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Rendering Systems and Product Quality

This Bulletin describes the types of rendering systems that are commonly used in New Zealand for processing material from meat plant operations and discusses factors affecting the quality of tallow and meal produced by rendering these materials.

Less than half of a slaughtered animal becomes human food (meat cuts, edible offals, ingredients in processed meats). The rest can be processed into various products, sometimes called co-products or by-products. These co-products can significantly add to a meat plant's profitability.

In New Zealand the inedible slaughter wastes (viscera, hooves, heads, blood, etc.) are usually sent to the rendering department for processing into tallow and meal. Bones and fatty trim left over after carcasses have been further processed or boned out are also sent to the rendering department.

WHAT IS RENDERING?

The term "rendering" refers to a variety of processes in which the fat and protein components of animal material are separated into commercial products. During this process, water is removed, which stabilises the products. Rendering aims to produce commercially valuable, stable products that do not contain disease-causing organisms, from raw material that is often unsuitable or unfit for human consumption.

RAW MATERIAL

If good-quality products are to be produced, the raw material must be of good quality and should be processed promptly. If possible, poor-quality material should be segregated so it does not down-grade quality. If delays are unavoidable, the raw material should be kept whole (unbroken) as long as practicable and preserved by cooling or and/or acid addition. Keeping the tissues whole and cool minimises microbial and enzymatic activity.

The raw material is usually pretreated before rendering, to make it more suited to being processed. One form of pretreatment is cutting and washing. Viscera (soft offal) can contain partially digested materials that downgrade tallow quality. Also, if large amounts of gut contents enter the rendering process, they can reduce the meal's protein content and add to processing costs. Thus, the viscera are usually cut and washed before being rendered, to clean away these materials. Ideally this cutting and washing system should use the minimal amount of water necessary and minimise the loss of valuable product, such as pea fat.

Another pretreatment is to size-reduce the raw material, for example by prebreaking and/or grinding. This aids heat and mass transfer during cooking and drying.

A third pretreatment avoids problems associated with wool in those rendering systems that do not use a pressure cycle. This pretreatment involves either wool removal by Slipemasters and scudders, or wool hydrolysis by adding a sodium hydroxide solution, followed by washing and draining.

It is important not to have too much added water in the raw material. Excess water can come from gut washers and water chutes, blow conveying and unnecessary hosing. The raw material moisture content should not exceed 55% (which represents about 10% added water).

RENDERING SYSTEM VARIETY

Rendering processes can operate in a batch, semi-continuous or continuous mode. Some rendering systems are classified as low temperature rendering (LTR) because the fat separation stage is carried out before drying, using only moderate heating. Each type of rendering system has advantages and disadvantages that must be considered when choosing the best rendering system for your needs.

SYSTEMS COMMONLY USED IN NEW ZEALAND

Dry Rendering

Dry rendering systems can be either batch or continuous. Size-reduced material is heated in a horizontal, steam-jacketed vessel containing an agitator (which may also be steam heated) until most of the water has evaporated. The cooking time is chosen to produce a 'dry' material, and the end-point temperature of the meal/tallow mixture is often 110 to 130°C. The evaporated water is usually condensed to recover heat and the remaining gases are treated to reduce atmospheric pollution.

In batch systems the material can be heated under pressure for some specified time during cooking, to sterilise the material and/or hydrolyse wool and hair. The cooking time can be up to 3 hours.

Cooking times in continuous systems depend on cooker volume, cooker heat-transfer capability, and the characteristics and feed-rate of the raw material. Pressure cannot be applied in most continuous systems operating in New Zealand.

With both batch and continuous systems, after the material is sufficiently dry, cooker contents are discharged into a percolator to remove free-draining fat, then the solid material is pressed (a continuous operation) or centrifuged (a batch operation) to remove additional fat. The solids are then ground into meat meal, and the fat is treated to remove fines and moisture.

Dry rendering has several disadvantages arising from the high temperatures used before separation of the tallow. At high temperatures, gut contents and other 'dirt' can down-grade the colour of the fat. Therefore the raw material must be washed, to clean away these contaminants before processing. Also, towards the end of the cooking process, when most of the free water has evaporated, the solids (cracklings) are essentially 'frying' in the fat. The high cooking temperature degrades protein and produces fines that can pass into the fat, reducing its quality. The fines can also enter the effluent from the polishing centrifuges. Finally, high temperature systems use a lot of energy, which can be costly if there is no use for the recovered heat.

Low Temperature Rendering (LTR)

In LTR systems, the gut material need not necessarily be washed to produce a tallow of good colour, because high process temperatures are avoided before separation. However, in practice, gut washing may still be needed, to achieve a high protein content in the meal and to avoid excessive smoke during meal drying in a direct-fired dryer.

After size reduction, the raw material is heated to 90 to 95°C in a rendering vessel, after which the solid and liquid phases are mechanically separated in decanters or presses.

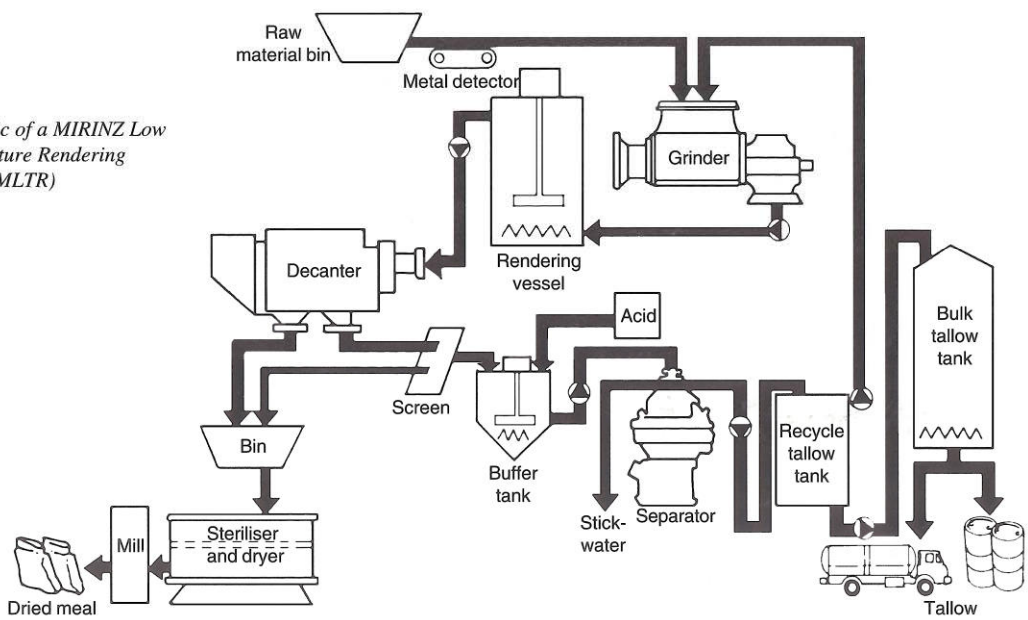
LTR systems are usually continuous, so material flow through the various unit processes must be balanced by using surge bins and/or variable speed drives.

In the early 80s, MIRINZ designed the MIRINZ Low Temperature Rendering system, or MLTR, which is now used by many plants in New Zealand. In an MLTR, the size-reduced material is heated indirectly, by coils within the vessel. The residence time for the raw material, along with some recycled liquid, to reach 90 to 95°C is just 6 to 8 minutes. The resulting liquor and solids are mechanically separated in a decanter, and the wet solids are then dried, often in a direct-fired rotary dryer, to give a low-fat meal. The liquor is separated into tallow and an aqueous phase (stickwater). The system should be operated so that product loss in the stickwater is low.

In wet-pressing low-temperature systems, the size-reduced raw material is heated indirectly to about 90 to 95°C over a 30 to 60 minute period in a continuous pre-cooker, then pressed. The pressed solids are dried, usually in contact dryers. Fines recovered from the liquid drained from the pre-heater and press through a decanting and separating stage, may also be dried with the pressed solids.

Stickwater from LTR systems can contain significant amounts of organic material. Plants can concentrate the stickwater by various means, including ultrafiltration, evaporation or physicochemical treatment, then dry the residue or recycle it to rendering, to prevent solids in the stickwater entering the waste treatment system. Where an evaporator is used, the steam side is often supplied with waste vapours from the

Schematic of a MIRINZ Low Temperature Rendering System (MLTR)



cooker/dryer to save energy. Heat can be recovered from the stickwater and from the vapours from the dryer and used to pre-heat incoming raw material, or to provide hot water.

LTR systems have several disadvantages, including their mechanical complexity, high capital costs and the need for more highly trained operators than with batch dry rendering. Also, because the systems are continuous, a pressure cycle cannot easily be applied for sterilisation or wool hydrolysis.

Compared with dry-rendering systems, LTR systems use much less energy because they remove much of the water mechanically. They also produce a better-quality tallow because only low temperatures are reached before separation.

PRODUCTION CONTROL AND QUALITY CONTROL

Rendering departments should measure their inputs and outputs, to determine their product yields, the amount of water removed and effluent losses. This knowledge will enable renderers to efficiently control their operations and maximise returns from their raw material source.

Rendering departments should also practise good quality control, to help them avoid producing overdried or high fat meal, and poor-quality tallow. For good quality control, renderers should use control charts to track product quality attributes. This will enable renderers to act on variation so product can be kept within customer specifications. Renderers should also monitor critical control points such as process temperatures and cook times.

PRODUCT QUALITY AND USES

Tallow Quality

Tallow quality is measured by free fatty acid (FFA) content; FAC colour (standard set by the Fat Analysis Committee of the American Oil Chemists Society); bleach colour; titre; and moisture, insoluble impurities and unsaponifiable matter (MIU). Other tests that can be specified include saponification number, iodine value, peroxide value, and smoke point.

FFA Free fatty acids are released when fat molecules break down (hydrolyse). The FFA content is usually expressed as percentage of free oleic acid. Plants wanting to produce tallow low in FFA should process only fresh, good-quality raw materials and keep their processing equipment and storage tanks clean.

Tallow Colour Two main factors affect tallow colour: the presence of contaminants in the raw material (faeces, gut contents, etc.) and the processing conditions used (temperature, time). Tallow can be almost white, or it can be yellow or green due to contact with chlorophyll in ingested plant material, or it can be red or brown due to overheating or contact with blood.

Bleaching with activated clay can remove some colour components from the tallow. This bleachability is greatly influenced by the raw material condition and the temperature used before fat separation: the cleaner the raw material and the lower the temperature, the better the bleachability.

Titre Titre reflects the tallow's composition. Tallow is made up of triglycerides (triglycerides are molecules in which three fatty acids are esterified to glycerol). The number of double bonds in the fatty acid chains and the length of the chains both affect titre; the fewer the double bonds (that is, the more saturated the fatty acid) and the longer the chains, the higher the titre. Fats of different animal species and from different sites in the body have different titres. The type of diet can also affect the titre, but the rendering method used cannot.

MIU The MIU value indicates fat purity, and should be low.

- Moisture (M) allows the tallow molecules to be broken down (hydrolysed) by microorganisms and enzymes.
- Insoluble impurities (I) such as protein fines, ground bone, manure, etc. can form colloidal fines that are not removed by settling or centrifuging. Other insoluble impurities such as trace amounts of copper, tin and zinc can cause fat oxidation. Plastic contaminants can cause problems in industrial processes that use tallow.
- Unsaponifiable matter (U) reduces soap yields and can make tallow smell bad.

Saponification Number, Iodine Number, Peroxide Value The saponification number indicates the average length of the fatty acid chains, and the iodine number indicates the degree of fatty acid unsaturation. These values can be used to identify types of fats and oils. The peroxide value indicates how rancid the tallow is. (Rancid fat smells and tastes bad.)

Smoke Point The smoke point is directly related to FFA, and is the temperature to which the fat can be heated before it begins to smoke.

Tallow Uses

Edible tallow (tallow processed from edible raw materials) can be used in margarine, shortenings and cooking fats. Tallow tends to give a better flavour to fried foods and is more stable during the cooking process than vegetable oils. However, the consumption of hard fats such as tallow has been associated with heart disease.

Most of the tallow produced in New Zealand tends to be inedible grade and is used in processes such as soap manufacture, oleochemical production, and animal feed production. Tallow is a useful component of animal feeds, as it has about twice the energy content of an equivalent weight of protein or carbohydrates. Tallow (or other fats) also reduces dust during animal feed processing; it improves feed colour, texture and

palatability; and it increases pelleting efficiency and reduces machinery wear.

Legislation in New Zealand allows manufacturing grade tallow to be used in products for human consumption so long as the tallow has been further processed so it would have no significant effect on human health. Such processing often includes deodorisation by a high temperature treatment or equivalent.

Meal Quality and Uses

The type of raw material rendered has a major influence on the composition of the meal produced. Meals made from protein-rich material such as trimmings and washed viscera will be high in protein (the crude protein content is usually >50%) and are used in animal feeds. Meals made from material with a high bone content tend to be low in protein and have a relatively small market. These meals are often used as a fertilizer, in competition with mineral fertilizers.

Most meat meal is sold as meat and bone meal, and has a typical composition of: 50% minimum crude protein, 2-7% moisture, 8-16% fat, and 20-30% ash. The price received for a meal usually depends on its crude protein content, although some animal food manufacturers may also specify a minimum digestibility and availability of amino acids.

MIRINZ staff believe that there is considerable opportunity to improve returns from meat meal by tailoring the product to match the various market requirements. We hope to undertake research activities in this area in the future.

STERILISATION

Some countries require certification that the meal they import has received a sterilisation treatment. With batch processes, a pressure cycle can accomplish this. However, with continuous systems, the heat treatment in the dryer must be sufficient to meet sterilisation requirements. MIRINZ engineers can survey most rendering systems used in New Zealand, including those with continuous steam-heated dryers, to determine the heat treatment being applied.

SALMONELLA CONTAMINATION

If meal samples regularly test positive for *Salmonella*, almost certainly there are one or more sites of endemic contamination after the last heat treatment. Refer to MIRINZ Bulletin no. 24 for a discussion of *Salmonella* contamination and rendering hygiene. If a plant needs help in identifying and eliminating sites of endemic contamination, MIRINZ can evaluate the process on site and recommend solutions.

PROFITABILITY

The profitability of any rendering system can be maximized by ensuring maximum yields, by processing for the best possible product quality, by appropriate marketing of the products and by minimising costs. For example, regular and planned maintenance of equipment will minimize repair and maintenance costs.

An important factor influencing profitability is the presence of excessive amounts of added water in the raw material. This added water must then be processed, which uses more energy and requires a larger rendering capacity for a given throughput of solid material than if the water were not there.

WASTE MANAGEMENT

Rendering plants play a valuable role in minimising waste from meat processing plants, but the rendering process itself produces wastewater that must be treated before it can be discharged to the environment. Offensive odours must also be controlled. MIRINZ waste management specialists can provide advice on how to minimise and treat rendering plant wastes and odours. Developments resulting from our research and experience in this area include an improved odour-control biofilter design and a cost-effective biological wastewater nitrogen removal system.

FURTHER READING

Animal By-Product Processing, by J.E. Swan, Encyclopedia of Food Science and Technology, pp 42-49. (1991)

Rendering, *Salmonella* and Meal Sterilisation, MIRINZ Bulletin no. 24. (1994)

The MIRINZ Low-Temperature Rendering System, by T. Fernando, Proceedings, 22nd Meat Industry Research Conference, pp. 79-84. (1982)

Viscera Washing, MIRINZ Bulletin no. 7. (1983)

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