nitrogen are readily

Table 3.9: Example of separation achieved using a Gayco Centrifugal Separator

Product	Yield (%)	Protein (%)	Fat (%)	Ash (%)
Untreated meal		55	10	29
Low ash fraction	40	67	14	12
High ash fraction	60	50	9	35

available and it may be possible to control the release of these elements by adjusting the bone particle size. A 15% share of the fertiliser market could result in sales of about 15,000 tonnes[29].

Four samples of high ash meat meal were produced either by rendering bony material or by separating standard meat meals into low and high-ash fractions. The samples ranged from 37 to 60% ash. The 60% ash sample was produced by rendering bony raw materials and was used in fertiliser trials. In these trials, the nutrients in the bone meal were readily released into the soil to support the growth of five different vegetable crops.

Fertiliser is the application with greatest potential for large scale use of high-ash meat meals. However, meat meal is not a balanced fertiliser. It is deficient in potassium and magnesium and contains no humus.

In a theoretical study of the value of a fortified high-ash meat and bone meal it was estimated that if a 50% protein meat meal is fractionated into 65% high-protein (57.5% protein) fraction and 35% of a 36% protein fraction, the total return can be increased from $450 per tonne to $475 per tonne. The estimate assumed no increase in the value of protein in the high-protein fraction and a high-ash fraction value of $400 per tonne. If the protein in the high-protein fraction were valued at 75% of protein in fish meal, the total value of the high and low-protein fractions is $664.[30]

If a high-ash fraction of meat meal is fortified with benonite (a magnesium source), potassium, compost, gypsum and trace elements, the ingredient cost of a fortified meat meal-based fertiliser would be $279 per tonne if the meat meal is valued at $324 per tonne. If this product is sold at $400 per tonne, the margin is $44 greater than selling the low-protein meat meal at $400 per tonne.

Another approach to the use of high-ash meat and bone meal as fertiliser is to target the organic agriculture industry. An MLA project assessed the use of high-ash meat meal in organic farming[31]. It included a survey of organic producers to determine the use of fertilisers in different size organic farming operations.

There are no apparent barriers to the use of high-ash meat meal as an organic fertiliser. There are relatively few products available to organic farmers that supply the high nitrogen content of meat and bone meal. High-ash meat meal would be a useful fertiliser in organic farming but the potential market size is not clear. However, there are up to 200 organic farmers who might have a significant demand for fertiliser. Survey results indicate that growers mostly use less than 5 tonnes of fertiliser a year. The market for meat and bone meal is not likely to be much more than 1000 tonnes per year.

It is recommended that renderers market a blended complete fertiliser to organic farmers rather than sell high ash-meat meal.

Resource: Meat meals as organic fertilisers brochure in MLA Advisory Package “Novel co-products from the meat industry”

3.7.11 Customer requirements for meat meal

The use of meat meal, mostly in intensive animal production and pet food has been examined from the customer’s point of view.

In one project, end-users of meat and bone meal (MBM) were interviewed to find out what customers thought were the main quality issues for MBM[32]. Customers who use MBM in stock feed, pet food, fertilisers and export traders were interviewed.

For stock feed, the benefits of meat and bone meal are the presence of essential amino acids, additional energy from the fat content and highly available phosphorus. Some quality issues were:

- freshness of raw material and resulting levels of biogenic amines in meat meal;
- washing of raw material and its affect on crude fibre and the colour of meat meal;
- over-cooking resulting in the loss of digestibility and amino acid availability;
- effective milling and screening and its affect on particle size and the presence of wool and hair in meat meal;
- product consistency particularly in relation to variations in crude protein, amino content and amino acid availability.

Quality issues for the pet food industry were:

- palatability as affected by raw material quality, and oxidation (rancidity) of finished meat meal;
- digestibility of the meat meal including ash content and the effect of ash on digestibility;
- contaminants including metal, plastics, wool and hair.

A relatively small amount of meat and bone meal is used in fertiliser. The end users expect meat and bone meal to have low moisture content to ensure that the meal is microbiologically stable.

The report recommends processing conditions to meet the quality requirements of the different types of end-user. The recommended processing conditions are not unusual and generally relate to consistent application of known techniques such as:

- excluding physical contaminants from raw material;
- cleaning gut material;
- rendering fresh material;
- avoiding high temperatures (above 125ºC);
- efficient milling and screening of meals.

A more detailed study examined the attributes of Australian meat and bone meal and matched them to requirements for different uses[33].

Australian meat and bone meal was evaluated against a range of 20 supply and quality issues. From this, benefits and disadvantages of using MBM were compiled and discussed. Benefits include an excellent source of protein and phosphorus and unique features include freedom from BSE and availability and proximity of supply. Disadvantages are mainly quality issues.

Some of the recommendations from this evaluation were:

- identify and use rendering practices that improve amino acid digestibility;
- develop rapid assays to determine amino acid digestibility;
- consider production of high-protein meat meal to supply aquaculture and poultry industries in Asia;
- expend independent testing of meat meal to better define quality and reduce product variability;
- use anti-oxidants in exported product.

The value of meat meal can be improved by increasing domestic usage by getting nutritionists to increase the nutrient specification used in feed formulations so that meat meal is valued more highly relative to other protein sources and by increasing the digestibility and protein content of meat meal.

The analysis in the report identified potential added value of 15 to 20% resulting in a b enefit of $30-40 million per year to the meat industry.

The evaluation of Australian meat meal was accompanied by a technical dossier which brings together a wide range of literature on the use of meat and bone meal. The dossier presents information on rendering processes, microbial issues, and quality factors including discussion of protein quality. The use of meat meal in poultry, pig, aquaculture and pet food feeds is discussed in detail. The contribution of meat meal to the nutritional value of feeds is explained and recommendations for inclusion rates in diets for different animals at different stages or production are given. Table 3.10 shows the recommended inclusion rates of meat and bone meal in various rations.

Target species and growth stage	Recommended inclusion of meat meal in rations
Poultry – broiler starter feed	8% max.
Poultry – broiler grower/finisher	10% max.
Poultry – layer	10% max.
Turkey	10% max.
Pig - early weaner	5% max.
Pig – weaner	8% max.
Pig – grower/finisher	10% max.
Pig – breeder	10% max.
Fish – carp, tilapia, perch (fresh water omnivorous)	75 – 100% replacement of fish meal
Fish – barramundi (warm water carnivore)	100% replacement of fish meal
Fish – trout and salmon (cold water carnivores)	25% replacement of fish meal
Crustaceans – prawn and shrimp	25% replacement of fish meal
Companion animals - dog	20 – 25%

Resource: Australian Meat and Bone Meal Guide for Feed Manufacturer. Brochure and CD available from MLA and website http://www.ausrenderers.com.au/ in English and Chinese translation

3.7.12 Process development

MLA has supported several projects to develop new rendering processes. One novel process is the Keith Airless Rendering system[34]. Keith Engineering has developed an airless dryer that uses superheated steam as a drying medium. A commercial scale dryer has been installed in New Zealand and is used to dry wet-rendered solids and bone chips for gelatine manufacture.

3.7.12.1 Superheated steam

There are potential advantages to using superheated steam as a heating source in a rendering process. Some of the claimed advantages are reduced odour; less oxidation during rendering; reduced fire risk; improved energy efficiency; improved nutritive value of meat meal; no boiler required and no production of stick water. Some of the issues to be resolved in developing the dryer as a rendering system are how to separate tallow from solids; the optimum steam temperature and impact of superheated steam on tallow.

The initial stages of the project involved an independent review of the proposed rendering system and claimed benefits. This review agreed that the airless rendering system should have benefits in terms of reduced energy use but there are several issues that can only be resolved by building a pilot plant.

In view of these recommendations, a pilot plant rendering system using superheated steam as a heating medium was designed, built and installed at a rendering plant. The evaporation capacity of the plant was 125 kg/hr. Trials were conducted with a variety of raw materials. Modifications were made during these trials. The conclusions from the trials were that:

- raw material was effectively cooked so that free-run tallow could be released and recovered;
- steady state conditions were easy to establish and maintain;
- high temperatures affect tallow colour;
- an outlet product temperature of 140 to 150ºC gives good tallow quality and appropriate moisture content in crax.

The pilot plant used 5.4 MJ per kg of water evaporated compared with 3.92 MJ/kg for conventional rendering. The poor energy efficiency may be due to losses in the pilot scale plant.

3.7.12.2 Alkaline rendering

Another novel rendering system that has been supported by MLA is the ADT alkaline rendering process[35]. The ADT rendering process uses alkaline hydrolysis to treat the defatted solid fraction of wet-rendered material followed by drying of the hydrolysed solids at relatively low temperature. The advantages of the process are that the hydrolysation process is claimed to inactivate the BSE infective agent and hydrolysation of protein improves bioavailability. The use of low temperature also has potential benefits of lower energy costs and reduced odours.

A pilot scale trailer-mounted ADT dryer and hydrolysing rendering system was built and taken to rendering plants to be tested with the defatted and dewatered solids from continuous wet-rendering. Drying efficiencies of up to 135% were achieved in terms of energy required to evaporate moisture compared with in-put gas energy. This efficiency is due to using the energy content of ambient air to evaporate moisture at the low drying temperature.

Odour production was rated as very low. Product yields were about 6% higher than with other rendering systems due to the addition of alkali and retention of moisture in the meat meal. The biological value of the meals was tested by chicken bioassay. The performance of meals from the ADT process in chicken diets was equivalent to conventional meat meal except for ADT meal dried at 80oC.

Microbiological control of meat meal from the ADT process was excellent in respect of vegetative bacteria such as Salmonella but low temperature drying failed to eliminate Clostridium perfringens added to material for drying.

3.7.12.3 Blood processing

MLA has also supported optimisation of existing rendering systems. One investigation looked at the effect of processing conditions on the recovery of protein from blood when making blood meal[36]. The stick water produced when blood is coagulated and dewatered contains nutrients which represent a loss of product and an added load in the effluent stream.

In the investigation at a commercial rendering plant the mass balance of input and outputs from the blood decanter indicated that protein equivalent to one tonne of blood meal was lost per daily intake of 140 tonnes of raw blood. This is a loss of 5.6% of protein processed. Settling blood stick water resulted in 53% reduction in nitrogen and a 35% reduction in COD in the supernatant. Further recovery of nutrients in stick water by ultra-filtration, pH adjustment, and further heating was investigated. Ultra-filtration was most effective in reducing COD and TKN. COD and TKN were also reduced by lowering the pH to 4.8 and recovering precipitated solids by centrifugation. Further heating did not recover nutrients. None of the methods effectively reduced the phosphorus content of the stick water.

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4 Pet Food

4.1 Background

Pet food is probably the most profitable use of the not for human consumption co-products of red meat production. Products used in the pet food industry include chilled and frozen offals, mainly liver and lungs, meat meal and tallow. Offal items sold as pet food may be fit for human consumption but are not required for human consumption or may be downgraded from human consumption due to minor defects and blemishes.

If suitable offals are not required for human consumption the main alternative to selling them as pet food is to render them. The pricing of pet food generally confers a premium over rendering. For example an MLA study conducted in 2006, reported that the following margins are available after costs[1]:

- about 17 to 23 cents per kg for fresh offal;
- about 12 cents per kg of offal if the offal is rendered.

These costs do not take into account capital investment in collection facilities and other infrastructure required for pet food collection.

Meat and bone meal is used in dry pet food and tallow is used mainly as a flavour coating in dry pet food. Large premiums may be available for specialty meat meals used in pet food, for example exported low-ash ovine meals. Standard meat meals do not receive a premium when used in pet food although some customers have operational requirements such as use of fresh raw material and exclusion of dead stock. Pet food manufacturers may have some requirements for specialised tallow specifications and price premiums may be available for tallow that meets these specifications.

The yield of offal available for pet food per head of cattle and sheep is variable as it depends on how much offal is required or is suitable for human consumption. Typical recoveries of natural fall fresh pet food from medium size beef or mixed species abattoirs is about 7 to 10 tonnes per day with a total value of about $1000 to $2000 per day depending on pricing. Yields of frozen pet food offal are less because the offals are sorted into specific items. Recoveries of about 5 to 20 tonnes per week valued at about $2000 to $14,000 per week have been reported[1].

The supply of meat and offal to the pet food industry has changed over the last 20 years or so. According to an MLA market study in 1992 all red meat products recovered for pet food were frozen[2]. The quantity of red-meat pet food ingredients was about 123,500 tonnes per year and the total value of pet food offal from the red meat industry was about $30 million per year.

In the 2006 MLA study[1] it was estimated that the amount of beef and sheep offal collected for pet food was up to 35 000 tonnes and the value is about $12 million per year. It was estimated that about 70 to 80% of pet food offal was supplied in fresh/chilled form.

A report by the Australian Renderers Association indicated that in 2001 about 45,000 tonnes of animal protein meals including poultry meal and feather meal and 30,000 tonnes of tallow were used in manufactured pet foods[3].

The reduced use of red meat products in pet food appears to be due to increased use of chicken products and textured vegetable protein.

In view of the declining use of red meat products in pet food and the value of pet food ingredients compared with other outlets such as rendering, MLA has conducted several projects to help the industry understand the requirements of the pet food industry and to investigate how the volume of red meat products used in pet food can be increased.

4.2 Pet food collection systems

Supply of meat and offal for pet food is regulated by the Australian Standard for Hygienic Production and Transportation of Meat and Meat Products for Human Consumption (AS 4696:2002).

The main intent of the regulations is to maintain separation between meat and offal suitable for human consumption and meat and offal that is not suitable for human consumption but can be used for pet food. In abattoirs, decisions about whether meat or offal is suitable for human consumption or can be downgraded to pet food status are made during post-mortem inspection on the slaughter floor. Once the disposition is made, meat and offal for pet food must be handled separately from the product for human consumption and must be identified at dispatch.

There are four possible dispositions of meat and offal at the time of post-mortem inspection. They are:

- suitable for human consumption;
- not suitable for human consumption but suitable for animal food. Examples of conditions that cause meat and offal to be in this category are ecchymosis (blood splash) and bruising.

- not suitable for human consumption but suitable for animal food if subject to heat sterilisation. This category generally applies to abnormalities that are not associated with specific infectious diseases for example, unusual odours, tumours, cysts, discolouration and fatty infiltration of liver. Lungs affected by pneumonia may also be put into this category.
- condemned with no option for recovery as animal food. Condemned material is generally disposed of by rendering.

4.2.1 Red and yellow banded pet food

The two dispositions as animal food are known as red-banded pet food and yellow-banded pet food. Material that may be used as animal food without heat treatment is yellow-banded pet food. It must be stained with a blue dye and packed in a container that has a yellow band at least 50 mm wide around the container or package. Material that can be used as animal food after heat sterilisation must be moved to a designated pet food room under a secure system and must be put in a container or package that is identified with a continuous red band 50 mm wide. (Other details relating to segregation and labeling apply to red and yellow banded pet food but are not reproduced here. They are contained in section 17 of AS 4696:2002).

4.2.2 Fresh pet food

Fresh pet food has become the preferred method of collection. The pet food is sent by chute direct from the slaughter floor to 1 tonne bins. The bins must be located in a segregated and secure area according to the requirements for handling red-banded pet food. In some cases the pet food is chilled by recycling chilled water through the bins. The facilities to refrigerate and recirculate the cooling water may be installed by the pet food company or collection contractor.

Fresh pet food is not sorted at the collection point and is not trimmed. The bulk of fresh/chilled offal includes mixed liver, lung and other pet food offal. It may be supplied direct to a pet food company but the bulk offal is generally collected by the supplier to the pet food industry. The supplier provides value adding services such as inspection, trimming, sorting of offal into product categories and mincing.

Figure 4.1 shows collection bulk pet food offal with water cooling system.

Figure 4.1: Bulk bin of fresh pet food with water cooling

4.2.3 Frozen pet food

In general frozen pet food is delivered direct to pet food companies or intermediate cold storage.

Frozen pet food offals are segregated into the different offal items and may be trimmed. The most extensive trimming applies to lungs. The lung lobes are cut off the trachea and accompanying fatty tissue and only the lobes are saved for pet food. This requires a dedicated pet food room with facilities for trimming offal.

The trimmed and sorted offals are put into tubs and frozen on racks in an air blast freezer or are loaded into cells of a plate freezer. The freezing facilities must be dedicated for handing pet food only (pharmaceutical materials may be handled in the same facilities). Naked blocks discharged from the plate freezer or removed from tubs are stacked on pallets, wrapped in stretch film and a plastic pallet bag is placed over the load.

Figures 4.2, 4.3, and 4.4, show trimming, and freezing in tubs or plates.

Figure 4.2: Trimming pet food offal

Figure 4.3: Freezing sorted pet food offal in tubs

Figure 4.4: Plate freezing of sorted pet food offal

4.3 Typical uses

Fresh and frozen pet food offal is mainly used in canned pet food. Inclusion rates for red meat ingredients are reported to be 10 to 25% in dog food and 15 to 20% in cat food[4].

Meat and bone meal and inedible tallow are used in dry pet foods. Meat and bone meal is used in the extruded mixture as a protein source, for energy and for its flavour. In general more meat meal is used in dog food than cat food because magnesium in the ash content of meat meal can cause urolithiasis in cats. Typically, meat meals are used at levels of about 10 to 20% in dry dog foods[4].

Tallow is used as an energy source and flavour enhancer. It is used in the extruded mixture and is sprayed on the surface of dry pet food as an attractant.

Small amounts of red meat co-products are used in other types of pet food such as dried dog treats and chilled manufactured pet food.

4.4 Quantities

The amount of red meat co-products used in pet food is not accurately known.

Three MLA reports have estimated the amount of co-products used in the pet food[1, 2, 4]. In a 1992 market study volumes of red meat ingredients used in pet food were estimated from discussions with pet food manufacturers. In a 2004 study volumes were estimated from the total volume of production of pet food and assumed inclusion rates of red meat ingredients in formulations. In a 2006 study, volumes of red meat pet food ingredients were estimated from sales reported by abattoirs. The volumes of red meat pet food ingredients are summarised in Table 4.1

Table 4.1: Estimates of the use of beef and sheep pet food ingredients

	Year		
	1991/92	**2002**	**2006**
Fresh			25,000 tonnes
Frozen	123,500 tonnes		10,000 tonnes
Total	123,500 tonnes	Range 46,513 – 147899 tonnes*	35,000 tonnes

**Estimate is not confined to beef and sheep products and could include other non-poultry species e.g. pork and kangaroo.*

In addition to fresh and frozen offal, the 2004 study estimated that 21,537 – 48,910 tonnes of non-poultry meat meal were used in pet foods. In 2001 the Australian Renderers association estimated that 45,000 tonnes of animal proteins meals and 30,000 tonnes of tallow were used in pet food.

Meat meals, particularly ovine meals are exported specifically as pet food ingredients. In 2003/2004 about 20,000 tonnes of ovine meal was exported specifically for use in pet food.

The amount of pet food offal available for collection at abattoirs depends on demand for edible offal, and condemnation rates which result in offal being unavailable for collection. Reports from abattoirs indicate that available recoveries of fresh offal are about:

- 0.6 to 1 tonne per 100 head of cattle;
- 0.9 to 1.8 tonnes per 1000 head of sheep and lamb[1].

Recoveries of fresh offal per head are higher than frozen offal. Fresh offal is mainly liver and lung but may contain other items. The offal is not trimmed and the recovered weight includes absorbed water from cooling in water. Frozen pet food offal is a limited number of specific offal items such as liver, lung and spleen; some items may be trimmed and there is no added water. Reports from abattoirs indicate that available recoveries of frozen offal are:

- 0.2 to 0.4 tonnes per 100 head of cattle;
- 0.4 to 0.9 tonnes per 1000 head of sheep and lamb.

4.5 Values

The value of offal recovered for pet food depends on whether the product is fresh or frozen. Frozen pet food ingredients can be considered to have added value due to trimming and sorting and incur processing and handling costs compared with fresh pet food ingredients. For these reasons, the price paid for frozen pet food ingredients is higher than for fresh pet food.

The 1992 report to MLA on pet food markets indicated prices of 30 cents per kg ex-works for frozen liver and lungs and 23 cents per kg for other frozen offal[2].

The 2006 report indicated prices of 17 to 27 cents per kg ex. works for fresh offal and 50 to 74 cents per kg for frozen offal. Higher prices were reported for small volumes of other specialty product.

Based on reported prices of sheep and cattle pet food ingredients and the reported recovery rates from sheep and cattle, the value of pet food offal that can be expected to be recovered from cattle and sheep is shown in Table 4.2.

The total value of fresh and frozen pet food ingredients from the red meat industry is about $12 million per year.

Table 4.2: Value of pet food per head of cattle and sheep

Pet food type	Potential value of pet food offal per head ($)	
	Cattle	Sheep
Fresh	1 - 2.25	0.15 – 0.4
Frozen	1 - 3	0.2 – 0.6

4.6 Opportunities to increase value

4.6.1 Fresh and frozen offal

There are differences in prices paid to abattoirs by the pet food companies. The pet food companies value strong relationships with suppliers and the higher prices are paid where a good relationship exists and the supplier is regarded as reliable. Reliability includes an element of product quality but also includes consistent supply of contracted volumes. In general the highest prices are paid to the highest volume suppliers. Apart from the difference between the specification of fresh and frozen pet food, MLA has not identified quality issues that resulted in higher prices[1].

There may be opportunities to sell limited volumes of pet food offal at higher values. When these opportunities arise a certain amount of value adding is required such as selection of offal that is suitable for human consumption and processing and packaging as human food.

Production of alternative ingredients from red meat such as digest has been raised in the report of project PRCOPIC.09, Dynamics of the Australian Pet Food Industry[4]. Products that could be derived from offal were ranked first and third in a survey of the interest the pet food industry has in new products from red meat. However, demand or potential value of such products is not clear.

It is possible that if other ingredients are developed, the inclusion rate of the ingredients may be low and total demand could be satisfied by a handful of abattoirs. There may be opportunities for individual abattoirs to work with pet food companies to develop value-added ingredients.

The alternative to value adding is for meat companies to produce and market finished pet food, particularly dried pet food treats.

In summary the opportunities for value adding are:

1. Nil in the case of mainstream supply of offal for canned and chilled pet food. Higher prices may be obtained by abattoirs that are close to the customers' processing sites and where the abattoir has a good negotiating position due to volumes available and a history of reliable supply and a good relationship with customers.
2. There are markets for small volumes of pet food, mostly of edible grade, for supply to local specialty pet food companies.
3. Pet food ingredients from offal could be developed e.g. digest and flavour enhancers. These ingredients are used at low inclusion levels and the potential market is initially small because it would be necessary to compete with established chicken products.

4.6.2 Rendered products

The amount of meat meal and tallow used in pet food produced in Australia is relatively small at about 5% of production. The amount of meat meal used in pet food appears to have been more or less constant over the last ten years although production of dry pet food has increased. There has been increased use of poultry meat meal.

Production of high-quality meat meals and high-protein meat meals ranked second and fourth in interest shown by pet food companies in new products from the meat industry[4]. These types of meal are already available from producers of ovine meal for export and from renderers that have relatively small amounts of bone in the raw material. Domestic pet food producers have not sourced these meals and it appears that interest in this type of value-added meal is limited.

To some extent pet food companies favour meat meal produced from fat and bone. This type of meal

is less affected by flavour taints associated with meal produced from gut material but it has a high ash and low protein content.

In summary the opportunities for value adding to rendered products are:

1. Meat meal and tallow are both available in a wide range of specifications. Pet food companies can source supplies with the appropriate specification and pay the market price for the selected specification.
2. Pet food companies may have an interest in sourcing low ash meal but can use meal with ash content of about 30%. Available meals with lower ash content have not been particularly sought for use in domestic pet food.
3. It is useful for abattoirs and rendering plants to be approved suppliers to pet food companies because increasing the number of potential customers protects against price fluctuations in other sectors of the market. Some value adding such as screening of meal and operating a quality assurance program is required to supply pet food companies but there is no evidence of premiums being paid for this value adding.

4.6.3 Quality issues

There are specific quality issues associated with the supply of red meat pet food ingredients.

Contamination of fresh and frozen offal by plastic is a major concern[5]. The main source of contamination is from weasand clips and other clips and plugs used in slaughtering. In frozen product, an additional major contaminant is plastic fragments from the tubs in which the meat is frozen. To remove the frozen block from the tub, processors may strike the tub against a hard surface resulting in fracture of the plastic. This can lead to fragments of plastic being caught between frozen meat blocks.

Metal contamination, particularly in frozen product, can cause damage to equipment and potential inclusion of metal in pet food

Other issues such as spoiled product through insufficient cooling or freezing have been raised by pet food manufacturers[4].

Plastic contamination of meat and bone meal is also a quality defect. In this case the source of plastic includes ear tags and rumen boluses in addition to weasand clips. Plastic particles in meat meal can result in coloured specks in dry pet food products.

If meat meal is sold for use in pet food, plastic such as ear tags should be removed from the raw material at the source of collection. Sieving of meat meal removes some plastic particles but is not fully effective.

Other quality issues that are specific to supply of meat and bone meal for use in pet food include freshness of raw material, digestibility of the product, consistency of particle size and addition of anti-oxidant.

The freshness of raw material affects the palatability of meat and bone meal used in pet food. Raw materials should be less than 6 hours from the time of slaughter to the time they are rendered. Use of older raw materials may be detectable from measurements of biogenic amines in meat meal.

Dogs and cats produce an excessive amount of faeces when they consume pet foods containing meat and bone meals with poor digestibility. Digestibility is affected by ash content with high-ash meat meal being less digestible than low-ash meals. The presence of undigestible protein such as wool or hair in meat meal will also affect digestibility. There may be other factors such as temperatures used in rendering that may affect digestibility but this has not been investigated.

Meat and bone meals used in pet foods may require addition of anti-oxidant depending on customer requirements.

4.7 MLA work

The use of red meat in pet food generally provides better returns than the alternative of rendering. For this reason MLA has investigated opportunities to expand the use of red meat products by the pet food industry. MLA has also investigated the use of meat and bone meal in pet food. In general rendered products used in pet food do not receive premiums (apart from premiums for specialty rendered products such as low-ash ovine meat meal) other than what might be generally available commensurate with the quality specification. However the use of meat and bone meal in pet food provides another market outlet.

4.7.1 Novel pet food product

MLA investigated what novel products of the red meat industry might be attractive to the pet food industry[4]. The report provides data (up to 2003) on the size and growth of different sectors of the pet food market. It also contains estimates of the

amount of meat products used in pet food. This part of the report indicates that red meat pet food ingredients have lost market share to poultry-based ingredients.

Pet food manufacturers were surveyed to determine their views on red meat ingredients. Views were sought on the quality of raw materials, palatability contribution of meat ingredients and opportunities for novel meat-based ingredients. As a result of the survey, opportunities for development of new or improved meat products for the pet food industry were ranked. Development of a high palatability meat digest for coating extruded products was of most interest to pet food manufacturers. High quality meat meals and meat-based flavour systems were ranked highly. New ingredients from meat products such as glucosamine and chondroitin were ranked fifth out of ten ideas.

4.7.2 Pet food nutraceuticals

In view of interest from pet food companies in nutraceuticals derived from meat products, as expressed in a previous project, MLA has identified the top 5 nutraceuticals of potential interest to the pet food industry[6].

Meat products may contain naturally occurring nutraceuticals or may be used as raw material from which nutraceuticals can be extracted. Identifying nutraceuticals used in pet food may lead to increased use of meat products or extracts in the pet food industry.

An extensive literature review was conducted to identify the major ailments of cats and dogs and associated use of nutraceuticals in pet food. The review also identified nutraceuticals used in veterinary medicine.

A review of product information identified nutraceuticals used in products available in Australia, the USA and Japan.

The most commonly used nutraceuticals are glucosamine, chondroitin sulphate and pentosan polyphosphate used to combat the effects of arthritis and -3 fatty acids to manage a variety of ailments. The amino acids arginine, L-carnitine and taurine are also added to pet foods at elevated levels.

Skeletal muscle and some offals are rich sources of arginine, carnitine and taurine. The meat products in pet food usually supply sufficient arginine. Some manufacturers may use added synthetic carnitine and naturally derived taurine. Poultry meal is used as a source of chondroitin sulphate.

4.7.3 Contaminants in pet food

At a workshop convened by MLA to explore issues related to the supply of red meat ingredients, representatives of the pet food industry identified plastic contamination as a major constraint on the use of red meat products. As a result a project was conducted to characterise physical contamination of meat-based ingredients, describe how contamination occurs and to identify possible methods of overcoming contamination.

The project was conducted by interviewing pet food manufacturers, renderers and meat producers[5].

The main source of contamination in fresh pet food is weasand clips and other clips and plugs. Frozen pet food is also subject to contamination by plastic chipped off the plastic tubs in which the offal is frozen. A range of other potential contaminants is described. This contamination results in damage to machinery, loss of export and domestic sales opportunities, customer complaints and potential legal action in the pet food industry.

Recommendations for preventing contamination are:

- development of a degradable weasand clip;
- development of a suitable release agent/ application system for freezing pet meats;
- preparation of training materials for abattoir personnel.

4.7.4 Pet food markets and supply

Two projects have been conducted to assess the market for red meat ingredients in the pet food industry.

One project in 1992 reviewed published information on the volume of sales of pet food in the domestic market and surveyed the major manufacturers of pet food. Pet food manufacturers in Thailand and Japan were also interviewed.

It was estimated that the value of offal used in wet pet food in Australia is about $30 million per year. It was also estimated that the value of offal as pet food was about $200 per tonne higher than its value if rendered. One opportunity to increase supply of meat co-products to the pet food market was identified as decolourised blood or blood plasma.

Opportunities to supply pet food ingredients to Thailand and Japan were considered to be limited because the pet food industry in these countries is based on non-meat ingredients.

In a project conducted in 2006, the value of meat co-products collected for pet food was estimated by interviewing managers of 31 abattoirs, 19 of which collected offal for pet food. Offals for pet food are either frozen in naked blocks or are chilled in cold or iced water. Frozen offal are trimmed and sorted while chilled offal is handled in bulk as natural fall. Prices paid for frozen offal are from 50 cents per kg to $1.30 per kg. The higher prices are only available for small volumes of specialty products. The typical price is about 50 to 75 cents per kg. The prices for fresh offal are about 17 to 27 cents per kg and up to 80 cents for small volumes of specialty products.

Many abattoirs do not collect pet food because returns are low and quality specifications are demanding. Because of the low value, pet food manufacturers find it difficult to source reliable supplies. It appears that abattoirs can secure higher prices if they have large volumes of product and can provide reliable supply. Pet food companies have preferred to use intermediary suppliers who value add by trimming and sorting fresh product.

4.8 References

1. Cost benefit analysis of pet food in red meat processing. MLA Project PRCOPVA.014, January 2006.
2. Pet food market study. MLA Project M.257, November 1992.
3. Australia's rendering industry facts. Australian Renderers Association Inc., 2002
4. Physical contamination of co-products used in pet food. MLA Project PRCOPIC.24
5. Dynamics of the Australian petfood industry. MLA Project PRCOPIC.09, February 2004
6. Top 5 pet food nutraceuticals. MLA Project PRCOPVA.015, December 2006.

5 Hides and Skins

5.1 Background

Australia is a major supplier of salted and wet-blue hides and salted skins to world markets. Hide is the term applied to the covering of large animals whereas skin normally refers to the covering of small animals. Pelt generally refers to a part-processed sheep skin called a pickled pelt, which is a skin with the wool removed and preserved by pickling in acid and salt.

Australia is one of only a few countries that has open trade in hides and skins. As a consequence the price of the raw material fluctuates significantly due to world demand. Domestic tanners have to compete with overseas processors for their raw material. Prices dropped dramatically in 2008 but are rising slowly in 2009. Poor quality hides and skins are always difficult to sell.

Australia produces around 8 million cattle hides per year and 1 million calf skins. The number fluctuates depending on a range of factors such as climatic conditions and the price of meat. About 4.5 million hides are salted for export and about 3.5 million are processed in Australia to wet blue (a part processed material) each year. Very few hides are now processed through to finished leather in Australia. Wet blue is mainly exported to Italy, China, and Taiwan and salted hides are mainly exported to China, Thailand, Taiwan and Japan.

Australia produces about 32 million woolskins every year, roughly 12 million sheep skins and 20 million prime lamb skins. The number and proportion of each varies due to drought and the price of wool and meat. Lambskins are generally more valuable than sheepskins. This is because most are from cross-breeds of Merino and British breeds. Skins from cross breeds have more valued properties derived from the high density wool pile (from the Merino) and a skin which produces better leather (from the British breeds).

Sheep skins are derived mainly from the culling of animals from wool producing flocks as a result of age, poor reproductive traits or inadequate wool production. Around 2.5-3 million woolskins per year were processed in Australia to wool-on products in the 1990s. Most woolskin tanneries are now closed and most Australian skins are tanned in China. Wool skin tanners prefer skins with stronger type wools of around 24-28 µm in diameter. Skins with finer wools go into the fellmongering industry (removal of wool from the skin), which is largely practiced overseas.

A key issue in the whole leather supply chain is that farmers still regard skins and hides as by-products of meat and wool production and of the dairy industry. It is important for the leather industry that primary producers treat their hides and skins as an important co-product.

In view of the value of hides and skins, MLA conducted projects to investigate quality improvement, new products and processes, and the expansion of processing in Australia.

5.2 Uses

All leather is made from hides and skins. Cattle hide leathers are used for shoes, upholstery, automotive leathers, clothing, bags, industrial leathers and saddles. Woolskins, depending on wool length, become garments, medical sheepskins, various types of rugs including infant care, car seat covers and ugg boots. Fellmongered skins are used for garments, bookbinding, lining and chamois leathers. Table 5.1 Summaries the uses of leather derived from different types of hides and skins.

Table 5.1: Use of different types of hides and skins

Hide/skin type	Leather type	Typical use
Unblemished cattle hides	Full grain leather	Shoes, upholstery.
Cattle hides with damaged surface (bacterial damage, scratches, brands, ticks)	Corrected grain leather	Lower value shoes and upholstery
Cow hides	Garment leather	Garments
Calf skins	Calf leather	High quality shoes and garments
High quality fellmomgered skins	High quality sheep skin leather	Garments, bookbinding
Low quality fellmongered skins	Low quality sheep skin leather	Linings and chamois leather
High quality wool skins	Double face garment leather	High quality garments
Low quality wool skins		Ugg boots, car seat covers
Selected skins	Medical sheep skins	Medical use

Quality and value. One of the major factors in determining the quality and value of leather is the early treatment of hides and skins. If there is a delay between removing the hide or skin from the carcass and the beginning of tanning or preservation, damage often occurs. As soon as the skin is removed, like meat it is susceptible to autolysis (self digestion) and bacterial degradation, and the rate of degradation increases with temperature. Therefore it is best to preserve the skins at their source.

Wet blue processing is the chrome tanning of unsalted (green) hides, preferably at or near their source. About 45% of Australian hides are processed to wet blue for export. Short-term preservation methods have been developed to facilitate this green processing. Chemical methods or chilling are used when necessary to preserve hides during transportation and storage.

Figure 2.1: Dropping wet blue from a tanning drum

Long term preservation is carried out by salting (curing). Brining in raceways or drums, and drum salting with no added water, are now widely used in Australia and are labour saving alternatives to conventional stack salting. Brining is most commonly used for salting hides; about 90 to 95% of salted hides are brine salted. Although there has been a tendency for purchasers to prefer this treatment, the simple process of dry drumming is also acceptable on overseas markets.

Drum salting is now the major method for the curing of sheep and calf skins. Brining is not suitable for these skins.

All salting methods produce brine effluent and a 25 kg hide produces about 5 litres of excess brine. Disposal of this effluent is a major problem. If the hides are wet, more brine is generated. Salt preserves hides by lowering their water content from about 65% to less than 50% and saturates all the water with salt.

Fleshing, meat meal and tallow. Before a hide is tanned, the attached fat, muscle and connective tissue, often amounting to 20% or more of the hide weight, must be removed by passing the hide between the rotating knife blades of a fleshing machine. The fresh fleshings are rendered. Fleshing the hide before salting produces high quality meat meal and tallow from the fleshings and a better cure is achieved. Around 20 to 30% of brined hides are now exported fleshed.

The skin is the largest organ of the body. A cattle hide is around 11% of the carcass weight and consists of about 73% water. Hides and skins are complex structures. In addition to the structural protein collagen, which is laid down in a weave-like pattern, hides and skins contain the physiological structures for hair or wool growth, muscles, blood vessels, nerves and fat tissue.

Leather making follows three basic steps:

- The removal of extraneous tissues and structures from the hide or skin. This is done in the early stages of processing mainly in the fleshing, soaking, liming and deliming steps for hides and in the soaking and pickling steps for wool-on lamb and sheep skins.
- The stabilisation of the collagen. This is done by chemically cross-linking the protein chains. Stabilisation provides resistance to bacterial degradation and increases the stability of the collagen to heat. The cross-linking process is called “tanning”. The properties of leather can be determined by the type of cross linking agent (tanning agent) used. For example the sole leather of a shoe is quite different to that of the shoe upper leather despite both being made from fundamentally the same material. In the former case the hide has been tanned with vegetable tanning agents (hence the yellow or orange colour) whereas the upper leather is generally made by tanning with chromium salts. There are numerous tanning formulations which have been devised to obtain the desired leather properties.
- The conversion of the tanned material into leather. Following tanning the product is converted into useable leather by a series of processes that colour, lubricate and physically change the material to produce leather with the desired appearance, handle and feel. The tanning process for woolskins and hides and fellmongery skins is summarised in Figure 5.1

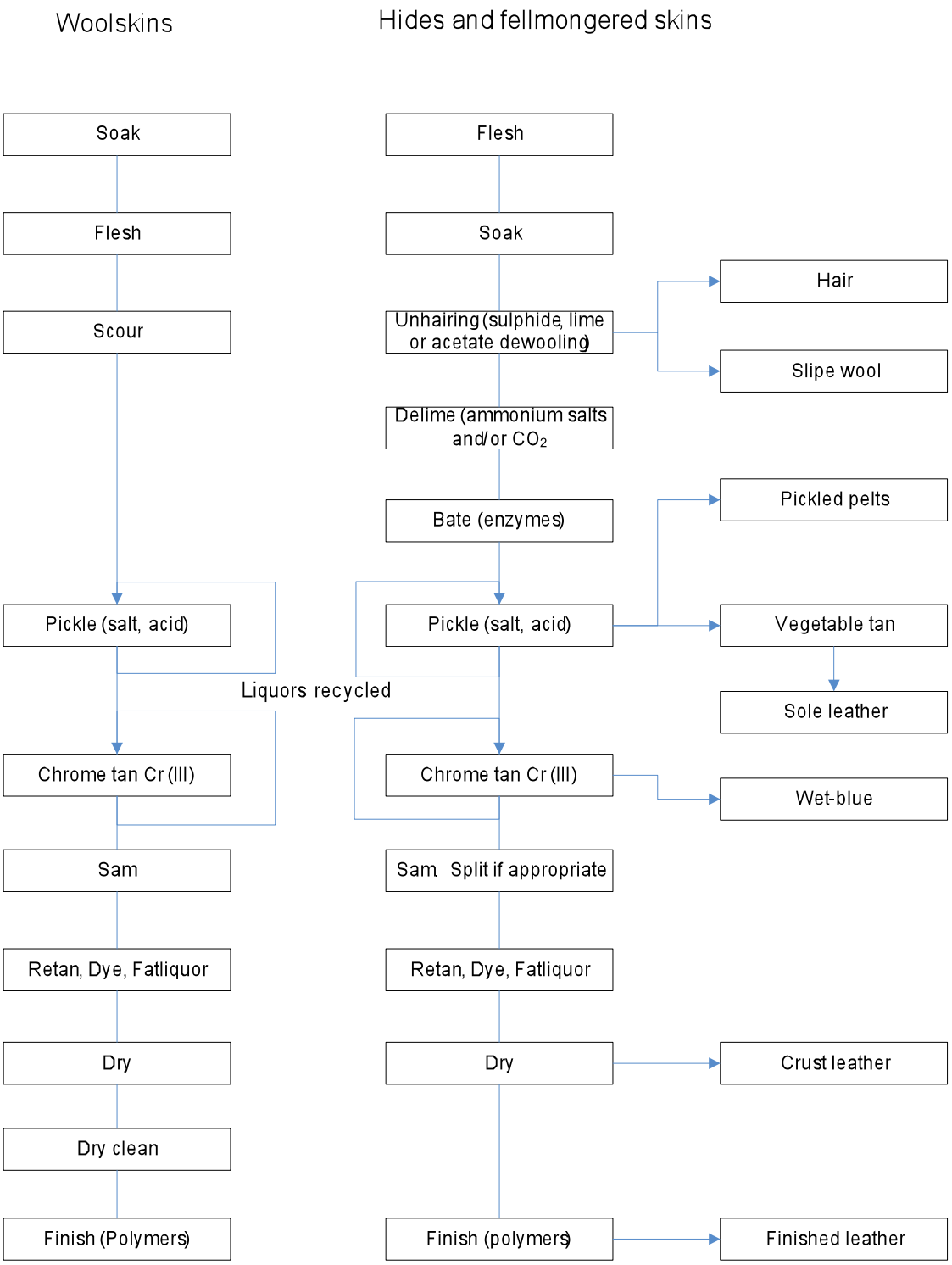


Figure 5.1: Summary of tannery processes

Fellmongering is the removal of wool from sheep skins to realise the separate value of the wool and the pelt. Acetate fellmongering can only be applied to fresh or green skins. The natural enzymes in the skin are activated at pH 4 and loosen the wool by degrading the interior of the wool follicle.

The Merino skin does not produce durable leathers because the grain layer is weak and is easily damaged by abrasion and scratching. The number of wool follicles can be over 5000 per cm^2. This high number of follicles and the structures associated with them produce a grain layer that is weaker and thicker than the grain layers of other sheep breeds. Many Merino skins are therefore processed into second quality leathers, or into chamois leathers.

Chamois tanning is a special tanning process which uses fish oils to tan the skin.

5.3 Quantities

About 8 million hides are produced each year in Australia and about 45% are processed to wet blue and 55% salted for export. Slaughter numbers and consequent hide and skins production are shown in Table 5.2.

5.4 Values

Table 5.2: Livestock Slaughtered for Human Consumption

	Cattle million head	Calves million head	Sheep million head	Lambs million head
2002/03	8.1	1.1	13.7	16.9
2003/04	7.8	1.0	10.4	16.6
2004/05	8.0	0.9	11.4	17.3
2005/06	7.6	0.8	11.8	18.7
2006/07	8.2	0.9	13.3	20.2

Source: ABS, Livestock Products, Australia (7215.0).

Cattle hide prices fluctuate greatly according to demand for leather goods

MLA tracks prices monthly in the Co-products price monitor[1]. Prices reported in the Co-products monitor are derived from surveying export plants and traders. Offal prices from the monthly survey are maintained in a data base dating from 1992.

Figures 5.2 and 5.3 show examples of hide prices tracked by the monthly co-products monitor in 2008 and 2009.

Figure 5.2: Historical hide prices

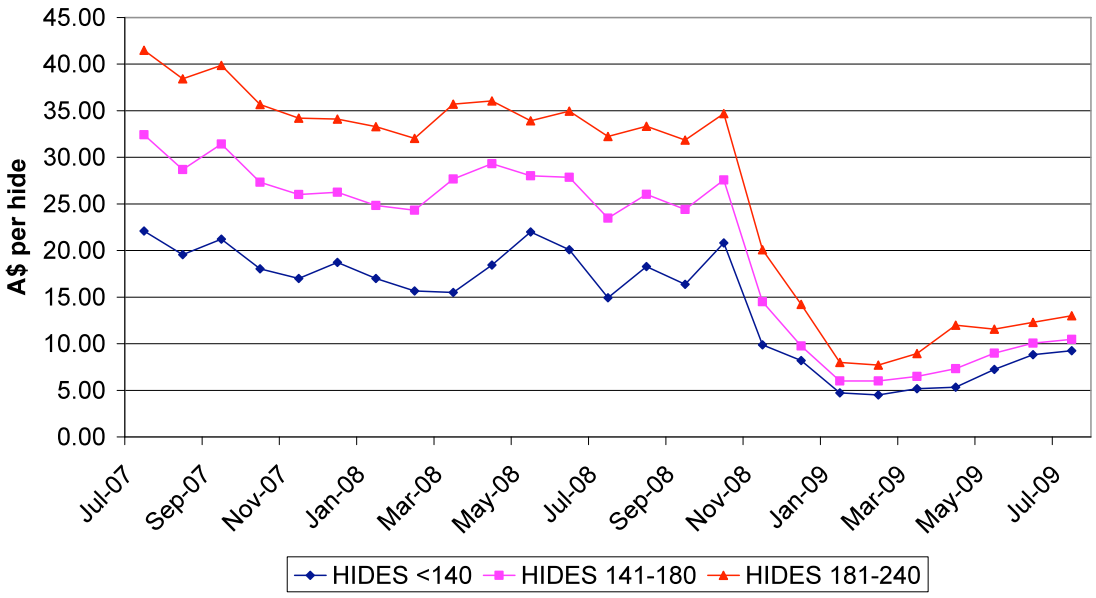
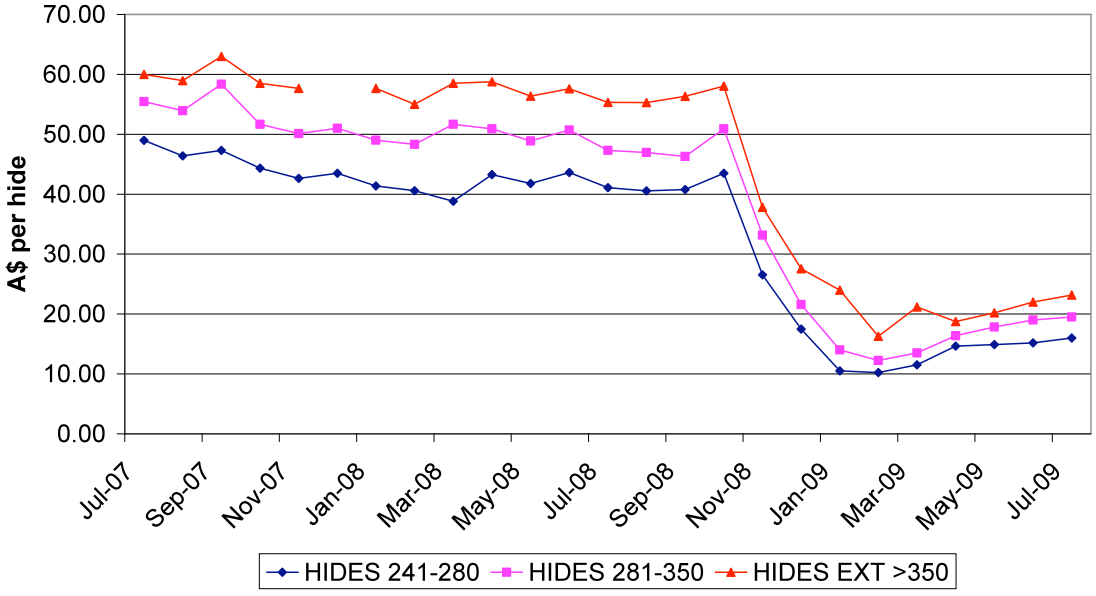


Figure 5.3: Hide prices



Hide values typically represent about 20 to 25% of the value of co-products from cattle. Since prices fell in November 2008, hides have represented about 8 to 12% of co-products values.

Resource: MLA Co-products Market Analysis Report[1] available at: http://www.mla.com.au/TopicHierarchy/MarketInformation/DomesticMarkets/Processing/Coproducts/Co-products+monitor.htm

5.5 Opportunities to increase value

5.5.1 Wet blue

The processing of hides to wet-blue, without salting, is the most efficient method of preservation both from an economic and environmental point of view. The cost of salting plus the higher freight cost is a "wasted" cost as the process has to be reversed before tanning can be commenced. The main problem with salting is the salt. Excess salt, saturated brine purged from hides and salt washed out during later processing cause major salinity problems. This is a critical environmental problem world wide.

In Australia, clean tannery processes as represented in Figure 5.1, greatly reduce pollution loads and when green hides and skins are processed, tannery effluent can be irrigated beneficially. Some processes for treating green hides and skins have been developed by CSIRO in MLA projects[2]. End of pipe effluent treatment used in processing salted hides in other countries is environmentally detrimental. Also, wet blue production in Australia means the fleshings produce high quality meat meal and tallow as valuable co-products. In the future, the environmental benefits should result in increased wet blue processing in Australia.

Resource: Rapid Processing with Minimal Effluent, MLA-CSIRO Project CS 116, 1993

5.5.2 Fleshing

Exporting hides fleshed before salting also reduces freight costs and enables beneficial use of fleshings. Overseas, the fleshings from salted hides are a major problem.

If fleshings are obtained in a fresh condition they can be rendered to produce good quality tallow and meat meal. It is difficult to render fleshings on their own because they are difficult to handle in screw conveying systems. In addition, the collagenous nature of the protein makes it difficult to extract fat from the rendered material. If fleshings are blended with other bony raw materials they can be rendered satisfactorily.

The typical yield of fleshings from hides is about 5 kg.

The yield of rendered material from fleshings assuming no added water is about:

- 43% tallow;
- 12% meat meal.

There is potential revenue of about $180 from tallow and meat meal produced from fleshings from 100 hides.

5.5.3 Hide and Skin Improvement

The development of regional brine-curing plants and wet blue plants has resulted in large numbers of hides being transported prior to processing. Previously hides were often immediately salted at their source. Many green hides are being held for several hours at temperatures above 20°C. This causes degradation that is sometimes only apparent in the finished products. The grain layer of a hide is very susceptible to damage.

The production of high quality leathers requires not only precise control over processing conditions but also the availability of high quality raw materials. There is much that the primary producer can do to enhance the value of hides by carrying out simple husbandry practices, for example:

- by not branding or, if necessary, branding in positions which minimise leather cutting area loss;
- avoiding the use of barbed wire wherever possible;
- the proper maintenance of cattle yards so there are no protruding bolts or sharp edges;
- the de-horning of cattle so that hides do not suffer from horn tears
- reducing the tick burden on cattle.

Similarly woolskins can be badly damaged by poor husbandry practices, for example seeds and burr, poor crutching and mulesing, shearing cuts, inoculation damage and the failure to control sheep lice and mite infestations.

MLA projects[3, 4] have resulted in technological advances in classifying hides according to quality and identifying them for potential trace-back to growers. Unfortunately, it has not yet been economically viable to implement payment systems based on hide quality to give growers an incentive to produce better quality hides. However, often improvements can be made with little cost to the grower or the abattoir.

5.5.4 Hide and Skin Defects

There are many sources of hide and skin defects that result from on-farm and abattoir practices. Defects that arise in cattle hides and calf skins from on-farm practices are shown in Tables 5.3 and 5.4. Defects that arise from abattoir practices are shown in Tables 5.5 and 5.6:

Table 5.3: Defects in cattle hides and calf skins as a result of on-farm practices

Type of defect	Cause and prevention
Brands	The most damaging brands are the Queensland rib brands. Brands on the rump near the tail cause considerably less loss in cutting value.
Horn gouges	Horns cause hide damage, particularly between animals in close quarters. Breeding poll cattle or dehorning should be encouraged.
Scratches	The most common causes of scratches are from barbed wire, parasitic irritation and rough handling. Often races, holding yards and transport vehicles have sharp edges and bolts. Scratches can be prevented by use of electric fencing where possible, removal of sharp edges, bolts and spikes from cattle yards and transports, flattening barbed wire spikes around posts and gates, treating livestock for parasites to prevent skin irritation. Unhealed scratches and scars are far more detrimental to leather quality than healed scars.
Parasites	• Ticks - leave permanent scars of about 2 mm on the grain. • Buffalo fly - leaves permanent scars • Follicular Mange (Demodectic Mange) - damage is caused by mites that burrow into the skin through the hair follicles. • Lice - cause skin irritation leading to rubbing and scratches on the grain. Also associated with white spot damage.
Vertical fibre	A genetic condition causing weak leather associated with Hereford cattle.
Diseases	Ringworm, warts
Dung	Mainly associated with feedlots. Dung is a major problem and can cause damage known as “nappy rash”.

Table 5.4: Defects in sheep and lamb skins as a result of on-farm practices:

Type of defect	Cause and prevention
Seed	Grass seeds trapped in wool work their way into the skin. Seed damage is mostly seen as scar tissue from healed seed holes but seeds can also leave holes. Seeds embedded in the skin can cause damage during fleshing and in finishing operations.
Burr	Five types of burr affect woolskin processing. These are the medics, clover, Bathurst, noogoora and ring burrs. Damage from burr occurs mostly at the fleshing machine but burrs are also a focal point for felting.
Dermatitis	Mycotic dermatitis or lumpy wool is caused by a bacterial infection. The scabs or lumpy pieces in the wool are not removable during processing and these skins are fellmongered.
Inoculation abscesses	Animals are inoculated by injection against diseases such as pulpy kidney and tetanus. Infection at the inoculation site may cause an abscess to form leaving scars or a hole in the skin. Inoculation should be in the neck area.
Mulesing	The mules operation is performed to remove britch skin wrinkles to control fly strike. Scar tissue formed makes it more difficult to remove the skin from the carcass without damage.
Crutching	If animals are crutched too heavily, dressing skins are downgraded due to a large area of shorter wool.
Shearing damage	This is seen as uneven wool length and scars from the shearing comb.
Rib	Ribbiness is associated with merino and merino cross sheep. The majority of these skins have no application as dressing skins, although light rib is tolerated in products such as car seat covers, medical and infant care woolskins and some footwear.
Double hiding	This is a condition where the grain and corium layers of the skin delaminate from each other during processing.

Table 5.5: Defects in cattle hides and calf skins as a result of abattoir practices

Type of defect	Cause and prevention
Hide pullers	These have greatly reduced cuts and flay marks. However, hide pullers can cause strain marks, particularly in calf skins because the skins are thinner and have a more tender grain.
Flaying damage	Cuts and scores
Open scratches	Received in yards and races and post slaughter
Hot water scalding	Never allow warm or hot water to contact raw hides or skins
Trimming damage	
Poor storage and transport	In summer, the risk of damage is very high: • consider cold water spraying, or fluming, to cool hides as rapidly as possible; • store full and empty hide bins in the shade before transport; • consider dispatching hides several times a day in summer; • consider chilling or short-term chemical preservation of the hides before transport.

Table 5.6: Defects in sheep and lamb skins as a result of abattoir practices

Type of defect	Cause and prevention
Cuts and flay marks	Usually occur in the opening up stage where knives are used.
Grain strain due to take off	This occurs both with hand take-off and mechanical skin pullers. It became a severe problem with the mechanical pullers and inverted dressing systems and has been investigated by MLA. It is suspected the problem worsened due to incorrect pulling techniques.
Fat	Can be minimised by careful pelt removal.
Shape and symmetry	Skin value is affected if unsymmetrical.

5.6 MLA work

5.6.1 Hide Identification and Assessment System

The hide identification system was a key part of the comprehensive hide improvement program of the MLA design to increase the quality of hide production in Australia. The implementation of hide identification would allow traceability of hide quality information from wet blue or finished leather back to the grower. A major benefit of the hide improvement program was to have been the implementation of payment systems based on hide quality to give growers an incentive to produce better quality hides and to reduce butchering defects in abattoirs.

A number of MLA investigations were undertaken within the Hide Improvement Program up until 1996. From 1996 to 1998, the Program became the National Hide Quality R&D Program and from 1998 to 2000, the MLA National Hide Quality Improvement Program.

The major, comprehensive project[3], completed in 1993, estimated the cost of hide damage in Australia to be in the range of A$200 to$300 million per year.

A hide assessment system and software were developed and evaluated in field trials. Three methods of hide identification were also assessed in Queensland, NSW and Victoria. The trials covered some 12,000 hides. The hides were processed to wet blue and finished leather at six different tanneries.

Assessments of hide defects were made at both the wet blue and the finished leather stage. Each hide was graded for brands, scratches, parasites/disease and abattoir damage. Each quality parameter was rated on a score of 1 to 5 with 1 being gross damage and 5 virtually no damage. The software scored each hide out of 100, and calculated a premium or discount.

A summary of the results is:

- The average hide quality scores were

  Victoria 74.9;

  NSW 66.6;

  Queensland 59.1.
- The scratch score for Queensland was better than expected.
- Tick was the major parasite damage in Queensland with buffalo fly worse than expected.
- The incidence of mite in NSW hides was very high. It was lower in Victoria but was also a major problem.
- The value of the hides could be increased by improving abattoir practice.

As part of the trials, ‘On Farm’ Questionnaires were completed by 42 growers and a positive correlation was found between scores estimated from the ‘On Farm’ Questionnaire alone and the actual wet blue assessment. It was concluded that for situations where assessment of hides in wet blue is not appropriate, a live assessment along with the ‘On Farm’ Questionnaire should be useful.

There was a positive reaction to the system and an incentive payment to growers based on quality hides was envisioned. Recommendations were made for future investigations and for a National Hide Quality R&D Program.

After 1996, the Gibson-Bass Stamper was developed to number cattle hides in the green state at the abattoir. This was an improvement on the earlier hide identification systems and enables reliable identification of the hide at the wet blue stage of processing. The Stamper punches a human and machine-readable number through the edge of the hide in any orientation. The number of digits is variable and is generated by software to identify the number with the producer or supplier. The machine can interface with a wide variety of networks for communication with factory control systems.

However the labour and capital costs of placing the mark and later reading it and recording and utilising the information are high. In addition the mechanisms for rewarding or penalising for quality were not established. Therefore it has not yet been economically viable to implement payment systems based on hide quality to give growers an incentive to produce better quality hides. In future, for wet blue tanneries repeatedly receiving hides from large properties, an annual live assessment along with the ‘On Farm’ Questionnaire could be used to determine a premium price for hides known to be of high quality.

5.6.2 Training

The MLA project Development of the Training Package[4] was an important aspect of the hide improvement program. The comprehensive project provided:

- Improved definition of hide assessment standards;
- A system to judge assessor performance;
- Training materials for assessor training comprising:
  - Training Manual: course notes in six modules;

- o Overhead transparencies for the six modules;
- o Colour slides: 65 slides of hide defects detailed in Module 3.

Tanneries have improved their hide grading and sorting by using the hide assessment and grading systems, the grader training materials, and the software and the hardware developed in Projects M.254B and M.563 and the later projects.

5.6.3 Sheep and lamb skin projects

MLA published 15 brochures in the Processing & Product Innovation (PPI) Skin Advisory Kit in 2001. This is an excellent review of the large range of projects MLA supported in order to increase the value of sheep and lamb skins; improve quality, develop new products and processes, and to expand processing in Australia. Many of the outputs of the projects are still relevant.

Brochure 1, Farm management for improved woolskin properties[5]

Farm management continues to be important in determining the value of woolskins. The farm practices that can influence woolskin properties include:

- breed selection;
- husbandry and nutrition;
- environment and season;
- handling and marketing procedures;
- ease of pelt removal.

The woolskin properties which affect specification, grading and value and which can be influenced by on farm management practices, include:

Wool and Fleece Properties

- fibre diameter and range from breed selection;
- pile length from age and shearing time relative to slaughter;
- pile density from breed;
- staple characteristics from breed and age;
- vegetable matter contamination, particularly seed;
- rib (wrinkle) from breed;
- live weight as relates to skin size;
- damage and faults, including, kemp (hairy britch), coloured wool, wool tip weathering, over-crutching, mulesing, unscourable dye-markers, bacterial stain, fly-strike, dermatitis and wool matting.

Skin Properties:

- size and shape from breed and age;
- rib (wrinkle) from breed;
- vegetable matter, including seed penetration through skin to carcass;
- damage and faults, strain damage, double-hiding and abscesses. Injections should be applied in the neck area as they cause abscesses and downgrade skins

Brochure 2, Prevention of strain damage[6]

Strain damage on woolskins, in the form of cracks in the grain layer, is a major problem in the fellmongering industry. It is caused by incorrect handling of the animal skin during life, in particular pulling on the wool just prior to slaughter and excessive strain on the grain surface during skin pulling resulting in distinctive multiple breaks termed “butcher strain”.

Generally, butcher strain is symmetrically located in the lower belly and flank areas, with the cracks aligned perpendicular to the backbone. It can be difficult to detect before the later stages of leather making and hence causes substantial waste of resources. Studies have shown between 60% and 100% of skins can be affected in Australian abattoirs.

In order to reduce the cost and waste from grain strain, it is desirable to detect damage at an early stage. For the abattoir this means monitoring the occurrence of strain in, or close to, real time and modifying the abattoir procedures as necessary. For the fellmonger, it requires detection at an early stage of processing to prevent the unnecessary expenditure of resources on poor quality skins.

Strain can be caused by any of the pelt removal techniques and is most affected by the extent of opening up prior to pulling, especially where the hind legs are left unopened as socks.

Grain strain can be reduced by appropriate opening up of skins and by using well designed and operated pullers or careful manual techniques. Whether dressing is manual or mechanically assisted, it is critically important to carry out adequate work-up and clearing before any pulling actions are applied to the skin.

Brochure 6, Preservation of sheepskins and lambskins[7]

The preservation method of choice is to start processing raw skins into final products soon

after removal. This is not usually possible but it is necessary with acetate fellmongering.

A range of preservation methods were investigated in MLA projects. A plate chiller was developed but in commercial operation, the capital and operating costs were major issues.

Drum salting is now most commonly used for sheep and lambskins. Salt mixed with additives (30% of skin weight) is drummed into skins in large mixers, churns or drums for 1-2 hours. Skins are stacked to purge for several days, packed on pallets, covered with a layer of salt to intercept condensing moisture and wrapped in polythene for export. The problem with salting is the salt: excess salt, saturated brine purged from skins and salt washed out during later processing cause salinity problems. This is a major environmental problem world wide. Research into economic alternatives to salt for long term preservation has not been successful.

Brochure 7, Utilisation of waste skin from sheep and lamb production[8]

Each sheep and lamb slaughtered produces 1 to 1.5 kg of wool-bearing waste skin pieces (head and face, brisket, legs). In addition, some whole skins are of No Commercial Value (NCV) because of low or zero demand, or excessive damage. The high cost of disposal and the potential to achieve some return from processing the skin prompted MLA investigations into a number of systems for utilising the waste skin. Practical options for handling waste skin pieces are:

- Rendering

  Meat meal and tallow can be recovered from waste skins by rendering the skins together with conventional abattoir offal. Prior to rendering, hair and wool can be destroyed by treatment with caustic soda using commercially available equipment. Rendering of skin pieces, after the wool is destroyed by caustic soda treatment, is now the preferred option and is commonly used.

- Composting

  NCV sheep and lamb skins and waste pieces can be composted together with equal volumes of another solid waste such as sheep and cattle paunch material and a bulking agent such as pine chips.

Brochure 8, Fellmongering in Australia[9]

Fellmongering is the removal of wool from sheep and lambskins to realise the separate value of the wool and the dewoolled skin or pelt. Two fellmongering systems have been used commercially in Australia. They are lime/sulfide and acetate treatment. After rapid expansion of the industry in the 1990s, most fellmongeries closed as they were not economically viable.

However, as a result of MLA support[9] the acetate method is now successfully used in NSW and in Western Australia. It is the only commercially viable system for Australia.

The acetate method is most suitable for the recovery of high value wool from fresh (unsalted) Merino sheepskins. The method is based on adjusting the pH of the skin by coating the flesh side with an acetate buffer to stabilise the pH at around 4. The skins are incubated at 35-37° C for around 14 hours or at lower temperatures for longer. Under these conditions the natural enzymes remaining in the fresh skin are activated and loosen the wool by degrading the interior of the wool follicle.

Brochure 12, The environmental safety of trivalent and hexavalent chromium[10]

Trivalent chromium, Cr(III), is a very effective tanning agent with 7-8% of the global chromium consumption credited to the leather industry. It has been widely used in tanning for over 100 years and despite much research, its properties and performance have not been matched. The tanning industry uses a range of methods to maximise the utilisation of Cr(III) and consequently to minimise its waste. However it is not possible to eliminate Cr(III) containing tannery wastes. The tanning process does not use hexavalent Cr(VI) and the chromium in the waste is Cr(III). Cr(III) is rendered insoluble, immobile and unreactive in soils. Cr(III) does not convert to Cr(VI) in natural environments.

Scientific research does not indicate that Cr(III) contributes to any human health or environmental ill effects. Epidemiological studies have found an association between work-related inhalation of some Cr(VI) compounds and lung cancer.

High levels of Cr(III) in water and soil can be tolerated by humans. Based on US EPA Reference Doses, the allowable Cr(III) concentration in soil that might be ingested by a 2 year old child is

120,000 mg/kg while that for Cr(VI) is 600 mg/kg. In ecosystems, Cr(VI) is the more toxic form of chromium.

Based on risk assessment, the US EPA has revised their limit for total chromium in sewage sludge applied to agricultural land to 100,000 mg/kg (i.e. 10%) of dry solids. The limits will never be reached but show that there is no environmental issue with Cr(III) application to land. Australia has unjustifiably restrictive regulations for chromium in effluents and for the utilisation of wastes.

Some progress has been made in achieving risk-based environmental regulations for chromium in Australia. However, there are still unreasonable limits being enforced and there is a real need for regulators to understand the chemistry and the environmental and health effects of chromium.

Brochure 14, Australian medical sheepskins[11]

The Australian Medical Sheepskin is a unique pressure relieving device of great value in the prevention of pressure ulcers (pressure sores or bed sores) in immobile patients. The requirements of the Medical Sheepskin tannage are demanding. In hospital use the skins must be washed and dried at elevated temperatures many times, placing stress on the leather substrate. The washability and the performance in institutional laundries are of paramount importance. The wool fibre diameter and staple length are important with respect to patient comfort and performance of the skin both in use and during laundering.

The MLA brochure provides details on:

- wool properties which lead to optimum comfort, performance and durability to laundering;
- processing Technology;
- performance standards and reliable test methods for Australian medical sheepskins;
- Australian Standard for Medical Sheepskins AS 4480.1-1998

The knowledge and information developed with MRC support has since been augmented by CSIRO Leather Research Centre in the areas of clinical trials, testing and laundering. The research and commercial development of the Australian Medical Sheepskin has been a success. The product is now well recognised and reliable clinical data supporting the efficacy of the product in preventing pressure ulcers is available from later projects including a National Health and Medical Research Council (NHMRC) Project.

Although many Australian woolskin tanneries have closed due to competition from China, in 2009 there are a number of small tanneries manufacturing the Australian Medical Sheepskin.

5.7 References

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9. Fellmongering in Australia. PPI Skin Advisory Kit, 2001, Brochure 8.
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6 Alternative co-products

6.1 Background

There are many potential uses of meat co-products. Some uses such as hides and skins for clothing and tallow for heating and light are prehistoric. The use of tallow for soap making pre-dates the Roman Empire and is still an important use for meat industry co-products. Other uses, for example extraction of insulin from pancreas glands, have been valuable to the meat industry and the community as a whole but have largely been replaced by other technologies.

The mainstream uses for co-products are edible uses, rendering to produce animal feed and tallow for soap making and other uses, leather and woolskin production and pet food. There are also examples of high prices being paid for speciality co-product items such as foetal calf blood and low-ash ovine meat used in pet food. Other co-product outlets pay price premiums for some products but the premiums are limited because there is plentiful supply of product. In addition the markets for these products may be small and only a few meat producers can supply products without swamping the market. Examples are speciality pet foods such as dried liver strips, trachea for production of chondroitin and extracts, lung for extraction of heparin and meat and bone extracts.

Mainstream uses of co-products provide profitable outlets to large markets. However these markets are threatened for time to time. For example the use of meat and bone meal in animal feed has been questioned since the spread of BSE was linked to feeding ruminant meat and bone meal to cattle and this use of meat and bone has been discontinued in the EU and Japan. The red meat share of the market for pet food ingredients has been lost due to competition from poultry ingredients. In view of this, MLA has investigated alternative uses for co-products as protection against the loss of existing markets. Many of the potential alternative uses have been aimed at red meat materials that are currently used in animal feed. Some of these uses would not necessarily provide better returns for co-products.

MLA studies have also focussed on alternative uses of co-products which could provide improved returns from co-products. The revenue from co-products items if rendered is about $200 to $500 depending on fat and bone content. Some co-product items could provide better returns if other uses are developed.

A third focus for alternative uses for co-product is recovery of material from what otherwise might be regarded as a waste stream. Co-products from waste streams might be profitable or at least could reduce the cost of disposal of the waste streams.

6.2 Typical uses

There is a wide range of potential uses for co-products other than the mainstream uses. Table 6.1 lists some of the known and potential uses of co-products. Possibly dozens of downstream uses of tallow derivatives such as fatty acids, mono- and di-glycerides and glycerol could by listed but from the red meat industry point of view, tallow is a mainstream product and the many alternative uses do not affect returns to the industry. Also, most of the potential bioactives that could be extracted from red meat co-products are not listed.

Table 6.1: Potential alternative uses of red meat co-products

Co-product item	Potential/actual use	Comment
Blood	Plasma for edible use, pet food and aquaculture use	
Bovine serum albumin, enzymes, growth factors	Blood plasma is used for edible use overseas. Plasma is produced for pet food and aquaculture use in Australia.	
Foetal calf serum	Cell culture	Used extensively but high price has encouraged the use of alternatives.

Co-product item	Potential/actual use	Comment
Tallow	Biodiesel production	Biodiesel is a potential alternative to established uses of tallow. About 30,000-50,000 tonnes of tallow are expected to be used in Australia to make biodiesel in 2009.
Hides	Collagen for sausages casing wound dressing, tissue sealants orthopaedic implant coatings injectable collagen and isinglass	Collagen casing produced from hides is well established in Australia and overseas. Other uses are small scale or potential uses of bovine collagen.
Hide pieces and bone	Gelatin for food use, capsules and pill coatings; photographic use	
Glue		
Pet food treats	Gelatin for food and pharmaceutical use is produced in Australia. Small quantities of hide pieces are used to make pet food treats.	
Lungs	Heparin blood thinner and anti-coagulant for pharmaceutical use.	Lungs are exported for pharmaceutical use
Trachea	Chondroitin sulphate and trachea extract for arthritis treatment.	Trachea is used in Australia to make extract for arthritis treatments. Trachea could be exported to China for chondroitin production but prices are low.
Gall	Cleaning agent for leather, paint and dyes, steroid pre-cursors.	Concentrated gall is exported for production of mixed crude bile salts and products derived from bile salts.
Intestines	Surgical sutures, tennis racquet strings musical instrument strings, heparin from the mucosa	Production of sutures and tennis strings is no longer carried out in Australia. There may be a small export market for intestinal serosa.
Pancreas	Insulin and pancreas extracts	Pancreas-derived insulin and other pancreas preparations are no longer produced in Australia. There may be some production overseas.
Nasal septum	Chondroitin sulphate	No production in Australia
Bones	Edible bone extract, bone char, ceramics, gelatin for photographic use. Ossein, Dicalcium phosphate, glue	Bone extract is produced in Australia. Use of bone to make photographic gelatin has almost disappeared due the prominence of digital photography. Other uses of bone may occur overseas
Horns	Organic fertiliser	Horns are reputed to be an excellent fertiliser and there may be some cottage industry use.
Hooves	Glue, neatsfoot oil	Hoof glue and neatsfoot oil has been mostly replaced by synthetics.
Thyroid	Thyroid extracts for pharmaceutical use	Thyroid extracts are produced overseas
Calf stomach	Rennet for cheese making	Rennet from calf vells is still used in cheese making

In an MLA project conducted by CSIRO[1], potential alternative co-products were investigated and prioritised after consultation with industry partners. Co-products that appeared to have commercial application but which have not been fully developed are summarised below.

6.2.1 Production of bone stock and meat extracts

The market for meat and bone extracts in Asia was reported to be US$49 million in 1992[1]. Bone stocks are used in a range of food industry applications including instant soups, ramen noodle soups, and soup bases.

The process for production of bone stock is summarised in Table 6.1

Resource: Preparation of bone stock brochure in MLA Advisory Package "Novel co-products from the meat industry"

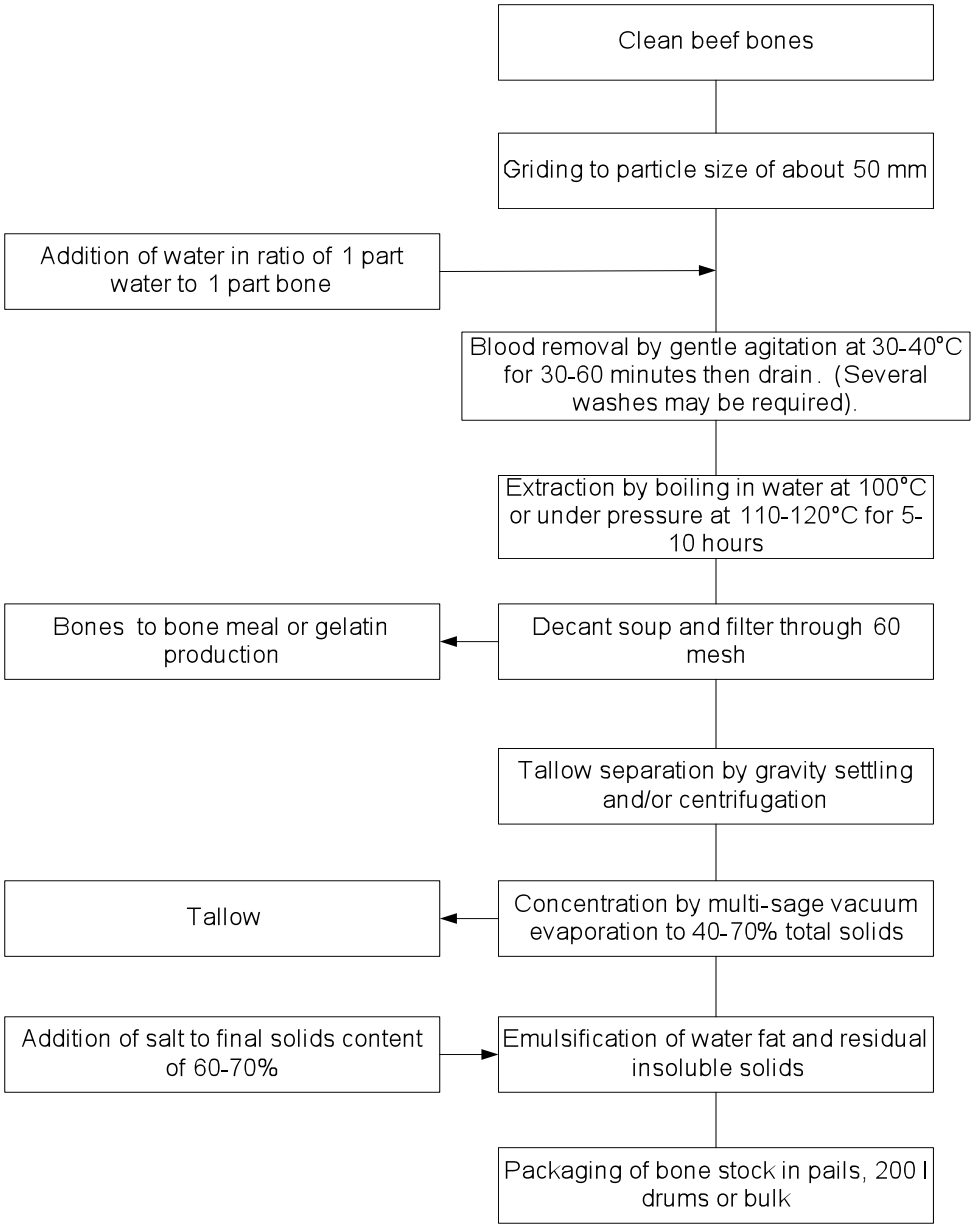

Figure 6.1: Summary of bone stock production

6.2.2 Edible meat powders and extracts

Meat extracts are co-products of meat canning. Meat for some canned products is pre-cooked in water. The soup produced by pre-cooking is concentrated by evaporation to about 70% solids content or is dried as a soluble meat powder. The main product of the operation is canned meat and the extract is a secondary product. If extracts are produced separately from canning operations, an outlet for the cooked meat must be found to make the process economically viable. One option is to dry the cooked meat to produce a meat powder

The process for meat extract and powder production is summarised in Figure 6.2

Extraction of soluble proteins from meat by cooking is inconsistent and produces extracts of variable quality. Use of enzymes such as papain, bromelain and other proteases can increase yields, reduce the extraction time and produce more consistent results. However use of enzymes may affect the flavour profile of the extract and the enzyme and extraction conditions must be selected to give the required flavour.

Resource: Edible meat powders and extracts brochure in MLA Advisory Package "Novel co-products from the meat industry"

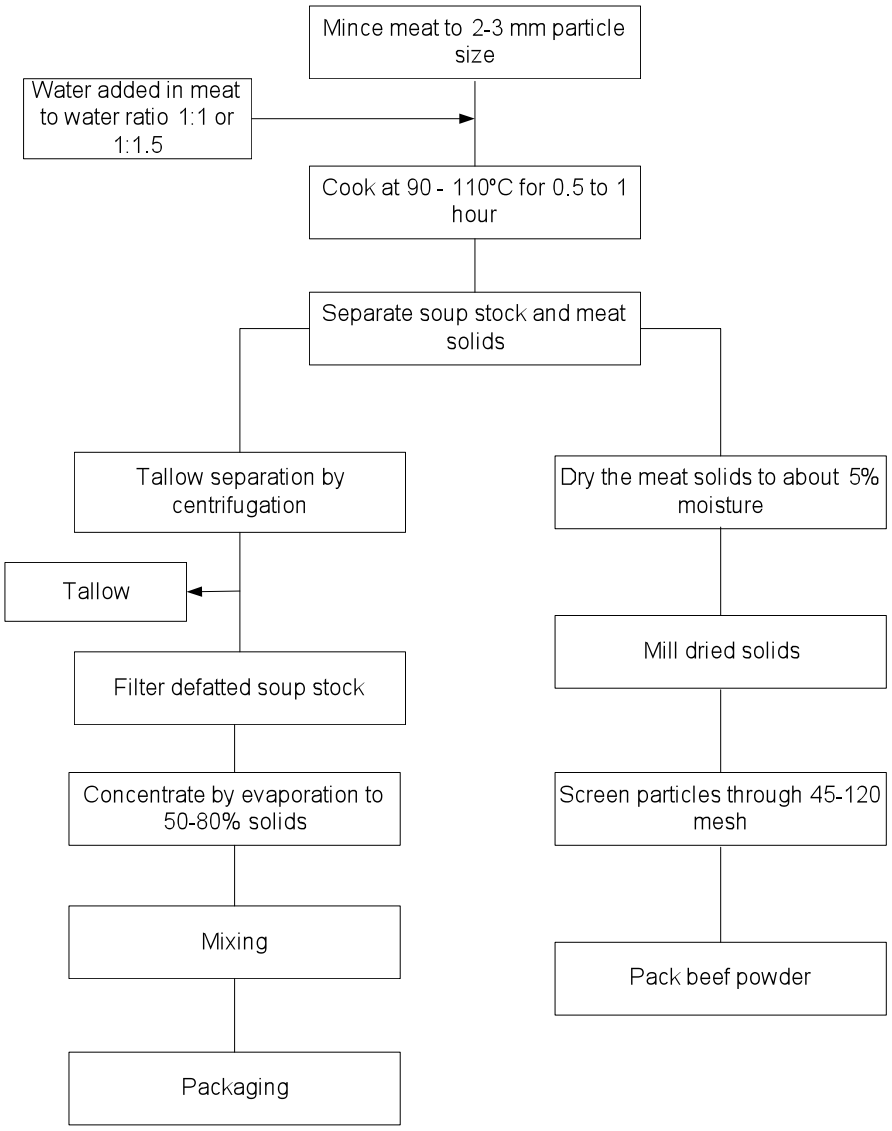

Figure 6.2: Summary of production of meat extracts and powders

6.2.3 Recovery of proteins and enzymes from blood and offal

Some proteins that can be recovered from offal and blood and which may have commercial application are listed below.

6.2.3.1 Aprotinin

Aprotinin is a low molecular weight protein that can be obtained from the pancreas, lung and blood. Aprotinin is a protease inhibitor i.e. it can prevent the break down of protein by enzymes. Its main application is as an additive in diagnostic kits to prolong shelf life. It may be used clinically to inactivate proteases released into the blood steam of shock victims after coronary attacks.

The market for aprotinin is small. About 5 grams can be recovered from 50 kg of fresh lung. The retail value of 5 grams of highly purified aprotinin is about $32,000 (1996 value).

6.2.4 Transglutaminase

Transglutaminase (TGase) is a class of enzymes that can bind protein molecules together. TGase is present in blood plasma. It is reported to have medical, nutritional and food processing applications. It is an important component in fibrin glue which is used in surgical techniques in Europe. It has been used in the food industry to cold-bind proteins e.g. to make steak-like products from lower value meat pieces, and to incorporate amino acids into proteins to improve nutritional and functional properties. The strong gelling properties of fish surimi is due to the action of TGase in fish muscle.

TGase derived from bacteria is more widely used than bovine plasma TGase.

The yield of crude TGase in powder form is about 5 kg from one tonne of plasma and production costs are about $50 per kg. The yield of purified TGase is about 4 kg per tonne of plasma and production costs are $100-$500 per kg.

6.2.5 Fibronectin

Fibronectins are cell surface and blood glycoproteins. They work as cell attachment factors and can be used in the growth of cells that have to be anchored to a substrate. The world wide market for fibronectin is estimated to be about $5 million. The major use for fibronectins is in cell culture.

Resource: Recovery of specific proteins and enzymes from blood and offal Part 1 Aprotinin, transglutaminase, fibronectin, and related proteins brochure in MLA Advisory Package “Novel co-products from the meat industry”

6.2.6 Cell releasate

Cell releasate is an alternative to foetal blood serum used to stimulate growth in cell culture. It may also be useful in animal production. It may stimulate animal growth, particularly in pigs, when used in combination with spray-dried plasma powder in feeds.

Cell releasate is produced (or released) from blood cells. It can be made from adult bovine blood cells. Whole blood is centrifuged to separate cells and plasma. The cells are washed to remove plasma proteins and are challenged with thrombin and calcium. This stimulates production of extracellular releasate which is collected by centrifugation. The volume of releasate is reported to be equivalent to the initial volume of blood.

The cost of producing releasate for use in cell culture is reported to be $12 per litre at a production rate of 700 litres per week. A cruder preparation suitable as an animal feed supplement could be produced for about $1 per litre.

Growth rates in cell culture media containing cell releasate are not as fast as in media containing foetal serum. However, the advantages of blood releasate are consistency of the product; reduction of the protein content in the growth medium; and use of proteins that are certifiably free from viruses.

It is estimated that the value of serum-free releasate in cell culture media could be US$1 million to 1.8 million per year.

Resource: Recovery of specific proteins and enzymes from blood and offal Part 2 Growth factors brochure in MLA Advisory Package “Novel co-products from the meat industry”

6.2.7 Stick water recovery

Stick water generated by continuous wet rendering plants contains protein, other solids and fat. The components of stick water represent a loss of yield of rendered product and are a disposal cost if discharged to effluent without recovery of fat and solids. The composition of stick waters depends on the rendering system and operational conditions. In an MLA-funded investigation by CSIRO the composition of continuously wet rendered stick water was as shown in Table 6.2[1].

The stick water represented in Table 6.2 was a gell or viscous when cooled to 25 or 27ºC indicating a high collagen content.

Table 6.2: Example of composition of a stick water from continuous wet rendering

	Stick water	Stick water plus separator sludge
Average fat %	1.47	2.83
Average protein %	4.35	2.3
Total solids %	6.28	8.37

About 12 to 18% of the solids in stick water can be recovered by further centrifugation. A better method of recovering solids is to concentrate stick water by evaporation. The concentrate produced by evaporation can be dried with other solids to increase
meat meal yield and the condensate can be discharged as relatively clean waste water.

After evaporation, less than 0.25% of the stick water organic and nutrient loads remain in the condensate.

The viscosity of stick water limited the capacity of the two-sage evaporator used in trials. The viscosity of stick water can be effectively reduced by treatment
with enzymes although the improvements in evaporator performance have not been confirmed. The cost of enzyme treatment was about $30 per 30,000 litre of stick water.

Resource: Stickwater recovery brochure in MLA Advisory Package "Novel co-products from the meat industry"

6.2.8 Bovine serum albumin (BSA)

Serum albumin occurs in small quantities in blood. The
recoverable yield from plasma is about 2%. Over 80 uses of serum albumin have been identified in Australia
and New Zealand. The market for BSA is well established but other products from milk protein and potentially products produced by biotechnology compete with BSA.

BSA is produced in different grades and prices can range from $4,000 to $50,000 per kg

There are several methods of producing BSA. The most applicable for use in the meat industry is selective denaturation. The advantages of this method are:

- the process is relatively simple and produces a yield of 20 kg per tonne of plasma;
- it produces product with high protein purity;
- it can be used with bovine, ovine and porcine plasma;
- it uses equipment that is generally available for the food and wine industry.

The process involves heat treatment of plasma, vacuum filtration, carbon filtration, polishing, ultra-filtration, microfiltration and drying such as freeze drying or spray drying.

The plasma used to make BSA must be prepared from blood collected as an edible grade. If edible plasma is available to produce BSA other plasma components such as aprotinin and immuno gamma globulin can be co-produced to improve the economics of production.

Resource: Manufacture of serum albumin in MLA Advisory Package "Novel Co-products from the Meat Industry"

6.3 MLA Work

MLA has conducted some specific projects to investigate opportunities to produce alternative co-products

6.3.1 Co-products Development

This project evaluated new co-product opportunities and process technologies. It was intended to establish collaborative links with industry partners to further develop opportunities[1].

Initially the project focused on meat and bone extracts, meat powders and granules and hydrolysed protein products. These products were considered to have values of $5 to $100 per kg. After initial feasibility studies of a range of possible processes and products, commercial partners were approached to determine which processes should be further investigated with a
view to commercial development and implementation.

Other priority areas for product and technology development were identified as:

- cleaning meat from bone;

- production of low fat high protein meals;
- processing of collagenous wastes;
- blood processing and plasma recovery;
- protein recovery from stick water.

Experimental work included extraction of collagen from waste from casing processing; characterisation of edible grade stick water; use of enzymes and high pressure water to remove meat and fat from bones. In addition, a two stage evaporator was installed at a rendering plant to concentrate stick water. This included the use of enzymes to reduce the viscosity of the stick water concentrate.

Further projects arose out of this work including an evaluation of the recovery of co-product streams from commercial production of isolated muscle protein (IMP) and assessment of the ability of Australian renderers to comply with new EU regulations.

Two other confidential projects were conducted with industry partners. One was production of isinglass from meat collagen. The other was the use of enzymic hydrolysis to reduce the viscosity of concentrated stick water.

6.3.2Non Food/Feed Uses of Rendered Products

The largest portion of non-edible material from slaughter operations is rendered to produce meat meal for animal feed and tallow for soap making, and other industrial uses. Restrictions on the use of animal protein meals in feeds following the emergence of BSE and concerns about further restrictions prompted investigations of alternative uses for rendered product and the raw materials for rendering[2].

The materials going into and out of rendering plants were investigated in order to match the materials with possible alternative uses. The opportunities identified were:

- use of hard bone to produce hydroxyapatite (HAP);
- recovery of fugitive proteins, e.g. proteins recovered from effluents, to make adhesives;
- use of fugitive proteins to make protein-based surfactants.

A wide range of uses for fatty acid esters including production of biodiesel was also identified.

There are established uses for synthetic HAP. To break into this market it will be necessary to develop processes for extracting bone apatite and demonstrate the performance of bone-derived HAP.

The largest use of adhesive is in wood products such as plywood and particle board. There is a large potential market of alternative adhesive formulations and extensive work has been done on soy protein adhesives. Research groups that have experience with soy-based adhesives should be able to assess the potential for producing adhesives from rendered material.

Other uses for rendered products as surfactants or protein-films are not promising.

6.3.3Economic evaluation of the bovine plasma fractionation process

Potential opportunities for processing blood include separation into plasma and red cells and further fractionation of the plasma to produce BSA, protease inhibitor (aprotinin) and immuno gamma globulin (IgG)[3].

The cost of capital equipment and production costs to produce blood plasma and fractionated products from blood plasma were evaluated in this project.

Capital costs for equipment, including buildings to produce blood plasma were estimated to be $950,500 for a 45,000 litre/day plant and $512,500 for a 22,500 l/day plant. Capital costs, including buildings to produce plasma fractions were estimated to be $6,868,200 for a 22,500 l/day plant and $4,588,000 for an 11,250 l/day plant.

Assuming a value of $0.15 per litre for plasma the annual net return for a 45,000 litre/day plant was estimated to be $631,549 and $200,717 for a 22,500 litre/day plant. The annual net return from a plasma fractionating plant producing BSA, protease inhibitor and IgG was estimated to be $3,952,976 for a 22,500 l/day plant and $1,604,464 for an 11,250 l/day plant.

6.3.4Hydroxyapatite (HAP) from Hard Bone

Hydroxyapatite (HAP) is a calcium phosphate compound that makes up the mineral content of bone. It is also in naturally occurring minerals and can be produced synthetically. The Fats and Proteins Research Foundation in the USA and European Renderers Association had identified bone-derived HAP as a potential co-product of the meat industry.

A literature search was conducted, including patent searches, to discover what applications for the use of HAP have been identified[4]. Almost all references referred to synthetic HAP and there appears to be very little information about uses of bone-derived HAP in the public arena.

The main applications for HAP in large volumes are in catalytic conversions e.g. oxidation of methane to synthesis gas (hydrogen and carbon dioxide) removal of nitrogen oxides from flue gas and hydroprocessing (removal of sulphur and nitrogen) of petroleum feed stock. HAP can also be used as an absorbent of heavy metals. Further research is required to determine the appropriate processing conditions and performance of bone-derived HAP in these applications.

There are also medical applications of HAP as bone implants but these have not been considered for bone derived-HAP.

6.3.5 Extraction and use of collagen

There is an established use of collagen extracted from cattle hides to make sausage casings. Other applications for the use of collagen may expand opportunities for marketing collagen as a meat industry co-product.

A patent search was conducted to identify potential applications for the use of bovine and ovine derived collagen[5]. The search identified 359 international, USA and Australian patent applications or granted patents. The abstracts of these patents have been classified into categories of:

- wound dressings/tissue repair;
- pharmaceutical preparations; cosmetic preparation;
- foodstuffs casings;
- collagen extraction/preparation;
- miscellaneous.

The bulk of the patents cover wound and tissue repair. The patents originate from universities, medical research facilities and lesser known health companies. There were a significant number of documents in the name of Collagen Corp. Patents related to the use of collagen in cosmetics originated from The Boots Company, L'Oreal and Merck Gesellschaft.

6.4 References

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Co-products Compendium

Summary of Co-products Program Reports

Meat & Livestock Australia

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General Projects

Co-products Price Monitor A.COP.0059

Project Aims

- Compile monthly reports of co-product prices and market analysis.

Introduction

The co-products price monitor has been produced continuously since 1992. It was delivered quarterly from 1992 to 1999 and has been prepared monthly since 1999. The project includes maintaining a price data base that preserves co-products prices since 1992.

Information in the co-products monitor is used by MLA in market reports; it is used in strategic planning for co-product research programs; companies that contribute to the monitor use the information for benchmarking; the historical prices are used by the meat industry for business analysis.

Major Outcomes

1. A monthly report on co-products prices is prepared.

Description of project

Export meat plants and meat traders are surveyed on a monthly basis to obtain current information on co-product prices. Prices are collated and average prices and the high-low range is reported. Exporters and traders are interviewed to obtain information on market conditions and comments on the state of markets Market commentary is divided into various categories of edible offal, rendered products and hides and skins.

A market model that shows the value of co-products from different types of stock, based on assumed yields, is updated each month.

Implementation and uptake

The report is used on a regular basis to benchmark prices and to produce MLA market reports.

Further work or update

The project is continuing.

Co-products Development STR.008

Project Aims

- Evaluate new co-product opportunities and process technologies;
- Identify and establish collaborative links between industry partners interested in prioritised co-product development opportunities;
- Conduct experimental and market research to compile product and technology options for new products.

Introduction

This project explored useful and innovative ways of producing co-products to increase overall returns. Initially the project focussed on meat and bone extracts, meat powders and granules and protein hydrolysate products. These products were considered to have values of $5 to $100 per kg. After initial feasibility studies of a range of possible processes and products, commercial partners were approached to determine which processes should be further investigated with a view to commercial development and implementation.

Major Outcomes

1. A range of innovative co-product opportunities have been evaluated.

Project description

The current market opportunities for co-products were evaluated. Priority areas for product and technology development were identified as meat extracts, cleaning meat from bone, production of low fat high protein meals processing of collagenous wastes, blood processing and plasma recovery and protein recovery from stick water.

Experimental work included extraction of collagen from waste from casing processing, characterisation of edible grade stick water, use of enzymes and high pressure water to removed meat and fat from bones. In addition, a two stage evaporator was installed at a rendering plant to concentrate stick water. This included the use of enzymes to reduce the viscosity of the stick water concentrate.

Further projects arose out of this work including an evaluation of the recovery of co-product streams from commercial production of isolated muscle protein (IMP) and assessment of the ability of Australian rendering to comply with new EU regulations.

Two other confidential projects were conducted with industry partners. One was production of isinglass from meat collagen. The other was the use of enzymic hydrolysis to reduce the viscosity of concentrated stick water.

Implementation and uptake

This project represents one of the most concerted efforts to develop innovative co-product opportunities. It is claimed that work on enzymic hydrolysis to reduce the viscosity of concentrated stick water to aid drying was adopted by a commercial partner but it is not known if this technology is still used. There are examples of technologies that was investigated in this project being used but not necessarily as a result of the project. These examples are concentration of stick water by evaporation, production of dried blood plasma powder and production of bone extract and meat extract.

The work on rendering heat treatments in relation to EU regulations, conducted as a separated project, has been used by DAFF and AQIS in market access negotiations.

Further work or update

No further work required

Edible Offal Projects

Best Practice for Offal Collection A.COP.0037

Project Aims

- Benchmark typical yields and recoveries of edible offal from different classes of stock;
- Provide strategies for maximising the recovery and quality of offal;
- Demonstrate the value of the strategies through improved recovery at three plants.

Introduction

The potential value of offal collected from a 240kg steer is about $75 but in practice about $45 to $60 worth of offal is recovered. The project examined quality, yield and recovery rates that affect the value of offal from different classes of livestock.

Major Outcomes

1. An average beef abattoir can improve offal yields by about $250,000 a year and an average sheep abattoir by about $140,000.
2. Monitoring production can help improve yields and spreadsheet tools are available to help track production.

Description of project

Offal recovery from cattle and sheep was measured on two occasions at eight abattoirs. Three abattoirs provided further data on offal collection over a six week period to provide a picture of the consistency of offal collection.

No significant quality issues were identified. Use of the refrigeration index to assess satisfactory cooling rates and adherence to AUS-MEAT specifications produces offal of acceptable quality.

Yield and recovery of offal are affected by structural impediments, shortage of labour and lack of information on yields.

The report provides details about offal yields and recoveries both before and after taking into account condemnations. The details are a good guide to what an abattoir should expect to recover from different classes of stock and point to opportunities for increases in offal recovery.

A spreadsheet tool was developed to help abattoir keep track of offal production by comparing weekly recoveries over time. It is expected that use of the tool combined with management practices can deliver an average increase in offal value of $2 per head for beef, equivalent to over $250,000 per year for a daily kill of 500 head.

Implementation and uptake

The project report is a useful guide to expected yields of offal. The spreadsheet tool provides a useful basis for demonstrating improvements in yields. Some abattoirs have good systems of control over offal collection but for those that have not regarded offal collection as a management priority, the report provides an indication of the financial benefits of improving yields and how to achieve better yields.

The report has been summarised in a Meat Technology Update and this brought some response from industry.

Further work or update

The project was completed in 2007 and is up-to-date. No further work is required.

Storage life of frozen edible offal exported to Saudi Arabia SASO.01

Project Aims

- To study the storage lives of a range of frozen edible offal products being traded to Saudi Arabia and evaluate the cold chain from offal packaging through to receipt at the distribution warehouses in Saudi Arabia;
- To determine an appropriate commercial shelf life for offals.

Introduction

The Kingdom of Saudi Arabia is a major market for Australian sheep and beef offals. In 1996, new standards significantly reduced the entry times and total shelf lives for several products including hearts, kidneys, tripes, brains, spleens and testes.

A meeting between senior staff from the Saudi Arabia Standards Organisation and Australian representatives agreed that a trial should be undertaken for the purpose of determining timeframes for the entry of various offal products into Saudi Arabia.

Major Outcomes

1. The shelf life of frozen offal exported to Saudi Arabia should be set at 6 months or 90 months for liver. The entry date should be two months less than the expiry date.

Description of project

Frozen offals were exported to Saudi Arabia where they were assessed at intervals. Initially staff from the SASO visited Australia for training in sensory assessment and to agree protocols for preparing offals for assessment.

Logging of temperatures of product indicated that frozen offal stored in Saudi Arabia was held at -10°C or higher.

It was determined that the shelf life of frozen brains in the storage conditions that applied in Saudi Arabia was at least 6 months. The storage life of tripe was 6 months. The storage life of liver could not be determined because of changes in methods of preparation of liver for assessment during the trial.

It was recommended that entry times be set at two weeks less than expiry dates instead of 50% of expiry date because it is better to store product in Australia than in Saudi Arabia.

Implementation and uptake

The results of this research have been implemented.

Further work or update

No follow up required.

Microbiology of Variety Meats COPR.008

Project Aims

- Determine the microbiological quality of offal;
- Recommend ways to improve the microbiological quality of offal.

Introduction

Some offal tissues are sterile in the body while others may be contaminated from their environment e.g. stomach and tongue. Offal items can become contaminated when removed from the body and because they are warm they may support microbial growth.

Major Outcomes

1. The level of microbial contamination of offals is low.
2. A 5 to 10 second wash of livers can significantly reduce microbial counts.

Description of project

Samples of liver, kidney, hearts, rumen pillars and paunch tripe were examined for microbiological condition. The microbial condition of products on the viscera table, in the packing room and after freezing was compared. Alternative procedures such as washing livers and better washing and trimming of mountain chain tripe were assessed for their effect on the microbial quality of offal.

The total counts and coliform counts were considered to be excellent on all products. The microbial quality of liver can be significantly improved by a short (5 to 10 second) wash in water. Better washing and trimming of mountain chain tripe improved visual appearance and had a small improvement on microbial quality. There was little difference in the microbial counts on offal on the slaughter floor, in the packing room and after freezing, except for kidney. There was an unexplained increase in counts on kidneys after inspection. Kidneys are contaminated at the time of removal from carcases due to the use of dirty gloves.

Implementation and uptake

The results of this project were workshopped in 1998 and along with further work on recovery of edible product from burst paunches has resulted in an AQIS Meat Notice about alternative techniques for the recovery of offal. The report provides benchmarks for the microbial quality of offal and suggestions for improving quality. This information is probably not widely known but could be useful.

Further work or update

No further work is required.

Offal Pathology: an Analysis of Meat Inspection Procedures COPR.09

Project Aims

- To assess the appropriateness of dispositions of offal made by meat inspectors.

Introduction

Offals may be assessed as fit for human consumption, suitable for pet food or be condemned and then rendered as inedible material. The value of offal depends on the dispostion made by meat inspectors. The accuracy of decisions about dispostion can result in loss of revenue if the decisions are too conservative or could increase the public health risk if the decisions are too liberal.

Major Outcomes

1. The loss of value of livers and kidney due to unnecessary downgrading by meat inspectors is about $27 million per year.

Description of project

Livers and kidneys that had been inspected by AQIS meat inspectors were further examined by microscopic examination of histological samples or by assessment by gross inspection. These examinations were designed to confirm the diagnoses and decisions about disposition made by the meat inspectors.

Of 603 livers either condemned or graded as suitable only for pet food, 114 (19%) were considered to be fit for human consumption on further examination. Of 749 kidneys graded as suitable for pet food, 188 (25%) were considered fit for human consumption on further examination.

The agreement between diagnoses made by meat inspectors on-line and diagnosis made after further examination was rated as moderate or fair. There is room for improvement in decisions about disposition but pushing the limits of accurate dispositions would increase the risk of offal being inappropriately assigned for human consumption.

Major causes of downgrading of livers were hydatid cysts and liver fluke. The conditions are both preventable on farm.

The results from this survey were extrapolated across the Australian meat industry. It was estimated that the loss of value of livers due to inaccurate decisions about disposition reduces the value of livers by about $25 million per year and the loss of value of kidneys is about $2.5 million per year.

Implementation and uptake

There has been discussion between AQIS and industry as a result of this project but it is not clear if there have been any changes to meat inspection practices or training. An atlas of pathology of liver and kidney was produced to assist training of inspectors.

Further work or update

Feedback to producers about the pathology of offal could have more impact on increasing the value of offal than trying to tweak the accuracy of dispositions made by meat inspectors

Enhanced Recovery of Co-products – Mountain Chain and Tripe PRCOP.016

Project Aims

- Use microbiological and visual criteria to assess modifications to the processes for the recovery of tripe and mountain chain from burst paunches.
- To reduce water use in tripe processing.

Introduction

Some the inefficiencies in recovering mountain chain and tripe from paunches are: losses due to contamination from burst paunches; substantial water use to decontaminate and cool product; and delayed cooling due to large carton size.

Major Outcomes

1. Recovery of products from burst paunches could be worth $226,000 per year at the works concerned.
2. Modified processing techniques could save 12 Ml of water per year worth $60,000 in receival and effluent costs.

Description of project

A microbiological baseline for scalded tripe and mountain chain was set by testing products for total count and coliforms. The standard production procedure was modified by dry dumping paunches and recovering products from paunches contaminated with ingesta on the outside.

When paunches were dry-dumped, the microbiological condition of scalded tripe was no different to the baseline set with the standard procedure. The total counts and coliforms in mountain chain from dry-dumped paunch were slightly higher than the baseline counts. The microbiological condition of tripe and mountain chain recovered from deliberately burst paunches was no different from the baseline.

Other modifications to the tripe process included dispensing with the final rinse in cooling water. This reduced the microbial count on the product and improved the organoleptic quality through reducing added water.

Implementation and uptake

This project resulted in AQIS Meat Notice 2001/21 which allows for recovery of edible product from contaminated paunches. Other establishments have followed up the research in this project to recover product from burst paunches.

Further work or update

No further work required. The guidelines have been set for validating alternative procedures for recovery of offal and establishments can follow these procedures.

Recovery of Sheep Brains and Tongues PRCOPVA.001

Project Aims

- Develop procedures for hygienic collection of brains and tongues from sheep;
- Improve recovery of brains and tongues for human consumption to 65 to 100% of available offal.

Introduction

Recovery of lamb brains and tongues for human consumption is inhibited by inspection and hygiene issues associated with the inverted dressing systems. A collection system that allows brains and tongues to remain correlated with carcases until the final carcase inspection should make it possible for an abattoir to save brains and tongues.

Major Outcomes

1. An alternative protocol for recovery of brains and tongues from lambs has been approved
2. Product worth up to $750,000 per year could be recovered at the abattoir involved.

Description of project

In discussions with AQIS it was agreed that heads would be cut off immediately after bleeding and brains and tongues could be recovered from the unskinned heads. Under this protocol brains and tongues had to be retained in batches until the carcases were inspected.

A head processing room was constructed to collect brains and tongues.

The tongues and brains were identified in batches of 25. If a carcase was condemned, the corresponding batch of 25 tongues and brains were condemned.

Samples of tongues and brains collected according to these procedures were tested for total plate count and E. coli. Results were compared with tongues and brains collected in the conventional manner. The E. coli counts on brains and tongues collected using the alternative protocol were lower than counts on the brains and tongues collected by conventional methods. The total counts were similar for both collection systems.

Implementation and uptake

The results of the project were submitted to the Meat Standards Committee (MSC). The MSC approved the alternative protocol for recovery of brains and tongues at the abattoir concerned. Other abattoirs have also followed the procedures outlined in the report to get approval for alternative protocols for recovery of brains and tongues.

Further work or update

No follow up required.

Dehairing of Cattle and Sheep Heads and Hooves – Pilot Technology Evaluation PSHIP.169

Project Aims

- To develop a process for the removal of hair from beef feet;

Introduction

There is a market for dehaired beef feet in Korea and Indonesia. Australian product does not always match the quality of product produced in Korea. If a suitable product can be produced for the Korean market, the revenue from a 200,000 head per year cattle kill is about $2.7 million for edible beef feet compared with $400,000 if the feet are rendered.

Major Outcomes

1. The potential profit from producing dehaired beef feet for the Korean market is $500,000 per year based on recovering 40% of available feet from and annual kill of 200,000.

Description of project

A market study was conducted to establish the size of the market for beef feet and the required specifications. This study included a comparison of the preferred Korea domestic product and the imported Australian product.

Equipment to scald and dehair feet and removed toenails was installed at an abattoir. Minor changes to the method of recovering feet on the slaughter floor were made. In initial trials the amount of labour required to produce an item of acceptable quality was too high because hair not removed by the dehairing machine had to be removed manually. With development to the process, hair removal was improved and a satisfactory product produced.

The cost of the equipment was $132,000. Operating costs were estimated to be $824,000 per year (including amortization of equipment) to produce 623 tonnes of product. The margin on sales was estimated to be $500,728 per year.

Implementation and uptake

The market for beef feet is limited and seasonal. However the report provides the information required for operators to produce beef feet if the market opportunity arises.

Further work or update

No follow up required.

Beef and Lamb Offal Specifications for China PRCOP.033A

Project Aims

- To investigate offal products required in China;
- To assess Australia's ability to deliver the required products under current regulations.

Introduction

Meat and Livestock Australia's regional office identified edible offal as a major opportunity for Australian processors. However, impediments to supplying the market are: lack of understanding of Chinese market specifications; and AQIS requirements for HACCP-based process design for offal items.

Major Outcomes

1. Required specifications for offal in China in general match the specifications in the AHM.

Description of project

A delegation of meat industry representatives and MLA met with wholesalers in four locations in China including Hong Kong. The delegation also visited markets and cold stores, examined products and discussed requirements with traders.

In general, the specifications for offal required in China are similar to the specification in the Australian Handbook of Meat. The report provides preferred specifications and other background about use and preparation of offals in demand in China. Several items in demand but which cannot be exported because of restrictive Australian regulations, were identified e.g. uncleaned omasum, non-flushed pizzle and kidney with fat on.

Implementation and uptake

Since the preparation of this report there have been difficulties in exporting some offals (e.g. tripe) to China due to hygiene issue raised by Chinese authorities. This has inhibited an agreement with AQIS to export offal processed by alternative protocols which take into account customer requirements and intended use. China, particularly Hong Kong, remains a major market for tripe and sheep kidney.

Further work or update

No follow up required.

Risk Analysis Survey of Sheep Meat Processors for Improved Recovery of Offal and other Co-products PRCOP.029

Project Aims

- Determine the current recovery rate and value of offal and other co-products in sheep meat processing plants;
- Determine whether improved recovery rates of co-products are viable.

Introduction

The project was conducted to find out the value of sheep meat offal and co-products and determine the extent and causes of loss of value through condemnation and downgrading.

Major Outcomes

1. Downgrading of sheep co-products due to condemnation or damage costs about $3.5 million for offal and $6.3 million for skins.
2. Grass seeds in skins and liver fluke are major causes of losses.

Description of project

Eleven sheep and lamb processors were surveyed to find out the prevalence and cost of faults that cause loss of value of co-products. There was considerable variation in the co-products collected between establishments. For example, all establishments recovered 100% of skins and runners; 97% of livers were collected for edible use of pet food. It was estimated that 27% of liver, 10% of tripe 7.6% of tongues 6.5% of hearts are lost due to condemnation. There are further losses due to downgrading because of damage during collection. Downgrading due to damage was estimated to cost about $3.5 million for offal and $6.5 million for skins.

Conditions that cause the major loss of value of lamb co-products were grass seed infestation of skins and liver fluke. Cheesy gland and liver fluke were the main causes of losses in hogget and mutton.

The biggest economic losses arise from downgrading of skins for grass seed and livers for fluke. These are farm management issues and feedback to farmers could help reduce these losses.

Implementation and uptake

There does not appear to be any implementation or uptake of this work.

Further work or update

This project has been followed up by the best practice for offal collection project.

Edible Offal Market Study M.256

Project Aims

- Examine the structure and size of the offal market;
- Identify industry strengths and weaknesses;
- Recommend marketing and R&D strategies to increase offal utilization.

Introduction

At the time of this project, the estimated value of beef and sheep offal including pet food was $170 million. Beef offal was valued at $15.58 per head or 2% of the value of carcase products.

Description of project

Sectors of the domestic and export markets for offal were surveyed to determine customer opinions of Australian offal. The report includes extensive statistics on volumes and values of offal in different markets. Quality issues and inconsistent supply of fresh product were disadvantages in the domestic market. The type of offal exported to various export markets and the use that is made of the offal in the markets is also discussed.

Implementation and uptake

There has been a considerable change in the markets for offal since the report was written in 1993. Much of the report is not relevant today. The report was not implemented in an organised way but there has been natural development of offal markets. The report raised issues of inconsistent quality, poor recovery rates and lack of understanding of recovery rates for offal.

Further work or update

Some of the recommendations have been addresses in project A.COP.0037 “Best practice for offal collection”.

Rendering Projects

The Meat Meal and Tallow Industry and its Markets M.258 and M.829

Project Aims

- Describe the players, production, distribution structure, technology and costs involved in rendering;
- Determine strengths, weaknesses, opportunities and threats to the rendering industry;
- Revise the 1992 report with updated information in 1996.

Introduction

At the time of the initial report, it was projected that the revenue from rendered products would fall from $330 million to $120 million in 5 years.

Major Outcomes

1. Tallow has special strengths but renderers have not taken advantage of this and tallow has shown a long-term decline against better targeted competitive products.
2. Renderers have not marketed the key strengths of meat meal and have allowed their share of the intensive livestock feed market to fall.

Description of project

Both reports contain extensive statistical data on the production and exports of rendered product and world production of competitor products. The major uses of rendered products, quantities that go into different uses and quality issues raised by customers are discussed. In general, the initial report acknowledges that meat meal and tallow are by-products that are not well targeted at customers compared with competitor products. This has caused a loss of market share to competitor products.

Recommendations include establishing technical support to service user requirements; establish industry-based training; conduct R&D to improve product opportunities; facilitate long-term pricing and supply contracts; develop a strategic industry plan.

The 1996 report updated the statistics and information on product quality and added information on technology used in the industry and the revenue contribution of rendered products to the meat industry.

Implementation and uptake

These reports were seen as critical of the rendering industry and were not well received. However some of the recommendations have been followed through albeit on an ad hoc basis. Education, strategic planning, R&D on new products have all played a part in developing the industry. Some of the quality issues raised in the reports have been addressed e.g. there are now uniform specifications, but there is still room for quality improvement. The rendering industry, through the ARA, has taken an active role in promoting products in export markets using technical experts to support marketing initiatives.

The dire predictions of loss of value of rendered products have not eventuated

Further work or update

In 1993 the ABS stopped collecting data on production of rendered products. Since then it has been difficult to describe the size of the rendering industry. In 2002 the ARA conducted a survey to estimate production. There is strong need to update production figures. This information should be collated with exports and slaughter numbers to provide a current picture of the industry. This information is needed for strategic planning on an industry basis and individual company basis and is essential information for use in negotiations for market access with importing countries.

Separation of Meat Meal into Components M.745

Project Aims

- Characterize the composition of meat meal and behaviour of components during separation by screening, air tabling and air classification.

Introduction

Work on the use of meat meal in aquaculture feed indicates that meat meal with high protein, low ash and low fat would be preferred as ingredient in aquaculture diets. One option for producing low ash meat meal is to separate standard quality meat meal into high and low-ash fractions using screening or air separation techniques.

Major Outcomes

1. Low ash fractions of meat meal can be produced by air classification and air tabling techniques.

Description of project

Screening, air tabling and air classification were used to separate meat meal into fractions. In air classification, particles separate in an upward flow of air. Separations of from16:83 to 63:36 coarse material to fine material were achieved. However there was only a few percent difference between the ash and protein content of the fractions and the original meat meal.

The air table separated meal into three fractions. About 15% of meat meal was separated as bone containing 58% ash and 29% protein. With all methods of separation, fat was concentrated in the finer (low ash) particles. Fat also caused problems by blinding screens, coating the inside of the air classifier and causing balling of the fine fractions on the air table.

Implementation and uptake

Fractionation of meat meal is used at rendering plants to produce low ash meals. Commercial centrifugal air classification equipment (Gayco centrifugal separator) is used. Air tabling is also used to separate bone chips from unmilled milled meal in low temperature rendering plants.

Further work or update

No further work required.

Utilisation of the Ash Component of Meat Meal M.745

Project Aims

- Determine the potential uses of high-ash rendered meals.

Introduction

Work on the use of meat meal in aquaculture feed indicates that meat meal with high protein, low ash and low fat would be preferred as ingredient in aquaculture diets. If low ash meat meals are produced, the corollary is that there will production of high-ash fractions of meat meal. Unless the high-ash fractions can be sold for reasonable returns, the benfits of producing premium-priced low-ash meals could be lost.

Major Outcomes

1. High ash fractions of meat meal could be used in animal feeds, primarily as a phosphorus source.
2. There is a market opportunity for 15,000 tonnes per year of blood and bone or organic fertilisers based on high ash meat meal.

Description of project

Four samples of high ash meat meal were produced either by rendering bony material or by separating standard meat meals into low and high-ash fractions. The samples ranged from 37 to 60% ash. The sample produced from rendering bony material was used in fertilizer trials. The other samples were examined for composition.

The potential uses of high-ash fractions were reviewed. There are some unconventional uses of high-ash fractions including gelatine manufacture, bone char for bleaching sugar and bone china. Bone ash made for these purposes should be produced from bony materials after they are separated from other offals. High-ash meat meals can also be used in animal feeds and in fertilisers. Meals used in these applications can be produced by separating fractions of meals made from mixed raw materials.

Implementation and uptake

There are examples of rendered bone chips being used for gelatine manufacture although this market has diminished since the advent of digital photography. There are also examples of high-ash fractions of separated meat meal being used for animal feeds.

Further work or update

No further work required.

The Development of High Ash Fraction Meat Meal as "Fortified Blood & Bone" Fertilizers COPR.001

Project Aims

- Determine the cost benefit of producing a complete fertilizer from the high-ash fraction of meat meal.

Introduction

Previous studies have speculated that the value of 55% protein meat meal in aquaculture could be $1300 per tonne if the contribution of cholosterol and phosorus is taken into account. If low-ash meat meals are produced, the corollary is that there will production of ash-ash fractions of meat meal. A high-ash fraction with 36% protein may be discounted if used as stock feed by 28% of its value based on protein content. A high-ash meal may have a higher value as a fertilizer because the value of non-protein components e.g. phosphorus, may be realised.

Major Outcomes

1. In theory, the return for one tonne of 50% protein meat meal can be increased by $206 per tonne by fractionating the meat meal into 65% high-protein fraction and 35% low protein fraction which is fortified to make a complete fertilizer.

Description of project

The project is a theoretical study of the prospects of using high-ash meat meal as fertiliser. If a 50% protein meat meal is fractionated into 65% high protein (57.5% protein) fraction and 35% of 36% protein fraction, the total return can be increased from $450 per tonne to $475 per tonne if there is no increase in the value of protein in the high protein fraction and the high-ash fraction is valued at $400 per tonne. If the protein in the high-protein fraction is valued at 75% of protein in fish meal, the total value of the high and low-protein fractions is $664.

Meat meal as a fertilizer lacks potassium and magnesium and contains no humus. If a high-ash fraction of meat meal is supplemented with bentonite (magnesium source), potassium, compost, gypsum and trace elements, the ingredient cost of a fortified meat meal-based fertiliser would be $279 per tonne if the meat meal is valued at $324 per tonne. If this product is sold at $400 per tonne, the margin is $44 greater than selling the low-protein meat meal at $400 per tonne.

The market for fertiliser is estimated to be 100,000 tonnes plus 6000 to 8000 tonnes of blood and bone. To market additional blood and bone e.g. up to 78,000 tonnes, market share would have to be taken from chemical fertilisers.

Implementation and uptake

There has been no uptake although small amounts of meat meal (probably less than 5000 tonnes per year) are used in fertilizers.

Further work or update

No further work required.

High Ash Fraction meat Meal and its Potential Role and a Fertiliser in the Organic Industry COPR.006

Project Aims

- Determine the prospects for using the high-ash fraction of meat meal as an organic fertiliser.

Introduction

Work on the use of meat meal in aquaculture feed indicates that meat meal with high protein, low ash and low fat would be preferred as an ingredient in aquaculture diets. If low-ash meat meals are produced, the corollary is that there will production of high-ash fractions of meat meal. A potential option for the use of high-ash meat meals is as an organic fertiliser.

Major Outcomes

1. There are no restrictions on using meat meal as an organic fertiliser.

Description of project

The project is an assessment of the use of high-ash meat meal in organic agriculture. It included a survey of organic producers to determine the use of fertilisers in different size organic farming operations.

The report indicates that there are no barriers to the use of high-ash meat meal as an organic fertilizer. There are relatively few products available to organic farmers that supply the high nitrogen content of meat meal. High-ash meat meal would be a useful fertiliser in organic farming but the potential market size is not stated. However, there are up to 200 organic farmers who might have a significant demand for fertiliser. Survey results indicate that growers mostly use less than 5 tonnes of fertilizer a year. The market for meat meal is not likely to be much more than 1000 tonnes per year.

It is recommended that renderers market a blended complete fertiliser to organic farmers rather than sell straight meat meal.

Implementation and uptake

There has been no implementation of this work.

Further work or update

No further work required.

Biogenic Amines in Meat Meal US.021

Project Aims

- Determine the scope of the problem of biogenic amines in meat meals;
- Suggest possible strategies to minimise the occurrence of biogenic amines.

Introduction

Biogenic amines occur naturally and are also formed by bacterial conversion of free amino acids. There is evidence that biogenic amines are responsible for losses in poultry that consume diets that contain meat meal.

Major Outcomes

1. Biogenic amines in meat meal are produced during the delay between collection of raw material and rendering.

Description of project

An extensive literature search on the effects of biogenic amines on poultry and swine production was conducted. In some instances, biogenic amines may enhance growth but they also have also been shown to be toxic. In general, formation of biogenic amines is taken as an indication of spoilage.

Eighty-one samples of meat meal were tested for biogenic amines. Samples were submitted from different types of rendering plants and results are presented according to type of rendering and time delay between collection of raw material and rendering. Meat meals from continuous dry rendering had higher biogenic amines levels than samples from batch rendering. The samples from continuous system included examples of long delays between collection of raw material and rendering. Total amines in samples that were rendered within less than 6 hours of collection were mostly less than 150 mg/kg. Total amines in samples rendered up to 24 hour after collection was up to 656 mg/kg.

Pilot plant studies confirmed that biogenic amines in meat meal prepared from fresh and chilled raw material are low.

Implementation and uptake

Pressure from customers has pushed down the typical levels of biogenic amines in meat meal. This project set some benchmarks at the time but the current benchmark is below the results presented in the report.

Further work or update

No further work required.

Salmonella in Meat Meal PROCOPIC.031

Project Aims

- Assess the extent of the risk of transmission of *Salmonella* in meat meal to poultry, eggs and subsequently humans;
- To develop strategies to reduce the incidence of *Salmonella* in meat meal.

Introduction

Salmonella in meat meal is a potential source of contamination of poultry feed and could be a source of contamination of poultry and eggs. Domestic specifications for meat meal include requirements for meat meal to be *Salmonella*-free and many countries require that imported meat meal is *Salmonella*-free.

Industry requires specific scientific information, based on historical data from several sources, in order to address the perception of the risk of transmission of *Salmonella* in meat meal to poultry, eggs and subsequently humans.

Renderers also need tools to help identify and eliminate potential sources of contamination of meat meal with *Salmonella*. In order to achieve this, data is required on the extent of the potential contamination and to identify areas that can be improved.

Major Outcomes

1. The *Salmonella* Problem Solving Guide provides recommendations for the control of *Salmonella* in meat meal.

Description of project

Product and environmental samples collected from four rendering plants were tested for *Salmonella* on two occasions. A total of 280 samples were tested. After the first round of testing, the rendering plants were provided with advice about how to eliminate *Salmonella*. At the first round of testing, 25% of all samples were positive for *Salmonella* 17% were positive at the second round of testing. Specific sites of potential contamination were not identified since although *salmonella* might introduced at a “hot spot” it then becomes spread throughout equipment making it difficult to pin point the source.

As a result of these investigations, a *Salmonella* Problem Solving Guide was developed to help renderers control *Salmonella*.

Literature on serotypes of *Salmonella* in meat meal, animal feeds, poultry and humans was reviewed. While there is a similarity between *Salmonella* serotypes in poultry and humans, the serotypes in meat meal generally do not match the serotypes in poultry or humans. The exception is *Salmonella* infantis which is found in meat meal, poultry and humans.

Implementation and uptake

The *Salmonella* Problem Solving Guide has been used at Australian Renderers Association training workshops on hygienic rendering.

Further work or update

No further work is required.

Validation of Heat Treatments Used in Rendering PROCOPIC.026

Project Aims

- Assess the method of validating heat treatments used in rendering as prescribed in the Australian Standard for Hygienic Rendering of Animal Products.

Introduction

Some importing countries require that rendered product is treated according to specified times and temperatures. In Australia, the Australian Standard for Hygieinic Rendering allows for flexibility of heat treatments but requires that all heat treatments are documented and validated by testing cooked product for *Clostridium perfringens*.

The Australian Standard for Rendering is the basis for negotiating market access. It is important to demonstrate to importing countries that the heat treatments used in Australia and validated according to the Standard provide an acceptable level of biosecurity.

Major Outcomes

1. The requirements of the Australian Standard for Rendering provide an appropriate method of validating the heat treatments used in rendering.

Description of project

Rendering methods, literature relating to the ability of rendering processes to inactivate pathogenic agents and information on the risk of occurrence of pathogenic agents in raw materials for rendering were reviewed. Pathogenic agents of concern in Australian rendered products are *Salmonella*, Newcastle disease, *Bacillus anthracis*, Clostridium botulinum, and *Clostridium perfringens*. Experiments have demonstrated that *Salmonella* and viruses such a ND are eliminated in relatively mild rendering conditions. Spore-forming bacteria such as Clostridium spp. and Bacillus spp. may not be eliminated by rendering heat treatments.

Since *Clostridium perfringens* is expected to occur in raw material at levels of 300 to 600,000 per gram, testing cooked product gives an indication of the heat treatment's ability to kill this type of organism. The Australian Standard's requirement to validate heat treatments based on elimination of naturally occurring bacteria in raw material is an appropriate method of demonstrating the effectiveness of heat treatments. The requirements of the Standard should be more specific e.g. they should nominate the test method to be used and the required result.

Implementation and uptake

The Australian Standard has been amended and prescribes the use of AS 5013.16 to test for *Clostridium perfringens*, as recommended in the report. The Standard has not adopted the recommendation to test the whole aliquot of a 1 gram in 10 dilution so that results can be reported as "absent in 1 gram". The Standard allows a reporting level of <10 per gram.

Further work or update

No further work required.

Rendering Heat Treatments CS.280

Project aims

- Determine the range of rendering conditions used in Australia and assess compliance with EU and other importing country requirements;
- Review treatments that inactivate TSEs;
- Identify methods for measuring and verifying heat treatments.

Introduction

The spread of BSE caused severe restrictions on the use of meat and bone meal in the EU and precipitated new regulations about the processing of rendered products. Other countries also had public health concerns about TSEs and other pathogenic agents that could be associated with rendered products. Rendering conditions in Australia were not well documented but it was expected that heat treatments would not match the standards being introduced by the EU and possibly other countries.

Major Outcomes

1. Typical Australian rendering systems can be expected to reduce TSE infectivity by about 102 ID50/g
2. Recommendation to introduce and performance standard for rendering has been introduced in the Australian Standard for Rendering.

Project description

Renderers were surveyed to find out what heat treatment conditions were being used. One hundred and fifteen renderers were approached and sixty-three responses were received. Data on the heat treatments was collated and reported according to the different types of rendering e.g. batch dry rendering, continuous dry rendering and continuous wet rendering.

Two plants could meet the standard for rendering heat treatment set by the EU. Heat treatments at other plants were compared with the results of the research on inactivation of TSEs which led to the EU setting new rendering standards. It was concluded that while the EU standard heat treatment is expected to reduce TSE (scrapie) infectivity by at least 103.1 ID 50/g, rendering systems used in Australia can probably reduce infectivity by 102 ID50/g for continuous dry rendering systems; at least 101.2 ID50/g for batch dry rendering systems at atmospheric pressure and 101.7 to 102.5 ID50/g for continuous wet rendering with disc dryer.

Methods of measuring heat treatments were reviewed but it was concluded that a performance standard based on elimination of bacteria is the preferred method of assessing the performance of rendering plants.

Implementation and uptake

The information in this report has been used to prepare dossiers on Australia's TSE status and for assessments of Australia's Geographical BSE Risk (GBR) category.

The recommendation to develop a performance standard for rendering has been adopted. Compliance with the performance standard is a requirement of the Australian Standard for Rendering.

Further work or update

Some of the information on heat treatments used in Australia is out of date but an update is not required.

The Costs of Rendering PROCOPIC.035

Project Aims

- Establish benchmarks for the costs of rendering;
- Identify opportunities to reduce rendering costs.

Introduction

Members of the Australian Renderers Association have expressed an interest in benchmarking costs of production across the industry.

The value of rendered products fluctuates from month to month but in general prices have changed little in the last 15 years. During this time costs have gone up. For example prices have increased by 45% according to changes in the CPI. Rendered products such as tallow and meat meal are sold on the fats and oils and protein commodity markets and renderers cannot increase prices as costs go up. To maintain profitability the renderer's only option is to reduce costs. With this in mind, the MLA project was aimed at assessing current costs of rendering and identifying opportunities for cost control and reduction.

Major Outcomes

1. Costs of rendering range from $130 to $265 per tonne of finished product.
2. Choice of boiler fuel has a major impact on total rendering cost.

Description of project

In order to compare costs between rendering plants an excel-based model, which calculates costs using a standardized method, was developed. The model was developed principally to assist abattoir renderers and calculates costs per tonne of finished product or cost per kg carcases weight. The model takes into account labour, energy, R&M, interest and depreciation and environmental costs. It also takes into account yields of rendered product and allows comparisons of predicted and actual yields and costs.

The model was used to investigate costs at five rendering plants. Total costs ranged from $130 to $265 per tonne of product. Energy was the major single costs and variation in the price of different boiler fuels accounted for much of the difference in costs between plants. Energy costs were from $23 per tonne of product at a plant that used a wood-fired boiler to $112 per tonne for a plant that used delivered gas.

Opportunities to reduce costs relate to maximising energy efficiencies such as heat recovery to make hot water or to provide energy for evaporation. Minimising the water content of raw material will also reduce rendering costs

Implementation and uptake

A presentation on the cost of rendering was given at the 2007 ARA symposium. A subsequent project was conducted to implement the cost of rendering model at selected rendering plants. The ARA has introduced its own benchmarking process which looks at energy and water use rather than cost.

Further work or update

The report has not been presented in MLA format and there are errors in the spreadsheet model that should be corrected.

Implementation of Rendering Cost Model A.COP.0048

Project Aims

- Introduce the cost of rendering model at three rendering plants;
- Assess the benefits of the cost of rendering model.

Introduction

An Excel-based model for calculating rendering costs was developed as part of a previous MLA project. If the model could be used at rendering plants, it would provide a uniform method of tracking costs within the plant, showing the effect of cost control strategies and comparing key performance indicators between plants.

Major Outcomes

1. The cost of rendering model is too complex for routine use at rendering plants.
2. Costs are affected significantly by product yield and type of rendering with wet rendering being more economical than dry rendering.

Description of project

The model was introduced at six abattoir-based rendering plants. The model was demonstrated at the plants and training was provided to assist staff to use the model. The plants included both continuous wet and dry rendering plants with a variety of raw materials.

The plants varied considerably in the extent to which they used the model. Those plants that already tracked rendering costs had used the model regularly but did not find it to be any better that their custom-designed costing systems. Plants that were not used to costing rendering operations made little use of the model. This was partly because they did not have good figures to enter into the model. At these plants, rendered products were regarded as a revenue stream which provided cash flow for the abattoir operations and fine control of rendering costs was not seen as a priority.

The plants reported costs of $70 to $180 per tonne of finished product. The plant with the lowest costs used continuous wet-rendering, had very high yielding product and used natural gas at a favourable tariff. The plant with the second lowest costs ($110 per tonne of product) also used continuous wet-rendering with average yielding product.

Implementation and uptake

At the completion of the project, none of the plants continued to use the model. The model may be useful in conducting industry-wide studies but individual plants are more comfortable using their own costing models.

Further work or update

The costing model has errors that should be corrected.

Disposal of Specified Risk Material PROCOPIC.023

Project Aims

- Provide an estimate of the cost impact on the meat industry of removing SRM from animal feed;
- Provide guidelines for the disposal of SRM that cannot be used in animal feed.

Introduction

Removal of specified risk materials from animal feed is a precaution against the possible spread of BSE. Some trading partners, particularly the EU have put pressure on Australia to remove SRM from feed. Apart from reducing the risk of the spread of BSE, removal of SRM from feed could help to maintain trade in beef if a case of BSE is identified in Australia.

A Safemeat working group on SRMs requested a cost analysis of the removal of SRM from feed. One issue for such analysis is the definiation of SRM. The Safemeat working group requested that the EU definition of SRM be considered.

Major Outcomes

1. The cost of removal of SRM from feed is estimated to be $137 million per year with an addition $130 million capital expenditure.
2. The appropriate method of disposal of SRM would be to autoclave, dry and landfill.

Description of project

The quantity of SRM, based on the EU definition, was estimated to be 440,000 tonnes per year. The cost of removal of this amount of material from animal feed includes the cost of segregation of material, cost of separate processing and disposal of SRMs, loss of revenue from the rendered materials from SRMs and capital costs for segregation and disposal equipments. It was estimated that the total cost of removing SRM from feed would be $136 million per year. The capital cost of setting up facilities to segregate, process and dispose of SRM was estimated to be $130 million.

Options for alternative handling of SRM were reviewed. While there are proposed methods for safely processing SRM, most of these methods were not fully developed. Incineration is a method of disposal of SRM used overseas but Australia does not have sufficient incineration capacity and it was considered that environmental issues would make it difficult to develop sufficient incineration capacity. The recommended method of disposal of SRM is to process the material by autoclaving and drying in batch cookers followed by disposal by landfill.

Implementation and uptake

The costs of removal of SRM reported in this project have been considered by Safemeat and no action has been taken on removal of SRM to date.

Further work or update

An update of this report is being considered by Safemeat.

Influence of Operating Conditions on Protein Recovery from Blood in the Meat Industry A.BIT.005

Project Aims

- Develop a mass balance for blood processing to analyse processing efficiency;
- Evaluate effect of various methods for recovering nutrients from stick water.

Introduction

The usual method of processing blood is to coagulate the blood by direct steam injection and then separate the solid and liquid fractions by decanter centrifuge. The solids are dried to produce blood meal. The liquid phase is stick water and a considerable amount of nutrient can be lost in the stick water. The nutrients in stick water represent a loss of product and an added load in the effluent stream.

Major Outcomes

1. About 5.6% of potential product can be lost in blood stick water.
2. Simple techniques such as settling and pH adjustment can recover organic nitrogen from stick water.

Description of project

Blood processing at a commercial rendering plant was examined. An initial mass balance of input and outputs from the blood decanter indicated that protein equivalent to one tonne of blood meal was lost per daily intake of 140 tonnes of raw blood. This is a loss of 5.6% of protein processed. Settling blood stick water resulted in 53% reduction in nitrogen in the supernatant and a 35% reduction in COD. Further recovery of nutrients in stick water was investigated by ultra filtration, lowering pH, and further heating. Ultra filtration was most effective in reducing COD and TKN. COD and TKN were also reduced by lowering the pH to 4.8 and recovering precipitated solids by centrifugation. Further heating did not recover nutrients. None of the methods effectively reduced the phosphorus content of the stick water.

Implementation and uptake

The methods of reducing the nutrient content of blood stick water have not been used.

Further work or update

The project was conducted on a laboratory scale. Larger scale trials could demonstrate the benefits of simple techniques for recovering nutrient from blood stick water. A cost/benefits analysis should be conducted before doing further work.

Keith Airless Rendering Process PSHIP.133 and PSHIP.149

Project Aims

- Assess the potential benefits of the Keith airless rendering process;
- Construct and evaluate a pilot scale airless rendering system.

Introduction

Keith Engineering has developed an airless dryer that uses superheated steam as a drying medium. A commercial scale dryer has been installed in New Zealand and is used to dry bone chips for gelatine manufacture. There are potential advantages to using superheated steam as a heating source in a rendering process. Some of the claimed advantages are less odour, less oxidation during rendering, reduced fire risk, improved energy efficiency, improved nutritive value of meat meal, no boiler required and no stick water. Some of the issues to be resolved are how to separate tallow, the optimum steam temperature and impact of superheated steam on tallow.

Major Outcomes

1. A pilot scale airless rendering plant using superheated steam as a drying medium was built. Material was satisfactorily rendered material although energy use was high.

Description of project

The initial stages of the project involved an independent review of the proposed rendering system and claimed benefits. This review agreed that the airless rendering system should have benefits in terms of reduced energy use but there are several issues that can only be resolved by building a pilot plant.

In view of the recommendations of the first stage, a pilot plant rendering system using superheated steam as a heating medium was designed, built and installed at a rendering plant. The evaporation capacity of the plant was 125 kg/hr. Trials were conducted with a variety of raw materials. Modifications were made during these trials. The conclusions from the trials were that raw material was effectively cooked and free-run tallow released and recovered, steady state conditions were easy to establish and maintain, high temperatures affect tallow colour, outlet product temperatures of 140 to 150ºC give good tallow quality and appropriate moisture content in crax. The pilot plant used 5.4 MJ per kg of water evaporated compared with 3.92 MJ/kg for conventional rendering. The poor energy efficiency may be due to losses in the pilot scale plant.

Implementation and uptake

There has been no uptake of airless rendering because further development work is being conducted to demonstrate the benefits of the system.

Further work or update

Further work is required to demonstrate that the rendering system will work as a full scale commercial plant.

Quantitative Studies of the ADT Alkaline Dehydration Process PRCOP.037

Project Aims

- Determine the quality of meat meal produced by the pilot scale ADT alkali treatment;
- Determine the energy requirement of the ADT process;
- Determine the most efficient operating parameters of the ADT process.

Introduction

The ADT rendering process uses alkaline hydrolysis to treat the defatted solid fraction of material for rendering followed by drying of the hydrolysed solids at relatively low temperature. The advantages of the process are that the hydrolysation process is claimed to inactivate the BSE infective agent and hydrolysation of protein improves bioavailability. The use of low temperature also has potential benefits of lower energy costs and reduced odours.

Major Outcomes

1. The ADT process produces meat meal of equivalent quality to conventional meals at low energy cost.

Description of project

A pilot scale trailer-mounted ADT dryer and hydrolysing rendering system was built and taken to rendering plants to be tested with the defatted and dewatered solids from continuous wet rendering. Drying efficiencies of up to 135% were achieved in terms of energy required to evaporate moisture compared with in-put gas energy. This efficiency is due to using the energy content of ambient air to evaporate moisture at the low drying temperature.

Odour production was rated as very low. Product yields were about 6% higher than with other rendering systems due to the addition of alkali and retention of moisture. The biological value of the meals was tested by chicken bioassay. The performance of meals from the ADT process in chicken diets was equivalent to conventional meat meal except for ADT meal dried at 80oC.

Microbiological control of meat meal from the ADT was excellent in respect of vegetative bacteria such as Salmonella but low temperature drying failed to eliminate Clostridium perfringens added to material for drying.

Implementation and uptake

Efforts are being made to build a full scale ADT process but this has not occurred. The benefits of the process are that it has the potential to reduce energy input to rendering by using low grade energy sources such as solar. The drier is relatively low cost and would be suitable for smaller scale rendering plants.

Further work or update

Further work is required to demonstrate the ADT process in a full scale plant.

Rendering Industry Best Practice Guideline for Environmental Management PRCOPIC.036

Project Aims

- Identify key performance indicators for environmental management at rendering plants;
- Prepare guidelines for environmental management at rendering plants.

Introduction

MLA has produced environmental best practice guidelines for the meat industry with topics focussing on energy, waste water, waste solids, odour and effluent irrigation. The rendering environmental management guidelines are intended to focus on issues that specifically relate to the rendering sector of the meat industry. The rendering guidelines are intended be an added section in the MLA environmental best practice guidelines.

Major Outcomes

1. A draft EBPG for rendering has been prepared.

Description of project

All issues related to environmental management at rendering plants were reviewed. The issues are broken into odour and air quality management, water use and waste water treatment, energy including heat recovery, and current legislation. KPIs for water use are 0.35-0.8 kl of water intake per tonne of raw material and generation of 1-1.5 kl of effluent per tonne of raw material. KPIs for energy use are 760 kWh per tonne of rendered material and 3000 MJ per tonne of rendered material.

Methods of minimising odour and water use are presented and technologies for treatment of odours and water are discussed.

Implementation and uptake

The EBPG for rendering has been reviewed by the Australian Renderers Association. The ARA supports the idea of an EBPG but believes more work is required to produce a satisfactory guideline.

Further work or update

The report as presented requires editorial input. A further project to adapt the guideline in consultation with the ARA is required if the EBPG is to be used as intended.

Draft Codes of Practice for the Rendering Industry M.746

Project Aims

- Prepare a Code of Practice for the rendering industry.

Introduction

The Australian Renderers Association developed a Code of Practice in 1994. Shortly after the Victorian Meat Authority wanted to introduce a set of standards as a basis for licensing rendering plants. The VMA did not like the ARA Code and with MLA support commissioned a separate Code of Practice

Major Outcomes

1. A draft Code of Practice for Rendering was prepared.

Description of project

The report is in the form of a draft Code of Practice for rendering. It includes separate sections on inedible rendering, prime tallow production and guidelines for quality assurance.

Implementation and uptake

The draft code is a good example of what processing conditions are required to facilitate hygienic rendering. However, this draft Code was not supported by the ARA because it was seen as too detailed, too prescriptive and not outcome based. This version of the Code was dropped and other two version of a Code developed. Eventually a version of the Code was agreed to by the ARA and this was published as an Australian Standard in 2001.

Further work or update

No further work required.

Directory of Renderers COPR.014

Project Aims

- Prepare a directory of Australian renderers and products.

Introduction

There may be opportunities to market specialty products to customers with particular needs. In order to identify any specialty products that might be available and bring renderers into contact with customers, a directory of renderers was prepared.

Major Outcomes

1. A Directory of Renderers and Products was published and is maintained by the ARA.

Description of project

All Australian renderers were contacted and invited to submit their details for inclusion in a directory of renderers. Renderers were invited to submit information on their product lines including specifications and characteristics of products.

Implementation and uptake

The Directory of Renderers was first published in 1997. In view of the success of the Directory it was reprinted in 1998 to allow more renderers to register their products in the directory. Since then the ARA has taken responsibility for maintaining a Directory of Renderers. The ARA publishes the Directory on its web and regularly updates the directory.

Further work or update

The Directory of Renderers is maintained and updated by the ARA.

Rendering Technology Audit COPR.004a

Project Aims

- Identify technologies used in the Australian rendering industry;
- Identify renderers that are in a position to produce diversified products.

Introduction

MLA research on the use of meat meal in non-conventional uses such as aquaculture identified that better returns could be achieved if renderers diversified their product range. Diversification of products could require segregation and separate treatments of raw materials, fractionation of meals and use of techniques to minimise the fat content of meals. This audit was conducted to identify the range of equipment and processes used in the rendering industry and to identify rendering companies that are equipped to produce a diversified product range.

Major Outcomes

1. Criteria for flexible rendering to produce diversified products are identified.

Description of project

Renderers were asked to submit information on the type of equipment they use, the capacity of their production and the type of raw material handled. One hundred and fifteen renderers were surveyed and sixty-nine responses were received. Details of the capacity of plants and types of equipment used are presented.

Examples of plants that produce diversified products such as defatted bone chips fractionated meals and products from segregated raw materials are presented. Nine criteria for identifying renderers that have the ability to diversify were developed and plants were matched with these criteria.

Implementation and uptake

At least one plant has been built the capacity for a high degree of segregation of raw material in order to produce diversified products. In general, renderers produce diversified products such as low-ash ovine meals and separate species meals when there is a clear market opportunity. The information in the report has been used by DAFF for background on the Australian rendering industry in market access negotiations.

Further work or update

The report identifies rendering plants by name and the equipment used. If the report were released, it should be edited to remove confidential information.

Rendtech

Project Aims

- Prepare a compendium of rendering technologies.

Introduction

There is a wide range of rendering equipment that can be used by Australian renderers. Some types of equipment may be useful for dealing with particular types of problem raw materials or for producing specialised products.

Major Outcomes

1. A comprehensive compendium of rendering technologies and equipment was prepared.

Description of project

Equipment and technologies used in rendering were reviewed. A comprehensive compendium of technologies, equipment and suppliers was produced including information on novel rendering processes such as microwave rendering and electrode rendering.

Implementation and uptake

There has been very little use of the Rendtech compendium. It appears that the compendium was not completed in that figures were not included in the text. The compendium was not published.

Further work or update

The compendium could be revisited and finished off by updating, inserting figures (if they can be found) and publishing. However, although the compendium is very comprehensive it would probably not be widely used.

Animal Feed Projects

Evaluation of Meat & Bone Meal and Dossier of Australian Meat & Bone Meal PRCOPIC.005/PSHIP.135.1A

Project Aims

- Evaluate meat and bone meal to determine if there are attributes that justify identifying Australian product and claiming preferred status;
- Compile a technical dossier of published data on meat and bone meals and its use in animal feeding.

Introduction

The ARA and MLA identified that a key strategy to maintain the volume and value of export markets is to position Australian meat and bone meal as the preferred product. In addition the ARA and MLA identified a need to prepare a compendium of technical information on MBM to encourage nutritionists to use MBM in rations

Major Outcomes

1. Changing the real and perceived value of MBM should increase industry revenue by $30-$45 million.

Description of project

The project was conducted in two parts. The evaluation was conducted by interviewing stake holders including research scientists, nutritionists, renderers, exporters and Asian feed market MBM users to get opinions of the benefits, advantages and disadvantages of Australian MBM. The dossier was complied by reviewing research papers and other documents on the use of MBM in animal feeds.

Australian MBM was evaluated against a range of 20 supply and quality issues. From this, benefits and disadvantages of using MBM were complied and discussed. Benefits include excellent source of protein and phosphorus and unique features include freedom from BSE and availability and proximity of supply. Disadvantages are mainly quality issues. Issues expanded on include cost benefits of increasing protein and phosphorus; declining MBM usage and factors that affect nutritional value including processing conditions. Recommendations to protect and develop MBM attributes; develop unique attributes and address deficiencies are provided.

The dossier of Australian meat & bone meal presents information on rendering processes, microbial issues, and quality factors including discussion of protein quality. The use of meat meal in poultry, pig, aquaculture and pet food feeds is discussed in detail. The contribution of meat meal to the nutritional value of feeds is explained and recommendations for inclusion rates in diets for different animals at different stages or production are given.

The dossier of Australian meat & bone meal is presented in a condensed version as “The Australian Meat & Bone Meal Guide for Feed Manufacturers”.

Implementation and uptake

The Australian Meat and Bone Meal Guide for Feed Manufacturers has been translated into Chinese and has been used at promotional workshops held in China.

Recommendations in the evaluation of Australian Meat and Bone Meal to create a gold standard of Australian MBM backed by an independent verification system have been discussed by the ARA but have not been adopted.

Further work or update

The evaluation of MBM and dossier together provide a comprehensive picture of the benefits, disadvantages, problems and solutions related to the use of MBM in feeds. It does not require any update but it should be used more widely.

Customer Requirements for Meat and Bone Meal COPR.004

Project Aims

- Identify customer requirements for meat and bone meal;
- Identify processing equipment and procedures that contribute to quality control and will help to produce products that meet customer expectations.

Introduction

Renderers use a wide variety of equipment and process a range of raw materials. However, customers expect a consistent product. Renderers take into account factors such as production costs, environmental control, yield and capital costs when selecting equipment. They also take into account quality issues. This report was intended to identify some of the quality issues and identify the equipment best suited to produce product that matches customer requirements.

Major Outcomes

1. Rendering equipment and processing conditions that affect MBM quality are identified.

Description of project

End-users of meat and bone meal were interviewed to find out what customers thought were the main quality issues for MBM. Customers who use MBM in stock feed, pet food, fertilisers and export traders were interviewed. The required quality attributes of MBM from the point of view of customers are discussed.

Processing conditions to meet the quality requirements of the different types of end-user are recommended. The recommended processing conditions are not unusual and generally relate to consistent application of known techniques such as excluding physical contaminants from raw material; cleaning gut material; rendering fresh material; avoiding high temperatures (above 125oC) and efficient milling of meals.

Implementation and uptake

The information in this report has not been specifically implemented but renderers are aware of the quality and processing issues raised in the report.

Further work or update

The report is general in nature and there are some aspects of processing and product quality that could be researched in more detail, for example the effect of processing conditions on MBM digestibility and amino acid availability and methods of reducing physical contamination of raw materials.

Aquaculture Projects

Processing of Meat Meal for Utilisation in Aquaculture diets M.744

Project Aims

- To assess the suitability and appropriate inclusion levels of modified meat meals in trout and prawn feeds;
- Assess the affect of meat meal in feed on the quality of flesh from trout and prawns.

Introduction

One third of the global fish/shellfish catch is processed into fish meal. Fish meal is used in aquaculture feeds and commercial aquaculture feed production is expanding at 30% per year. Fish meal production increased by 1.6% in the decade to 1993. There is a need for replacements for fish meal in aquaculture feeds and meat meal is a potential replacement.

Earlier studies showed a wide variation in the composition of meat meals. Meals with high ash are unsuitable for use in aquaculture feeds. In this study a modified high protein, low ash meat meal was assessed as a fish meal replacer in trout and prawn feeds.

Major Outcomes

1. High protein, low ash meat meal can be successfully used in trout and prawn feeds at inclusion levels of 30%.
2. The market for modified meat meal in locally produced aquafeed is about 2,500 tonnes per year.

Description of project

The selected meat meal was used at 30% and 50% inclusion rates in trout and prawn feeds. In the case of trout, when substituting for 30% of the protein content of a feed, meat meal did not compromise the feed conversion rate, growth factors, environmental parameters or sensory qualities of the fish.

In the case of prawns, feeds with up to 30% meat meal performed similarly to standard fish meal-based prawn food but at 50% inclusion of meat meal there were performance penalties. This result is similar to the findings of previous studies.

The study demonstrated that meat meal can partly substitute for fish meal in feeds for trout and prawns. There is an opportunity to use about 2,500 tonnes per year of meat meal of the quality used in these trials in locally manufactured aquaculture feeds. However the meat meal must be at a discount compared with the equivalent protein content of fish meal. The meat meal used in this study was considered to be over-priced and would not be used in the future.

Implementation and uptake

The project report provides an example of how a modified high protein, low ash meat meal could be used in aquaculture feeds in Australia. This type of meat meal is not produced at the moment. Renderers can make a modified meat meal for aquaculture but would require a premium and it appears that the premium offered may not be enough. The report indicates that 2,500 tonnes of meat meal could be used in local production of aquaculture feed. This amount of production could be handled easily by one or two plants. There could be an opportunity for a few plants to specialise in meat meal production for locally produced aquaculture feed but the adoption of this report would not be more widespread.

Further work or update

The project was completed in 1995. The technical aspects of the report are probably current. Further work on the cost of producing a high protein, low ash meat meal and the price that the feed industry is prepared to pay could be useful but only a small number of plants could take advantage of the work.

Preliminary Evaluation of Meat Meal in Aquaculture diets for Prawns CS.233

Project Aims

- Determine the apparent digestibility of meat meals in prawn diets;
- Obtain preliminary data on the effect on prawn growth rate of replacing up to 50% of fishmeal with meat meal.

Introduction

Prawn diets are based on fishmeal and could contain up to 60% fishmeal. Supplies of fishmeal are not increasing but aquaculture in Australia and overseas is expanding. New protein source have to be found to support expansion in aquaculture.

Major Outcomes

1. Meat meal could replace 50% of the fishmeal in prawn diets.

Description of project

Three different meat meals were tested in prawn diets. One meat meal was low ash (9%) and two had ash contents of 35%. Seven diets were prepared. The control diets contained 60% fishmeal and no meat meal. The six other diets replaced 50 or 25% of the fishmeal with the three meat meals.

The apparent digestibilities of the meat meals were lower than the fishmeal. The low-ash meat meal had the highest digestibility. The digestibility of essential amino acids was sufficient to rate the low ash meat meal as a good ingredient and the other meat meals as useful ingredients.

The results indicate the meat meal could replace at least half the fish meal is diets for juvenile prawns. However, the low digestibility of meat meal would increase faecal waste and could have an adverse effect on water quality.

Implementation and uptake

The preliminary study led to further investigations.

Further work or update

No further work required.

In-pond Evaluation of High Meat Meal Diets for the Black Tiger Prawn PRCOP.011

Project Aims

- Assess the performance of prawn diets containing meat meal in simulated commercial ponds.

Introduction

Fishmeal constitutes 25 to 50% of most aquaculture diets and is the major protein source. Previous research in aquarium tanks has shown that meat meal can supply up to two-thirds of the protein requirements in prawn diets, equivalent to an inclusion of 500 g/kg. Feed manufacturers and prawn farmers indicated that they would be more willing to adopt research findings if the results had been obtained in an environment that more closely resembles a commercial prawn pond.

Major Outcomes

1. A premium quality meat meal (59% protein and 21% ash) can be included in prawn diets at 300 g/kg.

Description of project

Prawn diets containing 15 or 30% meat meal were compared with a base diet containing no meat meal and 30% fishmeal and a commercial prawn diet. The trials were carried out in simulated commercial prawn production ponds. The meat meal was high quality with 59% protein, 10.9% fat and 21.2% ash. The performance of the feeds was assessed on the basis of growth rate, survival of the prawns, food conversion ratio and the effect of feed wastes and faeces on the ponds.

The growth rate of prawns fed the four diets was not significantly different. Feed conversion rates and prawn survival rates were similar for all diets. The high meat meal diets did not create greater amounts of sludge under cages. Larger scale production trials using meat meal can be undertaken with little risk to production or pond environment.

Implementation and uptake

Meat meals designed for use in prawn feed have not been widely used.

Further work or update

No further work required.

Preliminary Evaluation of Meat Meal in Aquaculture Diets for Silver Perch M.561

Project Aims

- Determine the apparent digestibility coefficients for energy, protein and EAAs for four meat meals and analyse meat meals on three occasions to assess consistency;
- Recommend future research strategies.

Introduction

On a cost per unit of protein, meat meal is an attractive protein source. For aquaculture species the absence of carbohydrate is a significant advantage over vegetable protein. Feeds contribute up to 70% of the operating costs for fish and prawn farms and the most expensive component of feeds is protein. The major source of protein is fish meal. Fish meal production is declining as aquaculture production increases. If Australian aquaculture is to develop, suitable alternatives to fish meal must be found.

Major Outcomes

1. The cost of digestible protein in meat meals is about $1 to $1.3 per kg compared with $1.2 to $2 in imported fish meal.

Description of project

Four meat meals were evaluated in silver perch diets. The fish readily accepted feeds containing up to 30% meat meal.

The dry matter digestibility of high protein meals was better than for low protein meals and was comparable with low quality Peruvian fish meal. Digestibility of energy was lower than for fish meals but compared favourably with oilseeds and grain legumes. Digestibility of protein was lower than fish meal but similar to grain legumes. Meat meals were deficient in lysine. Batches of the same meat meals were consistent.

The cost of digestible protein in meat meals compared favourably with imported fish meals but was higher than vegetable protein sources.

Some of the problems with using meat meal in aquaculture diets are excessive wool and hair, high fat content and inconsistent quality.

Further experiments on the effect of meat meal in diets on growth were recommended.

Implementation and uptake

This was a preliminary study and was followed with further research. Meat meal is now used in sliver perch diets in Australia but the volume of feed produced is modest.

Further work or update

No further work required

Potential of Meat Meal to Replace Fishmeal in Commercial Diets for Silver Perch M.783

Project Aims

- Determine the potential to partially or totally replace fishmeal with meat products in diets for silver perch;
- Assess flavour and texture attributes of cooked silver perch fed least cost diets including meat meal.

Introduction

This project follows a preliminary study that assessed the digestibility of four meat meals in aquaculture diets. The work is in response to the need to find replacements for fishmeal in aquaculture in view of the shrinking production of fishmeal and expanding aquaculture industry.

Major Outcomes

1. Diets containing 5% fishmeal and 37% meat meal performed better then a commercial diets containing 27% fishmeal.

Description of project

Two types of meat meal, an ovine meal and a specialty high protein meal, were assessed. Five diets in which meat meal progressively replaced fishmeal were fed to silver perch. In a second experiment, least-cost formulations including up to 36% meat meal were fed to silver perch in ponds at commercial stocking rates

The ovine meal performed better than the specialty meal. The growth rate of fish fed diets containing 37% ovine meal and 5% fishmeal were better than growth rates for fish fed control diets containing 27% fishmeal. The meat meal-based diets did not significantly change the body composition or organoleptic quality of the fish.

Implementation and uptake

The experiments showed that meat meal can replace most of the fishmeal in sliver perch diets. This has led to inclusion of meat meal in silver perch diets in Australia.

Further work or update

No further work required.

Consumer Sensory Evaluation of Silver Perch Cultured in Ponds on Meat Meal Based Diets PRCOP.009

Project Aims

- To assess the eating quality of silver perch fed diets containing meat meal.

Introduction

Trails have been conducted to assess the use of meat meal in diets for silver perch. These trials have shown that silver perch diets containing 30% meat and bone meal produce satisfactory growth rates.

Major Outcomes

1. A diet containing 29% meat meal produced fish with good organoleptic quality.
2. The ingredient cost of the diet containing 29% meat meal was $0.74 to produce 1 kg of fish compared with $1.76 for a commercial soybean based diet.

Description of project

Silver perch were fed the best diet from an earlier experiment. The diet contained 5% fish meal and was compared with two least-cost formulated diets containing 10% poultry meal and 37 and 29% meat meal. The growth rates of fish fed the three diets were not significantly different.

There were differences in the sensory characteristics of fish fed the three diets. The diet containing 29% meat meal produced fish with the best all-round sensory characteristics. This diet also had the lowest ingredient cost of $0.74 to produce 1kg of fish.

Implementation and uptake

Meat meal is used in silver perch diets produced in Australia.

Further work or update

No further work required.

Potential of Meat Meal to Replace Fishmeal in Commercial Diets for Barramundi M.783

Project Aims

- Demonstrate on a commercial barramundi farm the suitability of meat meal based diets;
- Compare the sensory characteristic of fish fed on diets based on meat meal or fishmeal.

Introduction

The project continues work to assess the performance of meat meal in aquaculture diets.

Major Outcomes

1. Meat meal based diets can reduce the cost of feed for barramundi by 16 to 27%.
2. Meat meal can be used as a partial or complete replacement of fishmeal protein in grow-out diets for barramundi.

Description of project

Two types of meat meal, a high (60%) protein meal and conventional (52% protein) meal were used in diets for barramundi.

Diets containing up to 50% meat meal were equal to or better than a commercial diet in supporting fish growth and in producing fish with flesh of high sensory value. The conventional meat meal reduced the cost of feed by 16 to 27%. The high-protein meal was over-priced and did not reduce costs. However if the 60% protein meal was priced at about 15% above the conventional meal it would achieve the same cost reductions compared with fishmeal-based diets. The high meat meal diets were supplemented with fish oil to maintain the flavour of the fish but it was not necessary to use fishmeal in the diet to produce satisfactory fish.

Implementation and uptake

The experiments showed that meat meal can replace all of the fishmeal in barramundi diets. This has led to inclusion of meat meal in barramundi diets in Australia.

Further work or update

No further work required.

Survey of the Nutrient Composition of Meat Meals and Meat Co-products with Respect to their Use as Ingredients in Aquaculture Feeds– PRCOP.008

Project Aims

- Review Australian meat meals to assess their suitability for inclusion in aquaculture diets.

Introduction

MLA funded projects have demonstrated that that meat meals can be used as a partial replacement for fishmeal in commercial prawn diets. Meat meals can be used effectively at an inclusion of 300 g/kg. However, the high-ash content of meat meals results in low digestibility and increased faecal waste. Trials with inclusion rates of 300 g/kg of meat meal in prawn diets used a high protein/low ash meat meal. The amount of meat meal that can be included in a diet is limited by the ash content of the meal because the arbitrary limit of ash in the feed is 15%. To be used to the fullest extent in prawn diets, meat meal should be >60% protein, <20% ash and <8% fat.

Major Outcomes

1. No meat meals tested matched the ideal specification for use in prawn diets but can still be included in diets at levels below 30%.

Description of project

Twenty-seven meat meals were analysed to determine how closely they matched the ideal specification. Samples were analysed for dry matter, ash, gross energy, crude protein, total lipid, cholesterol, phospholipids and fatty acids. There was a wide range of results. For example crude protein values were from 47 to 76% of dry matter and ash was from 11 to 37% of dry matter. Cholesterol levels were lower than expected but meat meal has the benefit of containing some cholesterol which vegetable proteins do not.

Prawn diets should be less than 15% ash and must contain minimum amounts of highly unsaturated fatty acids at a total lipid content of about 10%. To keep the ash in the diet below 15%, 30% of a 25% ash meat meal could be included but only 15% of 35% ash meat meal. To maintain the appropriate fatty acid balance, 30% of an 8% fat (on a dry matter basis) meat meal could be used but only 20% of a 14% fat meat meal. A complicating factor is that low-ash meat meals are likely to be high fat and vice versa.

Not all renderers can produce the ideal meat meal for aquaculture. Other meat meals can be used but at lower inclusion rates. If higher ash meals are suitably priced they could still find room in aquaculture diets. The key to supply is providing a consistent product.

Implementation and uptake

There have been attempts to produce meat meals specifically for aquaculture but there has been no breakthrough. Meat meals are undoubtedly used in aquaculture but are not specifically markets as such.

Further work or update

No further work required.

The Prospects for Marketing Meat Meal for Inclusion in Indonesian Aquaculture Diets – COPR.013

Project Aims

- Assess the scale and the opportunity to market meat meal to the Indonesian aquaculture industry.

Introduction

MLA-funded projects have demonstrated that meat meal can be 40% of prawn diets, 30% of silver perch diets and can replace 100% fishmeal in barramundi diets. Indonesia was selected as the first country in which to study the potential for meat meal in aquaculture. The study was intended to develop a template for further studies in other countries.

Major Outcomes

1. There is a potential demand for 80,000 tonnes of meat meal per year for use in aquaculture feeds in Indonesia.

Description of project

A study group comprising David Smith, an aquaculture expert, Garry Minton, CEO of E.G. Green and Dennis Roberts, MLA Co-products key program co-ordinator visited Indonesia to review the aquaculture industry. About 120,000 tonnes of prawns are produced using about 240,000 tonnes of feed. The total production of aquaculture feeds is estimated to be about 400,000 to 500,000 tonnes per year. A small amount of meat meal has been used in fish feed but not in prawn feeds. Meat meal could be included in prawn feed at 20% giving rise to a demand for 48,000 tonnes of meat meal. It is estimated that 80,000 tonnes of meat meal could be used in the whole aquaculture industry.

Ideally, meat meal aimed at the prawn industry should be 55% protein, less than 4% phosphorus and less than 10% fat. BSE-free status and the price of protein in meat meal compared with fishmeal should be used as selling points for Australian meat meal. The potential cholesterol content of meat meal could also be a useful selling point. Meat meals for use in aquaculture must be treated with anti-oxidant to prevent rancidity.

Implementation and uptake

There have been attempts to market meat meal for use in aquafeeds in Indonesia but results are not known. Indonesia is the major market for Australian meat meal.

Further work or update

Price and use figures are out of date but there is no need for an update.

Opportunities for Use of Meat Meal in Aquaculture Rations - Taiwan PRCOP.015b

Project Aims

- Assess the potential market for Australian meat meal in aquaculture rations in Taiwan.

Introduction

MLA projects have demonstrated that meat meal can successfully replace fishmeal in aquaculture rations. This market study looks at the opportunities and constraints for using meat meal in aquaculture in Taiwan.

Major Outcomes

1. There is a potential demand for 38,000 tonnes of meat meal per year for use in aquaculture feeds in Taiwan.

Description of project

The Taiwanese aquaculture industry produces prawns, eels, milk fish and tilapia. In 1996, 421,000 tonnes of fish feed and 36,000 tonnes of prawn feed was produced. No meat meal is used in prawn diets. Fish feeds may contain up to 5% meat meal. The nutrient requirements of prawns and fish are not well understood and there is a reluctance to change successful rations. In addition meat meals imported from the USA and Canada have been poor quality and inconsistent. In view of this experience coupled with concerns about BSE, there is suspicion of meat meal.

Research has shown that meat meal could replace up to 30% of fishmeal in prawn feeds. The meat meal should be good quality i.e. >55% protein; <10% fat and <22% ash with antioxidant added and should be consistent. These requirements will add to costs of production of the meat meal. The amount of meat meal likely to be used in rations will depend on cost and figures are presented to show potential inclusion of meat meal in different feeds for a range of meat meal costs relative to a range of soy meal costs.

Standard quality meat meal at US$225 per tonne and higher quality meat meal at US$265 per tone could constitute 25 to 50% of fish feed. Premium meat meal at $US490 per tonne could constitute 4% of prawn diets.

Implementation and uptake

No uptake in terms of specifically marketing meat meal for aquaculture use in Taiwan although Australian meat meal is exported to Taiwan.

Further work or update

Price and use figures are out of date but there is no need for an update.

Opportunities for Use of Meat Meal in Aquaculture Rations – Thailand PRCOP.015c

Project Aims

- Assess the potential market for Australian meat meal in aquaculture rations in Thailand.

Introduction

MLA projects have demonstrated that meat meal can successfully replace fishmeal in aquaculture rations. This market study looks at the opportunities and constraints for using meat meal in aquaculture in Thailand.

Major Outcomes

1. There is a potential demand for 40,000 tonnes of meat meal per year for use in aquaculture feeds in Thailand.

Description of project

The Thai aquaculture industry produced 244,000 tonnes of prawns and 228,000 tonnes of freshwater fish in 1996. About, 470,000 tonnes of prawn feed and 200,000 tonnes of fish feed is produced each year. No meat meal is used in prawn diets. Fish feeds may contain up to 5% meat meal. The market for prawn feed is dominated by CP Feedmill Public Co Ltd. There have been variable experiences with meat meal in aquafeeds. There are also concerns about BSE.

It is not likely that much meat meal would be used in prawn diets. A minimum 35% of the protein in the diet must come from fish meal. The remainder of the protein could come from meat meal or soy meal. Premium meat meal priced at A$700 per tonne FOB could be used in prawn diets at an inclusion of about 4%. Tilapia rations are not constrained to use fish meat and can use lower quality meat meal. Inclusion rates of meat meal in tilapia diets could be 30-40% for a meat meal cost of A$300 per tonne of standard meat meal.

Implementation and uptake

There have been attempts to market meat meal for use in aquafeeds in Thailand but results are not known. Australian meat meal is exported to Thailand.

The Prospect for Meat Meal in Aquaculture Diets PRCOP.012

Project Aims

- Prepare a program of research and marketing activities to promote the use of meat meal in aquaculture.

Introduction

Expansion of aquaculture is likely to create a deficit of 1.6 to 2.3 million tonnes of fishmeal. Australian research has shown the meat meal can replace 60% of fishmeal in prawn diets and 100% of fishmeal in barramundi diets. A study tour to Indonesia indicated that there is a market for meat meal in aquaculture feeds. With this background the report maps out future work to support the introduction of meat meal into aquaculture diets.

Major Outcomes

1. Aquaculture could use 18 to 25% of Australia's meat meal production.

Description of project

Issues related to the use of meat meal in aquaculture feeds are reviewed and gaps in technical knowledge are identified. A strategy and matching program of research and market studies to advance the use of meat meal in aquaculture is proposed. There is a strong argument that meat meal is in oversupply in the domestic market and that better prices could be achieved if meat meal were to be more widely used in aquaculture.

Implementation and uptake

The research program was not progressed. In hindsight the argument that meat meal is worth more money in aquaculture feeds cannot be sustained. In theory, meat meal may be undervalued when the value of each component (protein, phosphorus. fat) is summed but meat meal prices are governed by competitor products and international supply and demand. It has been shown that meat meal prices are not affected by the targeted end-use. Other suggestions that meat meal has particular benefits in aquaculture such as contribution of cholesterol and gelatine, which could improve pellet bind were not researched but the suggested benefits were probably over-estimated.

Further work or update

No further work required.

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Pet Food Projects

Pet Food Market Study M.257

Project Aims

- To estimate the returns the offal used in pet food provide to the beef and sheep processing industries;
- Evaluate the potential for export of beef and sheep offal to Pacific Rim countries.

Introduction

At the time the project was commissioned (1992) there was very little data on the use of offals in pet food. This project was conducted to provide background information.

Major Outcomes

1. The value of red meat offal used in pet food is about $30 million per year in 1992
2. It is unlikely that returns for meat products used in pet food will be increased but there is room for higher volumes to be used.

Description of project

The project was conducted by reviewing published information on the volume of sales of pet food in the domestic market and by surveying the major manufacturers of pet food. Pet food manufacturers in Thailand and Japan were also interviewed.

It was estimated that the value of offal used in wet pet food in Australia is about $30 million per year. It was also estimated that the value of offal as pet food was about $200 per tonne higher than its value if rendered. One opportunity to increase supply of meat co-products to the pet food market was identified as decolourised blood or blood plasma.

Opportunities to supply pet food ingredients to Thailand and Japan were considered to be limited because the pet food industry in these countries is based on non-meat ingredients.

Implementation and uptake

Since this report, the use of meat products in pet food has declined as the use of poultry products has increased.

Further work or update

No follow up required.

Dynamics of the Australian Pet Food Industry PRCOPIC.09

Project Aims

- Assess the current and future market trends for the use of meat and meat by-products in pet food;
- Identify new or improved products that could enhance the marketing opportunities for meat and meat by-products in pet food.

Introduction

The Australian grocery trade accounts for 400,000 tonnes of wet and dry pet food. In addition there are substantial exports. Over the last 10 years, the percentage of meat and meat by-products used in pet food has fallen with increased use of poultry and seafood products.

Major Outcomes

1. The use of meat ingredients in pet food has been declining due to increased use of poultry products.
2. Pet food manufacturers are interested in new meat products such as digests and high quality meat meals.

Description of project

The report provides data (up to 2003) on the size and growth of different sectors of the pet food market. It also contains estimates of the amount of meat products used in pet food.

Pet food manufacturers were surveyed to determine their views on red meat ingredients. Views were sought on the quality of raw materials, palatability contribution of meat ingredients and opportunities for novel meat-based ingredients. As a result of the survey, opportunities for development of new or improved meat products for the pet food industry were ranked. Development of a meat digest for extruded products was of most interest to pet food manufacturers. High quality meat meals and meat-based flavour systems were ranked highly.

Implementation and uptake

This project was discussed at a workshop with representatives of the pet food industry and the meat industry. It was clear that the major issue for the use of meat ingredients in pet food is contamination by foreign material e.g. plastic. While there is interest in novel or enhanced meat products, so far there has been little development of new products.

Further work or update

No follow up required.

Cost-benefit Analysis of Pet Food in Red Meat Processing PRCOPVA.014

Project Aims

- Determine what sectors of the meat industry supply ingredients to the pet food industry, the cost of supplying these ingredients and the returns available.

Introduction

Previous MLA projects have estimated the quantity and value of meat products used in pet food and have identified the quality attributes of products used as pet food ingredients. Over the past 12 years there has been a marked reduction of the use of meat products in pet food and an increased use of poultry products. Pet food manufacturers have complained about the quality and reliability of supply of meat products compared with poultry products.

Major Outcomes

1. The value of red meat offal used in pet food is about $12 million per year
2. Higher prices are available for sorted frozen offal but costs are higher and the trend is to supply of unsorted chilled offal.

Description of project

The value of meat co-products collected for pet food was estimated by interviewing managers of 31 abattoirs, 19 of which collected offal for pet food. Offals for pet food are either frozen in naked blocks or are chilled in cold or iced water. Frozen offal are trimmed and sorted while chilled offal is handled in bulk as natural fall. Prices paid for frozen offal are from 50 cents per kg to $1.30 per kg. The higher prices are only available for small volumes of specialty products. The typical price is about 50 to 75 cents per kg. The prices for fresh offal are about 17 to 27 cents per kg and up to 80 cents for small volumes of specialty products.

Many abattoirs do not collect pet food because returns are low and quality specifications are demanding. Because of the low value, pet food manufacturers find it difficult to source reliable supplies. It appears that abattoirs can secure higher prices if they have large volumes of product can provide reliable supply. Pet food companies have preferred to use intermediary suppliers who value add by trimming and sorting fresh product.

Implementation and uptake

This project was intended to supply background information for MLA and has not been implemented by industry.

Further work or update

No follow up required.

Physical Contamination of Co-products Used in Pet Food PRCOPIC.024

Project Aims

- Characterise physical contamination of meat-based raw materials used in processed dry and wet pet foods and describe how contamination occurs;
- Assess the impact of physical contamination of meat-based pet food ingredients on the pet food industry;
- Identify possible methods of overcoming contamination.

Introduction

Previous projects identified the quantity and value of meat co-products used in the pet food industry and pointed to chicken products overtaking meat ingredient as the preferred animal protein. The pet food industry has made it clear that foreign object contamination is one of the constraints on the use of meat co-products in the pet food industry. If contamination is eliminated or reduced to an acceptable level, the amount of meat co-products used by pet food manufacturers could be increased.

Major Outcomes

1. Weasand clips and chips from plastic tubs are the major contaminants in pet food offal.

Description of project

The project was conducted by interviewing pet food manufacturers, renderers and meat producers.

The main source of contamination in fresh pet food is weasand clips and other clips and plugs. Frozen pet food is also subject to contamination by plastic chipped off the plastic tubs in which the offal is frozen. A range of other potential contaminants is described. This contamination results in damage to machinery, loss of export and domestic sales opportunities and customer complaints and potential legal action in the pet food industry.

Recommendations for preventing contamination are: development of a degradable weasand clip; development of a suitable release agent/application system for freezing pet meats; preparation of training materials for abattoir personnel

Implementation and uptake

None of the recommendations of this report have been adopted and contamination of pet food ingredients (and meat meal used in stock feed) is still an issue. The industry bodies AMIC and ARA have encouraged members to prevent contamination and this may have had a small effect.

Further work or update

Further work is required to provide solutions to contamination of pet food. The problem is justifying expenditure and increased costs of production for low value product.

Top 5 Pet Food Nutraceuticals PRCOPVA.015

Project Aims

- To identify nutraceuticals used in pet food;
- Identify the yields of nutraceuticals available from meat products.

Introduction

Meat products may contain naturally occurring nutraceuticals or may be used as raw material from which nutraceuticals can be extracted. Identifying nutraceuticals used in pet food may lead to enhanced use of meat products or extracts in the pet food industry.

Major Outcomes

1. The nutraceuticals used in pet foods are glucosamine, ω-3 fatty acids, arginine, carnitine and taurine. Apart from ω-3 fatty acids all are derived from meat products.

Description of project

An extensive literature review was conducted to identify the major ailments of cats and dogs and associated use of nutraceuticals in pet food. The review also identified nutraceuticals used in veterinary medicine.

A review of product information identified nutraceuticals used in products available in Australia, the USA and Japan.

The most commonly used nutraceuticals are glucosamine, chondroitin sulphate and pentosan polyphosphate used to combat the effects of arthritis and ω-3 fatty acids to manage a variety of ailments. The amino acids arginine, L-carnitine and taurine are also added to diets at elevated levels.

Skeletal muscle and some offals are rich sources of arginine, carnitine and taurine. The meat products in pet food usually supply sufficient arginine. Some manufacturers may use added synthetic carnitine and naturally derived taurine. Poultry meal is used as a source of chondroitin sulphate.

Implementation and uptake

Meat derived nutraceuticals are being used in pet foods, with or without the knowledge of the meat industry. The report is background information and makes no recommendations for implementation or uptake.

Further work or update

The information is up-to-date.

Non-food Non-feed projects

Non Food/Feed Uses of Rendered Products PRCOPVA.002

Project Aims

- Evaluate opportunities for the use of rendered products as raw materials for industrial uses;
- Assess market size and price structure and identify most attractive potential applications for the non-feed use of rendered products.

Introduction

The largest portion of non-edible material from slaughter operations is rendered to produce meat meal for animal feed and tallow for soap making, and other industrial uses. Restrictions on the use of animal protein meals in feeds following the emergence of BSE and concerns about further restrictions have prompted investigations of alternative uses for rendered product and the raw materials for rendering.

Major Outcomes

1. Potential non-feed uses of rendered products are production of HAP from bone and production of adhesives from fugitive proteins.

Description of project

The materials going into and out of rendering plants have been investigated in order to match these materials with possible alternative uses. The opportunities identified were: use of hard bone to produce hydroxyapatite; recovery of fugitive proteins, e.g. proteins recovered from effluents, to make adhesives; use of fugitive proteins to make protein-based surfactants. A wide range of uses for fatty acid esters including production of biodiesel was also identified.

There are established uses for synthetic HAP. To break into this market it will be necessary to develop processes for extracting bone apatite and demonstrate the performance of bone-derived HAP. The largest use of adhesive is in wood products such as plywood and particle board. There is a large potential market of alternative adhesive formulations and extensive work has been done on soy protein adhesives. Research groups that have experience with soy-based adhesives should be able to assess the potential for producing adhesives from rendered material. Other uses for rendered products as surfactants or protein-films are not promising.

Implementation and uptake

There is no uptake of this work because of high developments costs.

Further work or update

No further work required.

Economic evaluation of the bovine plasma fractionation process PRCOPVA.003

Project Aims

- Provide economic evaluations of production of bovine plasma and production of plasma fractions.

Introduction

Potential opportunities for processing blood include separation into plasma and red cells and further fractionation of the plasma to produce BSA, protease inhibitor and IgG.

Major Outcomes

2. A large plasma plant can generate income of about $1 million per year and has a payback time of 2.3 years
3. A large plasma fractionating plant can generate income of about $4 million per year and has a payback time of 2.5 years.

Description of project

The cost of capital equipment and production costs to produce blood plasma and fractionated products from blood plasma were evaluated.

Capital costs for equipment, including buildings to produce blood plasma were estimated to be $950,500 for a 45,000 l/day plant and $512,500 for a 22,500 l/day plant. Capital costs, including buildings to produce plasma fractions were estimated to be $6,868,200 for a 22,500 l/day plant and $4,588,000 for an 11,250 l/day plant.

Assuming a value of $0.15 per l for plasma the annual net return for a 45,000 l/day plant was estimated to be $631,549 and $200,717 for a 22,500 l/day plant. The annual net return from a plasma fractionating plant producing BSA, protease inhibitor and IgG was estimated to be $3,952,976 for a 22,500 l/day plant and $1,604,464 for an 11,250 l/day plant.

Implementation and uptake

There is no uptake of this work.

Further work or update

No further work required.

Application of Hydroxyapatite (HAP) from Hard Bone as a Chemical Catalyst PRCOPIA.005B

Project Aims

- From patent literature, identify opportunities for uses of hydroxyapatite derived from bone.

Introduction

Hydroxyapatite (HAP) is a calcium phosphate compound that makes up the mineral content of bone. It is also in naturally occurring minerals and can be produced synthetically. The Fats and Proteins Research Foundation in the USA and European Renderers Association had identified bone-derived HAP as a potential co-product of the meat industry.

Major Outcomes

1. There are several uses for HAP in catalytic conversions and adsorption of heavy metals but very little information on the performance of bone-derived HAP.

Description of project

A literature search was conducted, including patent searches, to discover what applications for the use of HAP have been identified. Almost all references referred to synthetic HAP and there appears to be very little information about uses of bone-derived HAP in the public arena.

The main applications for HAP in large volumes are in catalytic conversions e.g. oxidation of methane to synthesis gas (hydrogen and carbon dioxide) removal of nitrogen oxides from flue gas and hydroprocessing (removal of sulphur and nitrogen) of petroleum feed stock. HAP can also be used as an absorbent of heavy metals. Further research is required to determine the appropriate processing conditions and performance of bone-derived HAP in these applications.

There are also medical applications of HAP as bone implants but these have not been considered for bone derived-HAP.

Implementation and uptake

The feasibility of producing bone-derived HAP depends on creating a product that has satisfactory catalytic efficiency at a competitive price. It is considered in Europe and the USA that bone-derived HAP cannot compete with synthetic HAP and further research on production of bone-derived HAP is not warranted.

Further work or update

No further work required.

Patent Search – Extraction and Use of Collagen PRCOPIC.028

Project Aims

- Identify documents relating to methods for the extraction and uses of collagen from cattle hides and sheep skins.

Introduction

There is an established use of collagen extracted from cattle hides to make sausage casings. Other applications for the use of collagen may expand opportunities for marketing collagen as a meat industry co-product. Before research can be done on extraction and uses of collagen, a patent search was required to establish "freedom to operate".

Major Outcomes

1. 359 patents on the extraction and use of collagen were identified.

Description of project

A patent search was conducted to identify potential applications for the use of bovine and ovine derived collagen. The search identified 359 international, USA and Australian patent applications or granted patents. The abstracts of these patents have been classified into categories of: wound dressings/ tissue repair; pharmaceutical preparations; cosmetic preparation; foodstuffs casings; collagen extraction/ preparation; and miscellaneous.

The bulk of the patents covered wound and tissue repair. The patents originate from universities, medical research facilities and lesser known health companies. There were a significant number of documents in the name of Collagen Corp. Patents related to the use of collagen in cosmetics originated from The Boots Company, L'Oreal and Merck Gesellschaft.

Implementation and uptake

There is no uptake of this work.

Further work or update

No further work required.

Sheep Skin Projects

Sheepskin Advisory Kit PRCOP.034 Brochure 1

Farm management for improved woolskin properties

Summary

The farm management practices which can influence woolskin properties include:

- breed selection;
- husbandry and nutrition;
- environment and season;
- handling and marketing procedures;
- ease of pelt removal.

The woolskin properties which affect specification, grading and value and which can be influenced by on farm management practices, include:

Wool and Fleece Properties

- fibre diameter and range from breed selection;
- pile length from age and shearing time relative to slaughter;
- pile density from breed;
- staple characteristics from breed and age;
- vegetable matter contamination, particularly seed;
- rib (wrinkle) from breed;
- live weight as relates to skin size;
- damage and faults, including: kemp (hairy britch), coloured wool, district, dust, season (wool tip weathering), husbandry, over-crutching, mulesing, unscourable dye-markers, bacterial stain, pour-on damage, fly-strike, dermatitis and wool matting.

Skin Properties:

- size and shape from breed and age;
- rib (wrinkle) from breed;
- vegetable matter, including seed penetration through skin to carcase;
- damage and faults, strain damage, double-hiding and abscesses. Injections should be applied in the neck area as they cause abscesses and downgrade skins.

Sheepskin Advisory Kit PRCOP.034 Brochure 2

Prevention of strain damage

Summary

Strain damage on woolskins, in the form of cracks in the grain layer, is a major problem in the fellmongering industry. It is caused by incorrect handling of the animal skin during life, in particular pulling on the wool just prior to slaughter and excessive strain on the grain surface during skin pulling resulting in distinctive multiple breaks termed “butcher strain”.

Generally, butcher strain is symmetrically located in the lower belly and flank areas, with the cracks aligned perpendicular to the backbone. It can be difficult to detect before the later stages of leather making and hence causes substantial waste of resources. Studies have shown between 60% and 100% of skins can be affected in Australian abattoirs.

In order to reduce the cost and waste of grain strain, it is desirable to detect it at an early stage. For the abattoir this means monitoring the occurrence of strain in or close to real time and modifying the abattoir procedures as necessary. For the fellmonger, it requires detection at an early stage of processing to prevent the unnecessary expenditure of resources on poor quality skins.

Strain can be caused by any of the pelt removal techniques and is most affected by the extent of opening up prior to pulling, especially where the hind legs are left unopened as socks.

Grain strain can be reduced by appropriate opening up of skins and by using well designed and operated pullers or careful manual techniques. Whether dressing is manual or mechanically assisted, it is critically important to carry out adequate work-up and clearing before any pulling actions are applied to the skin.

Sheepskin Advisory Kit PRCOP.034 Brochure 3

Skin identification and supply chain communication

Summary

Systems have been investigated by which skin faults and quality can be communicated back to the producer. For such systems, cost is a significant factor that must be weighed against the anticipated benefits.

A variety of marking and tagging methods have been devised and some tested successfully. The demand for identification has come most often for cattle hides which are worth many times the average value of a sheep or lambskin. The labour and capital costs of placing the mark or tag and later reading it and recording and utilising the information are high, whereas the mechanisms for rewarding or penalising for quality are not established.

It is difficult to justify the general use of a sheepskin identification system in Australia. However, tagging of batches of skins could be of benefit for research purposes and quality control

Sheepskin Advisory Kit PRCOP.034 Brochure 4

Raw skin marketing

Introduction

It is difficult for producers, abattoirs and processors to obtain the best return for their sheep and lamb skins. Skins vary greatly and are there are many types and grades. Different skins are suitable for very different products and uses. Most Australian skins are exported.

Summary

Australian sheepskins are derived principally from wool producing Merino breeds that are culled for age or type. The Merino skin is typically weak, uneven (thick, ribby), coarse grained and scarred from shearing and seed. The wool is generally fine and dense. Merinos crossed with English domestic breeds provide the majority of ewes for lamb production. The crossbred skins from these ewes are variable in character. The few non-Merino skins are generally flat and strong, though with coarse wool. The fine-woolled skins are generally fellmongered for the wool value, with the dewoolled pelt going for low grade uses such as chamois, shoe linings, compost, or rendering. The medium-wool skins are generally used for wool-on tanning for medical, car-seat, and clothing products.

Lambskins from meat production are derived mainly from first and second crosses of Merino ewes with English sires. Australian lambskins are ideal for wool-on (dressing and cushion) products.

The value of a skin depends upon demand. It's suitability for an end use is affected by breed, seed contamination, damage, fibre length and diameter. Demand for skins is highly variable and has little or no effect on supply, with the result that the price fluctuates wildly. Nevertheless, the skin generally represents a major portion of the value of an animal at slaughter.

Update

After rapid expansion of the fellmongering industry in the 1990s, most fellmongeries closed as they were not economically viable. However, one Australian abattoir is still successfully fellmongering its own skins in two States. This gives a market advantage as raw skins are processed at the abattoir without incurring the costs of preservation and transport.

It is now very difficult for Australian woolskin tanneries to compete with China and unfortunately a number of tanneries closed around 2005. There are now no large woolskin tanneries in Australia and most woolskins are conventionally drum salted and exported to China.

Sheepskin Advisory Kit PRCOP.034 Brochure 5

Raw skin sales and specification

Summary

Australia accounts for 30% of the world's sheep population and is a large producer of skins. Currently, many skins are preserved and then individually graded by merchants according to general specifications such as wool type and length, seed, size, damage; or customer-specific classifications such as pile density, wool character, staple structure etc. Although sale-by-description is then used to market these grades, the application of the system to skins at an earlier stage of production has the potential to dramatically reduce the amount of handling required and improve the quality of the outcome. However, it will only succeed if it can be applied to skin lots that are similar in properties (e.g. mobs), and if it accommodates damage caused both during life and after slaughter.

Mobs of sheep bred for wool production have wool characteristics that suit fellmongers producing lines of wool. Described and marketed as a lot, skins from such mobs can be put directly into fellmongering without sorting or grading. However, the differences in characteristics of lambskins usually necessitate individual assessment for wool-on tanning.

Following the success of sale-by-description for wool and meat, Computer Aided Livestock Marketing (CALM) was introduced by the AMLC / MRC as the first centralised stock selling agency, marketing by direct computer link. CALM, operating under the name 'AuctionsPlus', achieves a certain level of description for carcases and skins by employing accredited assessors to grade a sample (up to 20%) of the animals within a sale lot.

Potential skin purchasers were concerned about the reliability and accuracy of the accredited assessors descriptions of skins of animals offered for sale, and have wanted to continue with their own assessment, which includes damage after slaughter.

Update

AuctionsPlus is reported to be working better than ever and has the facility for digital imaging of high value stock such as stud cattle and sheep. Sales of sheep and lambs are high, with skins not presently being marketed on the system.

Sheepskin Advisory Kit PRCOP.034 Brochure 6

Preservation of sheepskins and lambskins

Summary

The preservation method of choice is to commence processing of the raw skin into final products soon after removal from the carcase. However, this is not usually possible. Effects of failure to preserve skins and the range of preservation methods available are detailed.

Drum salting is now most commonly used for sheep and lambskins. Salt mixed with additives (30% of skin weight) is drummed into skins in large mixers, churns or drums for 1-2 hours. Skins are stacked to purge for several days, packed on pallets, covered with a layer of salt to intercept condensing moisture and wrapped in polythene for export. The problem with salting is the salt: excess salt, saturated brine purged from skins and salt washed out during later processing cause salinity problems. This is a major environmental problem world wide. Research into economic alternatives to salt for long term preservation has not been successful.

Drying was commonly used for sheepskins but is now rarely used because salting gives better preservation. Short term preservation, including chilling and chemical preservation, can be used but are more useful for cattle hides.

Sheepskin Advisory Kit PRCOP.034 Brochure 7

Utilisation of waste skin from sheep and lamb production

Introduction

Each sheep and lamb slaughtered produces 1 to 1.5 kg of wool-bearing waste skin pieces (head and face, brisket, legs). In addition, some whole skins are of No Commercial Value (NCV) because of low or zero demand, or excessive damage. The high cost of disposal and the potential to achieve some return from processing the skin have prompted the development of a number of processes for utilising the waste skin.

Summary

Rendering

The meat meal and tallow components of waste skin can be recovered by rendering it together with conventional abattoir offal. Prior to rendering, hair and wool can be destroyed by treatment with caustic soda using commercially available equipment.

Wool Recovery

In the past, controlled bacterial loosening (sweating) and bacterial degradation (pieing) of the skin to loosen wool were used but are not now acceptable. Scalding of the skin at 90oC and plucking of the wool using a “Slipemaster” has also been used but is marginal or un-economic for Australian conditions.

A Waste Wool Recovery System was developed by the CSIRO Leather Research Centre. The wool loosening process uses a weak acid solution applied to the pieces in bulk. A wool recovery machine was developed to the commercial prototype stage but was not adopted commercially.

With wool having declined substantially in value, one of the main incentives for recovering the waste wool has been removed. Alternative processes where the wool is destroyed and the skin residue rendered are now more attractive.

Composting

NCV sheep and lamb skins and waste pieces can be composted together with equal volumes of another solid waste such as sheep and cattle paunch material and a bulking agent such as pine chips.

Referenced reports: AMT.031, M.611, M.411, COPR.012, CS.090

Update

Rendering of skin pieces, after the wool is destroyed by treatment with caustic soda, is now commonly used.

Sheepskin Advisory Kit PRCOP.034 Brochure 8

Fellmongering in Australia

Introduction

Fellmongering is the removal of wool from sheep and lambskins to realise the value of the wool and the separate de-woolled skin or pelt. Two fellmongering methods, lime/sulphide and acetate, and the subsequent processing have been used commercially in Australia since 1990.

Summary

Details are provided about wool removal, pelt processing, wool processing and effluent generated for both the lime/sulphide and acetate fellmongering systems. The applicability of lime/sulphide and acetate fellmongering is discussed. In Australia, the acetate method is most suitable for the recovery of high value wool, typically from Merino sheepskins.

The economic feasibility of fellmongering in Australia, using either the acetate or the lime/sulphide method, is strongly influenced by the returns from wool and pickled pelts and the cost and availability of raw material. As these prices fluctuate dramatically and rapidly, any feasibility analysis is quickly out-of-date.

Update

After rapid expansion of the industry in the 1990s, most fellmongeries closed as they were not economically viable. However, one Australian company is still successfully acetate fellmongering in two States.

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Sheepskin Advisory Kit PRCOP.034 Brochure 9

Improved pelt production and processing

Introduction

Australian sheep and lambskins are fellmongered using either the acetate method or the lime/ sulphide method. Acetate is most suitable for Merino sheepskins where most of the return is from the wool value. The pelt quality is indifferent and provides only a small proportion of the return. Lime/ Sulphide is more suited to lambskins where pelt and wool provide nearly equal returns.

Summary

Issues discussed:

- The Direct Lime Process which is designed to process acetate fellmongered slats through to the pickled pelt stage in a time and cost efficient manner;
- Process and quality control;
- Pelt grading: a reliable and practical system is a key requirement for marketing pelts;
- Aqueous and solvent degreasing;
- Chamois process development.

Sheepskin Advisory Kit PRCOP.034 Brochure 10

An approach to rapid processing of skins

Summary

As tanning and fellmongering processes are time consuming and generate much effluent, there is an incentive to develop faster, more efficient and less polluting methods. One such approach was the “TanTech” rapid processing technology: a machine that applied chemicals under pressure to achieve rapid penetration for fellmongering, tanning and other processes. An MRC commissioned study to examine the feasibility of the technology found that further support for development of the TanTech process by the MRC was not warranted. Subsequently the TanTech concept was developed with alternative support.

The Leather Industry had concerns with the concept when the technology was presented to them in 1998 as EnviroTan. The EnviroTan method was claimed to enable depilation in less than one minute, and processing to wet blue within five minutes. Little interest in the EnviroTan technology was shown by the leather industry and no machines are in commercial use. A major concern expressed with the concept of EnviroTan was that a significant proportion of each skin would be held by the clamp and hence be wasted, making the system uneconomic. Skins are often of irregular shape and perforated by seed and butcher cuts. Such skins could not be clamped or pressurised and hence would be excluded from processing. Although the processing of individual skins by EnviroTan may be very rapid, the production rate of conventional processes is much higher with a lower labour component and using relatively simple and scalable equipment.

Sheepskin Advisory Kit PRCOP.034 Brochure 11

Effluent reduction in sheepskin and lambskin processing

Summary

There is a community expectation that industry should not pollute and regulators are enforcing the adoption of clean technologies. A number of clean tannery processes, which had been developed and adopted for hide processing, were investigated for sheepskin and lambskin processing.

When it is not economically viable to recover the wool from sheep or lambskins but the pelts are of value, the wool is 'burned' or destroyed with lime and sulphide. The reduction in effluent as a result of applying the Sirolime hair-saving process to woolskins is not as substantial as with cattle hides because wool is finer and more easily degraded.

Carbon dioxide deliming, which was developed for hide processing, was successfully adapted to pelt processing where it allows complete replacement of the ammonia salts. The pay back time for installing CO2 for use in deliming is well under 6 months. This makes the CO2 deliming process very attractive and it has been operated in Australian fellmongeries successfully.

The majority of lamb and sheepskin pelts are pickled in a strong sulphuric acid and salt solution to preserve them for storage and sale. Pickle liquor can be skimmed and settled to allow it to be recycled virtually indefinitely. Chrome liquor recycling has been practised successfully for many years for hide tanning and has been modified for pelt and woolskin tanning.

Sheepskin Advisory Kit PRCOP.034 Brochure 12

The environmental safety of trivalent and hexavalent chromium

Summary

Trivalent chromium, Cr(III), is a very effective tanning agent with 7-8% of the global chromium consumption credited to the leather industry. It has been widely used in tanning for over 100 years and despite much research, its properties and performance have not been matched. The tanning industry uses a range of methods to maximise the utilisation of Cr(III) and consequently to minimise waste. However it is not possible to eliminate Cr(III)-containing tannery wastes. The tanning process does not use Cr(VI) and the chromium in the waste is Cr(III). Cr(III) is rendered insoluble, immobile and unreactive in soils. Cr(III) does not convert to Cr(VI) in natural environments.

Scientific research does not indicate that Cr(III) contributes to any human health or environmental ill effects. Epidemiological studies have found an association between work related inhalation of some Cr(VI) compounds and lung cancer.

High levels of Cr(III) in water and soil can be tolerated by humans. Based on US EPA Reference Doses, the allowable Cr(III) concentration in soil that might be ingested by a 2 year old child is 120,000 mg/kg while that for Cr(VI) is 600 mg/kg. In ecosystems, Cr(VI) is the more toxic form of chromium.

Based on risk assessment, the US EPA has revised their limit for total chromium in sewage sludge applied to agricultural land to 100,000 mg/kg (i.e. 10%) of dry solids. The limits will never be reached but show that there is no environmental issue with Cr(III) application to land. Australia has unjustifiably restrictive regulations for chromium in effluents and for the utilisation of wastes.

Some progress has been made in achieving risk-based environmental regulations for chromium in Australia. However, there are still unreasonable limits being enforced and there is a real need for regulators to understand the chemistry and the environmental and health effects of chromium.

Sheepskin Advisory Kit PRCOP.034 Brochure 13

Merino leather quality

Summary

Uniform, flat, thin, strong leather is the usual objective for the majority of sheep and lambskin nappa leathers. The rib pattern of Merino skin and leather is a feature which clearly distinguishes it from the rest of the world's leather.

Details are given for the production of Merino leathers.

Update

Although product ranges were developed for Merino leathers, a market was not sustained. There were problems in production and selection of appropriate skins by fellmongeries, grain strength and rub characteristics, and skin weight for garment leathers.

Sheepskin Advisory Kit PRCOP.034 Brochure 14

Australian medical sheepskins

Summary

The Australian Medical Sheepskin is a unique pressure relieving device of great value in the prevention of pressure ulcers (pressure sores or bed sores) in immobile patients. The requirements of the Medical Sheepskin tannage are demanding. During hospital use the skins must be washed and dried at elevated temperatures many times, placing stress on the leather substrate. The washability and the performance in institutional laundries are of paramount importance. The wool fibre diameter and staple length are important with respect to patient comfort and performance of the skin both in use and during laundering.

Details provided:

- Wool properties which lead to optimum comfort, performance and durability to laundering;
- Processing Technology;
- Performance Standards and Reliable Test methods for Australian Medical Sheepskins;
- Australian Standard for Medical Sheepskins AS 4480.1-1998.

The knowledge and information developed with MRC support has since been augmented by CSIRO Leather Research Centre in the areas of clinical trials, testing and laundering. The research and commercial development of the Australian Medical Sheepskin has been a success. The new product is now well recognised and reliable clinical data supporting the efficacy of the product in preventing pressure ulcers is available from projects including a National Health and Medical Research Council (NHMRC) Project.

Update

Although many Australian woolskin tanneries have closed due to competition from China, in 2008 there are a number of small tanneries manufacturing the Australian Medical Sheepskin.

Sheepskin Advisory Kit PRCOP.034 Brochure 15

Merino leather products

Summary

The rib pattern of Merino leather is a feature which clearly distinguishes it from the rest of the world's leather. A major market launch and design input for Merino garments was made during the period of increased fellmongery activity in the late 1980's / early 1990's by the "anne dreske-somoff" studio and workshop (marketed as OZ-COS) in Fremantle. Although domestic and international reaction to the Merino product was positive, a substantial supply and market was not achieved. There were problems in production and selection of appropriate skins by fellmongeries, grain and rub strength, and skin weight for garment leathers.

Establishment of Improved Fellmongery Practices DAW.038 1992

Summary

The aim of the study was to encourage and facilitate commercial fellmongering in Australia. An Industry Handbook was prepared, extension and support was provided to industry and a pilot plant was trialled by prospective fellmongers. Pelt marketing was investigated.

Further work or update

In 2008 there is no requirement for further work on fellmongering. After rapid expansion of the industry in the 1990s, most fellmongeries closed as they were not economically viable. However, one Australian company is still successfully acetate fellmongering in two States.

Skin Preservation and Alternative Fellmongering DAW.039 1993

Summary

The aim of the study was to develop economically viable and environmental acceptable procedures to assist in the development of acetate fellmongering in Australia. Short term preservation processes (5-7 days) of sheep skins which are compatible with acetate fellmongering were compared and procedures were investigated for acetate fellmongering long term (3-4 months) preserved skins.

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Utilisation of waste skin pieces CS.090 1992

Summary

Novel wool-loosening and wool-recovery systems were investigated. A machine to recover loosened wool from waste sheepskin pieces was designed and constructed to the prototype stage. A wool loosening process based on the acetate fellmongering process was developed.

With wool having declined substantially in value, one of the main incentives for recovering the waste wool has been removed. Alternative processes where the wool is destroyed and the skin residue rendered are now more attractive.

Processing Sheep and Lamb Head Pieces. A Preliminary Assessment COPR.012

Summary

The aim of the study was to assess the likely economic viability of recovering wool from headpieces using acetate depilation. The headpieces were sprayed with acetate buffer and incubated at 35°C, 85% relative humidity for 16 or 40 hours. Wool recovery was unsatisfactory. It was concluded that acetate fellmongering of sheep and lamb headpieces was unlikely to be an economically viable process.

Skin Quality and Abattoir Practices CS.138 1990

Summary

Strain damage, in the form of cracks in the grain layer, is a major problem in the fellmongering industry. The problem was investigated.

In order to reduce the cost and waste of grain strain, it is desirable to detect it at an early stage. For the abattoir this means monitoring the occurrence of strain and modifying the abattoir procedures as necessary. For the fellmonger, it requires detection at an early stage of processing to prevent the unnecessary expenditure of resources on poor quality skins.

Strain can be caused by any of the pelt removal techniques and is most affected by the extent of opening up prior to pulling, especially where the hind legs are left unopened as socks.

Alternative Sharpening Agents and the Influence of Animal Age on the Properties of Merino Leather DAW.052

Summary

The aim of the study was to determine the influence of animal age, from zero tooth to full mouth, on the properties of the leather produced from Merino skins. An unacceptably high percentage of the skins processed, particularly those from young animals, produced leather with poor grain quality. The extent to which the poor grain was a result of inherent faults in the skin and to what extent it was due to processing, fellmongering or tanning was not resolved.

Hide Projects

Hide Identification and Assessment System M.254B 1993

Project Aims

The hide identification system was a key part of the comprehensive hide improvement program of the MRC designed to increase the quality of hide production in Australia. The implementation of a hide identification system would have allowed traceability of hide quality information from wet blue or finished leather back to the grower. A major benefit of the hide improvement program was to have been the implementation of payment systems based on hide quality to give growers an incentive to produce better quality hides and to reduce the butchering defects from abattoirs.

Introduction

Projects M.254B, M.563, M.668, M.669, M.670, M.854, and M.861 were all part of the MRC Hide Improvement Program up until 1996.

From 1996 to 1998, Joe Gibson was Coordinator of the MRC National Hide Quality R&D Program. From 1998 to 2000 Joe Gibson was Coordinator of the MLA National Hide Quality Improvement Program.

The early work up until 1996 investigated a wide range of hide identification systems.

Description of project

Project M.254B was managed by Joe Gibson of Gibson Management and completed in 1993. The project included a literature search, estimates of the costs of hide damage, field trials of three methods of hide identification and development of a hide assessment system and software.

Update

After 1996, the Gibson-Bass Stamper was developed to number cattle hides in the green state at the abattoir. This enables identification of the hide at the wet blue stage of processing. The Stamper punches a human and machine-readable number through the edge of the hide in any orientation. The number of digits is variable and is generated by software to identify it with the producer or supplier. The machine can interface with a wide variety of networks for communication with factory control systems.

Unfortunately it was not economically viable to implement payment systems based on hide quality to give growers an incentive to produce better quality hides and to reduce the butchering defects from abattoirs.

Tanneries have improved their hide grading and sorting by using the hide assessment and grading systems, grader training, and software and hardware developed in Projects M.254B and M.563 and the later projects.

Training Package on Hide Assessment M.563 1995

Project Aims

Hide assessment was a key part of the comprehensive hide improvement program of the MRC designed to increase the quality of hide production in Australia. A major benefit of the hide improvement program was to have been the implementation of payment systems based on hide quality to give growers an incentive to produce better quality hides and to reduce the butchering defects from abattoirs.

Introduction

Projects M.254B, M.563, M.668, M.669, M.670, M.854, and M.861 were all part of the MRC Hide Improvement Program up until 1996.

From 1996 to 1998, Joe Gibson was Coordinator of the MRC National Hide Quality R&D Program. From 1998 to 2000 he was Coordinator of the MLA National Hide Quality Improvement Program.

Description of project

- Improved definition of hide assessment standards;
- System to judge assessor performance;
- Training materials for assessor training and reference;
- Support training material on hide improvement;

The comprehensive Final Report includes

- Training Manual: course notes in six modules;
- Overhead transparencies for the six modules;
- Colour slides: 65 slides of hide defects detailed in Module 3.

Update

Unfortunately it was not economically viable to implement payment systems based on hide quality to give growers an incentive to produce better quality hides and to reduce the butchering defects from abattoirs.

Tanneries have improved their hide grading and sorting by using the hide assessment and grading systems, the grader training materials, and the software and the hardware developed in Projects M.254B and M.563 and the later projects.

Feasibility Study of Hide and Leather Identification Systems M.668 1995

Project Aims

The hide identification system was a key part of the comprehensive hide improvement program of the MRC designed to increase the quality of hide production in Australia. The implementation of a hide identification system would have allowed traceability of hide quality information from wet blue or finished leather back to the grower.

Introduction

Projects M.254B, M.668, M.669, M.670, and M.861 all investigated hide identification systems as part of the MRC Hide Improvement Program.

Description of project

A comprehensive trade off analysis was conducted on seven different hide identification systems.

Update

After 1996, the Gibson-Bass Stamper was developed to number cattle hides in the green state at the abattoir. This enables identification of the hide at the wet blue or finished leather stage of processing.

Hide and Leather Identification System M.669 1995

Project Aims

The hide identification system was a key part of the comprehensive hide improvement program of the MRC designed to increase the quality of hide production in Australia. The implementation of a hide identification system would have allowed traceability of hide quality information from wet blue or finished leather back to the grower.

Introduction

Projects M.254B, M.668, M.669, M.670, and M.861 all investigated hide identification systems as part of the MRC Hide Improvement Program.

Description of project

An initial feasibility study of a hide identification system using electrical discharge and microwave marking techniques recommended further research.

Update

After 1996, the Gibson-Bass Stamper was developed to number cattle hides in the green state at the abattoir. This enables identification of the hide at the wet blue or finished leather stage of processing.

Using an Array of Punched Holes to Trace Cattle Hides through the Tanning Process M.670 1995

Project Aims

The hide identification system was a key part of the comprehensive hide improvement program of the MRC designed to increase the quality of hide production in Australia. The implementation of a hide identification system would have allowed traceability of hide quality information from wet blue or finished leather back to the grower.

Introduction

Projects M.254B, M.668, M.669, M.670, and M.861 all investigated hide identification systems as part of the MRC Hide Improvement Program.

Description of project

Feasibility study using a pattern of 40 or more small holes punched through the hide.

Update

After 1996, the Gibson-Bass Stamper was developed to number cattle hides in the green state at the abattoir. This enables identification of the hide at the wet blue or finished leather stage of processing.

MEAT & LIVESTOCK AUSTRALIA

Overview

MEAT & LIVESTOCK AUSTRALIA

EDIBLE OFFAL

Edible Offal

MEAT & LIVESTOCK AUSTRALIA

RENDERED PRODUCTS

Rendered Products

MEAT & LIVESTOCK AUSTRALIA

PET FOODS

Pet Foods

MEAT & LIVESTOCK AUSTRALIA

Hides and Skins

MEAT & LIVESTOCK AUSTRALIA

Alternative Co-Products

MEAT & LIVESTOCK AUSTRALIA

Co-Product Summaries

CO-PRODUCT SUMMARIES