MEAT TECHNOLOGY – INFORMATION SHEET
Cutting edge technology for the meat processing industry

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Meat and Bone Meal

Before being used in stock-feed and pet-food formulations or as a fertiliser, meat and bone meal must pass certain quality requirements. For example, meal must be suitable for bulk handling through feed mixing and pelletising equipment and it must contain some nutrient value.

Meal is included in stockfeed rations as a protein source. Protein levels of meal are determined by the meals' crude protein content, sorted into three main categories: 50%, 48% and 45%. Meat and bone meals with a protein value of less than 45% are likely to contain too much bone material to be suitable for stock feed.

Specifications of meat and bone meal used for stockfeed have been agreed to by the Australian Renderers Association and Stock Feed Manufacturers Association of Australia. (Table 1)

Much of the variation in the nutritive value of meals is due to the level and availability of essential amino acids – compounds that make up meal protein.

The most important of the essential amino acids are lysine, methionine, cystine and tryptophan. Poultry and pigs require about 10 essential amino acids in their diet to allow for optimum growth, the correct levels and balance of which must be present in the ration. The higher the level of amino acids in the meal and the better their availability to the animal, the more the meal is worth to the manufacturer.

The ultimate estimate of nutritive value is reflected in the weight gain of the animals fed, but various laboratory tests are also routinely carried out to determine nutritive value.

Pepsin digestible protein, the amount of crude protein solubilised in vitro under standard conditions and time, is a minimum quality standard which indicates the nutritional value of meat and bone meal.

The protein keratin in wool, feathers and hair is not digestible by pepsin unless the rendering process includes a pressure cycle capable of hydrolysing keratin. Meat and bone meals with low pepsin digestibility are likely to contain a high proportion of wool, hair or feathers. Non-hydrolysed protein from these sources has no nutritional value for monogastrics (pigs and poultry).

Another specification which affects the nutritive value of meat and bone meal is ash. Ash is the residue remaining after incineration under the conditions specified for the test, and indicates the amount of minerals in the meal. Bone is the main source of ash.

The bone content of meat meal provides calcium and phosphorous, thus helping to supply necessary minerals to the animal's

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Table 1 Specifications for Meat and Bone Meal

Chemical Properties						
Minimum Crude Protein	55%	50%	50%	50%	48%	45%
Maximum Ash	30%	32%	36%	28%	37%	38%
Crude Fat	Maximum 15% on an “as-is” basis					
Crude Fibre	Maximum 3% on an “as-is” basis					
Moisture	Minimum 4%, Maximum 10%					
Salt	Maximum 1% on an “as-is” basis					
Pepsin Digestibility	Minimum 86% of the protein as determined by the method given in the official methods of analysis of the Association of Official Analytical Chemists (AOAC)					
Physical Properties						
Colour	Light to dark brown					
Texture	Minimum 98% to pass through a 2.00 mm (US Mesh No. 10) sieve					
Microbiological Requirements						
Meat and bone meal production should be aimed at minimising the level of microbiological contamination of the rendered product by the adoption of the ARA Code of Practice for Hygienic Production of Rendered Product.						

diet. The use of high calcium meals in some feed formulations must be limited, however. For example, if the calcium content of chicken diets is more than 1.2%, the early growth rate of chicks is depressed.

Another chemical property of meat and bone meal is crude fibre. Fibre is mainly the cell wall constituent of plants and is not readily digestible by animals. The main source of fibre is paunch contamination.

The remaining specifications applied to meat and bone relate to the ease of handling meal in feed mills.

The maximum moisture content of meal is specified as 10%. Meals with higher moisture levels can support mould growth and may not be free flowing. High moisture levels also dilute the nutrients in meat and bone meal.

Fat in meal is useful in that it contributes energy to a ration. As with moisture content, however, high fat levels can cause meal to cake in bins and chutes.

Meat meal colour is usually light brown to dark brown. Lighter coloured meals generally come from raw materials that contain a high proportion of bone, with the light colour due to the white particles of bone in the meal. Dark-coloured meals are also influenced by raw materials—for example, if raw materials contain blood or if blood is added to the raw material or finished meal, the meal will be a darker colour.

Raw materials that contain unwashed gut materials tend to be dark in colour because of the pigmentation contributed by the gut contents. Meat meal colour is also affected by the temperature applied during rendering, with excessive temperature producing a dark meal.

The particle size of meals is specified by feed millers because a meal which is not ground uniformly is difficult to mix with other ingredients and cannot be formed into pellets satisfactorily.

Meat meal supplies important B vitamins, particularly thiamine, as a supplement to rations.

Effects of Processing & Raw Materials on Quality

The quality of meals is affected by heat treatment and raw material composition.

During rendering or drying, three types of nutritional damage may take place depending on time and temperature conditions:

1. Total destruction of amino acids
2. Maillard or browning reactions

   For example, the free amino group of lysine reacts with certain types of sugars (carbohydrates from the stomach, glycogen and blood-sugars) preventing the subsequent breakdown by enzymes in the gut.
3. Cross linking between amino acids, preventing the breakdown of the protein by enzymes.

Nutritional damage reduces both the availability of amino acids and the quality of the meal.

Lysine is the first amino acid which becomes limiting for growth and, because it has a free amino group, it is often damaged during heat processing. As a result, the amount of available lysine in meal is used to provide an indicator of the degree of damage caused to the amino acids during meal production. Reliable, fast and simple laboratory techniques are available to determine the amount of available lysine in meals.

Nutritional quality of commercial meat meal is also extremely dependant on the type of raw material rendered. Meat meal derived from boning room cooking materials are of poorer nutritional quality than those derived from cooking materials from the slaughter floor.

The protein keratin is a major constituent of feathers, wool and hair – materials that are high in crude protein. Unless the keratin is fully hydrolysed under pressure, it is not digested by monogastric animals.

Hard offal – bones, heads, hooves, skin cartilage and connective tissue contain a high collagen content. Collagen is characterised by high levels of the amino acids hydroxyproline and glycine, which are of little nutritional value to the animal. In addition, collagen is deficient in essential amino acids, particularly lysine, tryptophan, cystine and threonine. In comparison, soft offal – muscle, guts and stomach – contain much higher levels of essential amino acids and will produce meals of greater nutritional value.

While not necessarily detrimental to meal quality, the addition of bloodmeal to meat meals to achieve protein specification upsets the balance of the essential amino acids in the resultant meal. These meals may be extremely variable in lysine composition, making it difficult for stockfeed nutritionist to define nutrient specifications. The practice is, therefore, not welcomed, and the industry would prefer to buy lower protein meals of consistent composition.

Pet-food manufacturers require high-quality meal. To achieve this, renderers may have to alter their normal operations for manufacturing to meet specific requirements of a pet-food manufacturer.

Meat Meal Rendering Treatment

Meat meals are mainly produced from dry rendering plants. Pressurisation of batch cooker contents – generally for about 20 minutes at 200 kPa (30 psig) – at the start or the end of the cooking cycle is not widely practiced nowadays, and it is impossible to pressurise continuous cookers.

In the continuous wet rendering process, the wet rendered material is dried as a separate step, following centrifuging. Two types of dryer are available in Australia: contact dryers and pneumatic dryers. These may also be used for drying blood. Contact dryers – for example, Stord Bartz drier, Australian Discor dryer, and batch cookers – are indirectly heated whereas pneumatic dryers – for example, ring dryer, the Australian AKT dryer and the New Zealand Flo-dryer – can be directly fired.

Research in Australia has shown that loss of available lysine takes place during the initial stages of the batch cooking process due to

Maillard reactions. Research also suggests that further damage occurs only as a result of quite serious deviations from normal dry rendering processing conditions (atmospheric pressure) involving temperatures of 140 °C or greater for longer than two hours. Similarly, pressure applied at any time during the processing cycle – to achieve, for example, hydrolysing of wool and hair – results in a substantial increase in the temperature of the contents with consequent damage to nutritional quality.

The degree of destruction of amino acids in meals, caused by pressure and temperature, is estimated by feeding trials. The result of these may vary, depending upon the species of animal used to evaluate the meal.

Meat meal produced in a batch dry rendering plant, in which high pressure – 275 kPa gauge, 141 °C for 30 minutes – was applied, particularly during the last stages of rendering, was found to reduce the level of available amino acids, if pigs were used as the test animal. In chicken feeding trials, however, changes were less important – that is, the chicks were less sensitive to this form of heat-damaged meat meal.

The results of chicken feeding trials indicate there is little difference between the availability of amino acids in meals made from similar raw materials which were either continuously wet rendered (and dried in a hot gas dryer at atmospheric pressure) or dry rendered (without pressure treatment, to normal endpoint of about 120 °C). However, pig feeding trials demonstrated that greater damage is caused by the dry rendering.

Additional information

More detailed information on this subject is provided in the following:

CSIRO Proceedings of Meat By-Products Processing Workshop, September 1986.