Techniques for the Separation of Meat Meal into its Components

The potential improvement in the commercial value of existing meat meals, by fractionation into high- and low-ash components, appears to be a real opportunity for the rendering industry in Australia. The opportunities for a high-protein, low-ash fraction for use in aquafeeds, as a substitute for fish meal, has been clearly demonstrated. It appears that the optimum return is likely to be achieved by fractionating conventional 50% protein meat meal into:

- 65% (by weight) of a high-protein (55+%), low-ash (<22%) meat-meal fraction;
- 35% (by weight) of a low-protein (36%), high-ash (up to 50%) meat-meal fraction.

The composition of conventional meat meal has been generally governed by the natural fall of raw materials available to the rendering plant. Composition has been governed by:

- the ratio of gut, offal, bone and fat in the raw material;
- the residual fibre content of any gut contents entering with the raw materials;
- the addition of raw blood to the process, or dried blood to the finished product.

Minor variations in composition can be made by varying the ratio of raw materials and the level of fibre contaminants.

The requirements of the aquafeed industry will require the rendering industry to consistently produce to a tight specification and to prepare at least two products of vastly different composition. The splitting of a conventional meat meal into two distinct streams can be achieved by one of two different approaches. These approaches are:

- pre-selection and segregation of raw materials for specific products;
- fractionation of finished cake or meal into separate streams based on their particles' physical properties.

A combination of the two approaches may be necessary to get the desired degree of fractionation and to achieve the required specification.

Raw material segregation

Segregation of raw materials can be carried out on two bases:

- raw materials segregated by type according to their protein and ash content;
- ash or protein selectively removed from specific raw materials before processing.

Segregation of raw materials

Generally hard offals, such as heads and hooves from slaughterfloors, and bones from boning rooms and butchers' waste, contain a high ash content while meat, offal and fats (once the fat is rendered out) contain high protein contents. Table 1 shows the typical composition of the rendered meals obtained from a range of rendering raw materials.

Clean bone typically produces a meal containing 37–39% protein and 47–49% ash, based on a 9% fat and 6% water content. Boning-room bones will produce a meal of higher protein and lower ash, dependent on the amount of meat left on the bones.

When boning room fats are rendered, they typically produce a meal containing 85–86% protein and virtually no ash.

Each meat-processing plant is likely to have slightly different yields of individual offals depending on the raw material sources and the extent to which fresh co-products are

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retained for packing for the edible or pet-food market. The information given in Table 1 can be combined with the estimated raw material yields from a plant to predict the analysis of product being produced. A test cook will be required to verify this.

Table 1. Typical composition of rendered meals from specific raw materials

	Percentage in rendered meat meal			
Species:	**Beef**		**Sheep**	
Raw material	**Protein**	**Ash**	**Protein**	**Ash**
Head	38.7	46.2	44.5	40.6
Tongue	78.2	6.7	79.2	5.2
Tongue Root	74.2	10.8	74.8	10.0
Cheek	78.5	6.3		
Feet	62.6	32.3	45.4	39.5
Liver	79.7	5.5	80.5	4.6
Lung	78.6	6.3	76.3	8.7
Trachea & trim	75.9	9.0		
Heart	79.7	5.5	79.1	5.9
Skirt	79.8	5.3	79.2	6.0
Kidney			79.3	5.8
Spleen	79.0	5.9	80.2	5.1
Paunch	79.3	5.9	79.0	6.0
Bible & reed	79.3	5.7		
Intestine	81.9	3.0	78.4	6.4
Runner			80.9	4.2
Caul Fat	85.7	0.0	84.6	0.0
Kidney Fat			85.4	0.0

Segregation of raw materials into three categories: hard offals/bones, soft offals/gut and fats will produce meals with approximate compositions as given in Table 2.

Table 2. Approximate composition of meals obtained by simple segregation.

	Percentage in rendered meat meal	
Raw material group	**Protein**	**Ash**
Hard offal/bone	38–40	41–45
Soft offal/gut	74–77	5.5–6.5
Fats	85–86	0

By blending the raw materials available, it is theoretically possible to prepare an infinite range of specifications within the limits of Table 2. In practice, most plants have restrictions on the ability of their process to handle some materials. For example batch cooking of pure soft offal and gut material can result in extremely long cook times with heat degradation of the resulting protein and loss of yield through the generation of high levels of fines. Some plants are also restricted by equipment availability to segregate or blend raw materials prior to processing.

However raw material blending is generally the simplest and most cost-effective option to create a product to a specific composition.

Selective treatment of raw materials

It is possible to adjust the finished meat-meal composition by adjusting the composition of some specific raw materials. Reduction of the ash content of boning room and butchers shop bones will result in an overall reduction in the ash content of the finished meal. Bones can be passed through a mechanical deboning machine that physically separates the attached meat tissue from the bone solids.

These machines were developed for the recovery of mechanically deboned meat for further processing as an ingredient in value-added products. They are designed to recover all bone solids and sinews in one stream, with the meat stream being free of bone particles. To achieve a bone-free meat stream a certain amount of the meat tissue carries over into the bone stream. However, when used to reduce the ash content in the raw materials for the production of a reduced ash meat meal, the need to achieve a bone-free meat stream is not critical. A small carry over of bone into the meat stream is unlikely to significantly affect the composition of the finished meal.

A greater yield of renderable meat is possible by adjusting the split of streams so that the bone stream has minimal meat tissue and a small amount of carry over of bone into the meat stream is allowed. Production of an essentially ash-free stream of meat from bones will allow the production of a very high-protein, low-ash meal.

However, it should be considered that the second stream of bony material will need to be disposed of into other products. Being extremely high in ash, any product that it is added to will necessarily have a high-ash content.

It should also be considered that mechanically deboned meat already has a market in the pet-food industry. The price of mechanically deboned meat in this market will establish the value of this material for rendering. If the indicative value is around $350 per tonne, allowing say 10 cents per kg for packaging, handling and freezing, the mechanically deboned meat has an ex-process value of approximately $250 per tonne.

At approximately 70% moisture the rendering yield from this material would be expected to be around 32%—giving the rendering breakeven point for this material at around $780 per tonne plus rendering costs. Unless specific markets are established for low-ash rendered material using mechanically deboned meat that realise premium prices, then the material may be of greater value as a frozen raw material for pet-food manufacture.

Fractionation of finished cake or meal

When the selective segregation of raw materials to produce meat meal to the desired specification is not an available option, the cake or meat meal must be separated into low- and high-ash fractions. Several options have been investigated with mixed success.

Air classification

An air classifier makes a separation on the basis of differences in drag forces on the particles in a moving air stream. Differences in drag may arise from differences in size or density. If the feed stream is prepared so that the particles are uniformly sized, the performance of an air classifier will operate primarily on the basis of differences in density. This would enhance its performance in the application of bone separation from meat meal.

Meat meal has been found to perform poorly in this type of equipment as fine dust appears to be lost from the mass balance of the operation, and the material tends to foul the equipment. This poor performance is attributed to the formation of agglomerates of meat-meal particles.

Air tabling

An air table makes a separation on the basis of differences in drag forces on the particles in an air-fluidised bed. Differences in drag may again arise from differences in size or density. Pre-screening of material through a triple screen system to establish products of consistent particle size allowed reasonably effective separation to occur using an air table.

The level of fat, and its distribution through a meal, must be considered whenever air classification or tabling is to be considered. Firstly, the screening of the meal prior to air classification or tabling is extremely difficult when fat contents are high. Meals with fat contents greater than 11% are known to be hard to screen in existing rendering processes. The screening of smaller particle sizes becomes increasingly difficult and requires lower fat contents.

Secondly, the fat is selectively attracted to the high-protein fraction. Fat in meat meal is distributed in two ways. Some is within the bone particles where it is bound and remains throughout handling. The bulk is, however, mobile within the meaty fraction where it is attracted to the protein material. As bone particles are removed from a meal the small amount of fat trapped within the bone is removed with the bone. The mobile fat within the meal stays with the meaty fraction and is not removed with the bone. The overall effect is that the fat content within the remaining meaty fraction (the high-protein meal fraction) increases in fat content.

The overall effect is that the more the meal is fractionated the greater the fat content in the high-protein fraction and the harder it is to separate out the bone particles. It may be possible to improve the performance of this type of separation technique if the fat is scavenged from the system by recycling coarse bone material, or an inert carrier material, through the product. The carrier picks up, and removes, some fat which can be recovered separately from the carrier.

Some degree of fractionation can be achieved by a combination of screening and air tabling. Large bone pieces can be removed from un-milled cake by screening while oversize bone particles from a milled feedstock can be removed by air tabling. However, the level of fractionation achieved may not justify the capital outlay required.

Further investigations should be made by renderers who are considering this option—to look at the range of air-classification systems available and the suitability of the most promising system with their product.

Developing fractionation options

It has been speculated that the ash fraction could be separated by solubilising the mineral content of the ash and then removing it from the insoluble protein fraction. The simplest method would be to acid treat the meat meal (preferably with concentrated hydrochloric or sulphuric acids). This would precipitate the protein and solubilise most of the mineral fraction.

The resultant protein could potentially be used in cat food un-neutralised, since cats have a high tolerance to acid foods, and actually have a preference for them. Some of the amino acids would be hydrolysed by the acid treatment, potentially increasing the availability of those amino acids and possibly improving the palatability of the meat meal. The solubilised mineral fraction could be treated with sodium hydroxide and the various minerals selectively precipitated. Development of a process to selectively remove individual minerals, rather than have the existing blend of minerals as in bone ash, would potentially produce worthwhile returns as some of these minerals, such as magnesium, command a high price in pure form.

While work is required to commercialise this process, it is based on simple chemistry and is technologically similar to existing processes in the mining industry.

Further reading

This information is a summary of information from the following projects funded by the Meat Research Corporation.

- Project M.745: Separation of Meat Meal into Components
- Project M.743: Utilisation of the Ash Component of Meat Meal

Further detail is available from the final project reports for these projects which are available from Meat and Livestock Australia.

Related information is given in these MLA Co-products brochures.

- Nutritive Requirements of Meat-meal-based Aquaculture Diets
- Preparation of Meat meals for Inclusion in Aquaculture Feeds
- Utilisation of the Ash Component of Meat Meal

Additional information on yields from the rendering of individual items from animal processing is available from the following CSIRO Meat Research Reports.

- Report 2/92: By-product Yields from Cattle and Sheep
- Report 2/91: By-product Yields from Pigs

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