MEAT TECHNOLOGY – INFORMATION SHEET

Cutting edge technology for the meat processing industry

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Validation of rendering processes

This information is for renderers who need to either validate their process, or need to substantiate their claim to a regulatory authority or a customer that their process has been validated.

Access for Australian animal protein meals (e.g. meat and bone meal; MBM) to some markets depends on meeting importing country requirements, which may include specified heat treatments for rendered products. The Australian Standard for Hygienic Production of Animal Products (AS5008-2001) requires that the heat treatments used in all rendering systems are validated annually by demonstrating that the heat treatment complies with a microbiological performance standard i.e. absence of *Clostridium perfringens* in the final product. Suitable heat treatments that can achieve this standard are not specified, allowing Australian renderers to customise their process to cater for different raw materials, the available equipment and product quality specifications.

The raw materials used for rendering may include hard materials such as heads, feet, horns and bones; and soft materials such as the gut (intestines, paunches etc.), offals and fat trimmings. All raw materials are reduced in size before rendering and intestinal material is cleaned of manure; however, because of the nature of this material, bacteria inevitably contaminate the raw product in high numbers.

Pathogenic organisms of concern

E. coli, *Campylobacter*, *Brucella*, *Staphylococcus*, *Yersinia*, *Streptococcus* and *Salmonella* are pathogenic non-spore-forming vegetative bacteria that may be present in raw materials.

However, contamination of meat meal by *Salmonella* is by far the most common bacteriological problem in the rendering industry. *Salmonella* does not survive the heat treatments applied during the rendering process, but recontamination can occur after cooking. *Salmonella* can grow in moist areas in meal-handling equipment, but can be controlled using good manufacturing practices.

Some bacteria form spores when conditions become too harsh for the vegetative cells to survive. If spores survive the rendering process, they may remain dormant until conditions are suitable for germination and growth—for instance if the moisture level rises. Bacteria that form spores (and the diseases they cause) include *Bacillus anthracis* (anthrax), *Clostridium botulinum* (botulism) and *Clostridium perfringens* (enterotoxaemia).

Bacterial spores are much more heat resistant than vegetative cells. As with vegetative cells, the nature of the medium in which spores are heated will influence the amount of death that occurs. For example, high concentrations of fats and proteins act to protect bacteria and spores during heating. Also, vegetative cells and spores in low-moisture products are more heat-resistant than in moist products. Consequently, sterilisation of dry products requires higher temperatures and longer times than for 'wet' products.

Heat treatment cycles used in rendering systems

Heat treatment during rendering is important, not only to produce a product of acceptable quality for inclusion in stock feeds and pet foods, but also to protect the health of animals consuming these products.

Rendering systems can be classified as 'wet' or 'dry', and each type can be carried out as a batch or continuous operation.

Dry rendering systems

Dry rendering systems are used at about 80–85% of rendering establishments in Australia. In dry rendering systems, fat is separated from solids by draining, centrifugation (extractors) or pressing (expellers) after most of the water has been evaporated from the material. This is called dry rendering because fat is separated from dry solids.

Typical dry rendering programs have a retention time of 90 minutes, or more for batch processes with an end point temperature of about 135°C. Effectively, raw material is boiled for at least one hour. Once most of the water has evaporated, the temperature rises above 100°C and the product 'fries' in the extracted tallow. In a continuous dry rendering process,

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material has an average retention time in the cooker of about 45 minutes with an end point temperature of about 130°C or higher.

As mentioned earlier, heat treatment times and temperatures are not stipulated in the Australian Standard (AS5008-2001); however, for mammalian product exported into the EU, raw material must have a maximum particle size of 50 mm and must be heated to a core temperature of at least 133°C for 20 minutes at a pressure of 3 bar absolute, (200 kPa gauge). Other acceptable treatments that are approved for non-mammalian product are listed in Table 1. These heat treatment programs will eliminate vegetative bacteria and viruses.

Wet rendering systems

In wet rendering, raw materials are heated in their own juices, with or without steam injection. Water is not evaporated from the materials, as occurs in dry rendering. Instead, after heating, centrifugal force or pressing is used to separate liquid—including tallow and free water—from the wet solids. The wet solids are then dried separately from the tallow.

Wet rendering processes used in Australia are continuous processes. In one type of continuous wet rendering system, raw material is initially heated to about 95°C and held for about 20 minutes. The cooked material is then defatted and dewatered by pressing. The defatted wet solids are dried in an indirect steam-heated drier. The material in the drier is in contact with steam-heated discs (170°C) with the end point temperature of the meal usually not exceeding 110°C. The material is in the drier for 60 to 120 minutes. Other continuous wet rendering systems use direct-fired hot-air driers to dry defatted wet solids.

Critical limits

The Australian Renderers Association's '*Code of practice for hygienic rendering of animal products, 1996*' suggests that the following parameters contribute to the extent of the heat treatment:

- raw material particle size;
- temperature achieved in the heat treatment process;
- pressure applied to the raw material;
- duration of heat treatment process (or feed rate for a continuous system); and
- degree of agitation.

Minimum process values should be specified for the parameters as appropriate for the rendering system. For example, raw material should be pre-broken to a consistent size; ideally less than 50 mm.

Table 1. EU approved heat treatment methods for mammalian (Method 1) and non-mammalian raw material (all methods).

Method	Size of particle (mm)	Core T°C	Time (min)*	Process type#	Process require-ments
1	50	133 at 3 bar	20	B or C	Use saturated steam
2	150	100 110 120	125 120 50	B	
3	30 110 120	100 55 13	95	B or C	
4	30 110 120	100 13 8	16	B or C	With added fat
5**	20 100	80 60	120	B or C	Allow to coagulate, remove fat & water before treatment

* Time for which core of particle must remain at the specified processing temperature.
# Batch (B) or continuous (C)
**Refers to a wet rendering process

Validation of heat treatments

The Australian Standard for Hygienic Rendering of Animal Products (AS 5008-2001) requires that establishments validate their heat treatments. Part 5.7.1 states:

"Adequacy of the heat treatment process shall be provided by:

(a) absence of *Clostridium perfringens* spores in rendered product immediately on completion of the heating process; or

(b) demonstration that the thermal process is equivalent in sterilizing effect to the conditions prescribed to regulatory authorities; and

(c) the effect will be demonstrated over ten continuous days operation each calendar year."

Clostridium perfringens is common in the microflora of animal intestines and can be expected to be in raw material for rendering. *Clostridium perfringens* is not necessarily a hazard in rendered product. It has been selected as a useful indicator to validate that heat treatments achieve a minimum level of microbiological control. *Clostridium perfringens* endospores have similar heat resistance to potential hazards such as *Bacillus anthracis*. If *Clostridium perfringens* can be eliminated during the rendering process, other heat resistant biological hazards of concern in Australia are likely to be eliminated.

1. Published literature

There is a limited amount of published information about validation of rendering heat treatments. The various published research papers about the efficacy of heat treatments used in rendering differ in the rendering parameters examined (wet system, dry system, simulated autoclave systems), the microbial methods used to recover microorganisms (inoculation level of spores, media used), and the choice of target microorganism (*Clostridium perfringens, Clostridium sporogenes, Bacillus cereus, Bacillus stearothermophilus, Bacillus anthracis*). The published information applies to a narrow range of rendering conditions and is not suitable as an alternative to the physical validation of heat treatments required by AS 5008-2001.

Danish researchers have formulated a predictive model for the sterilising effect of a batch dry rendering heat treatment using a heat transmission equation calculated for bone tissue, and thermal death graphs for spores of *Bacillus cereus* or *Clostridium sporogenes* (Hansen and Olgaard, 1984). The calculated thermal effects of six dry rendering processes were described. The results indicated that pre-drying for 45 minutes followed by cooking at 125°C for 15 minutes and final drying (100-115°C for 20 minutes) ensured a 6-$\log_{10}$ reduction of *B. cereus* spores even in the centre of 70 mm bone particles. Spores of *Clostridium sporogenes* were virtually unaffected (0.2 $\log_{10}$ reduction); however, by reducing the particle size to less than 40 mm, the same process resulted in a 4-$\log_{10}$ reduction of spores of *C. sporogenes*. Unfortunately this research did not examine the reduction in *C. perfringens* under the different processing conditions.

Generally, the above-mentioned research and other studies indicate that:

- processors should ensure that raw material is pre-broken to a consistent size—preferably less than 50 mm—before rendering;
- high initial moisture levels in raw materials aids in the reduction of bacterial spores in both naturally contaminated and inoculated products;
- whether the thermal process is conducted using a wet or dry rendering system, it is the wet stage that gives the most reduction in the number of clostridia; the end temperature when the moisture content is very low is less significant.

2. Experimental investigations

Investigations indicate that *C. perfringens* may be present in raw material at between 300 to 600,000 cells per gram. AS 5008-2001 does not specify a required bacterial reduction in rendering, nor is there a specified reduction in any current, importing country requirements.

The current Australian Standard method for enumeration of *C. perfringens* is AS 5013.16–2004. It is identical with, and reproduced from, ISO 7937:1997. AS 5013.16-2004 supersedes AS 1766.2.8-1991. This method is a pour-plate technique where 1 mL of the initial dilution or subsequent serial dilution is tested for *C. perfringens*. If the initial test sample was 10 g in 90 mL of diluent (i.e. 1 in 10 dilution), and 1 mL is pour-plated, the result will be reported as less than 10 per gram. Based on the reported concentration of *Clostridium perfringens* in raw material of 300 to 600,000 per gram, this represents a reduction of between 1.5 and 4.7 logs.

If it is necessary to demonstrate a greater reduction in *Clostridium perfringens*, the options are to use a more sensitive method to test rendered product or inoculate samples of raw material and subject the material to an actual or simulated rendering process. For example, it is possible to plate out 10 mL of the initial dilution over three plates i.e. about 3 mL in each pour plate. If this option is used, the concentration of agar in the medium should be increased to about 1.8%; normal agar strength as specified in the standard is 0.9%. The usual 10–15 mL of media is pour-plated with the 3 mL sample and then a 10 mL overlay is added after solidification. This will give a limit of detection of 1 per gram. Alternatively, a most probable number technique based on the superseded Australian Standard method AS 1766.2.8:1991 can be used. Results could be reported as <1 per 25 g or even <1 per 100 g depending on the sample size. A result of <1 per 25 g would demonstrate a reduction of 3.9 logs (7500-fold) to 7 logs (10-million-fold) based on the reported initial levels of 300 to 600,000 per gram in raw material.

Renderers are required to validate their heat treatment processes to meet AS5008-2001 requirements i.e. absence of *C. perfringenes* in final product.

As it stands, the current literature is not suitable to be used to validate heat treatments as an alternative to physical validation. Therefore, establishments must undertake their own investigations for their particular process.

Further reading

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Contact us for additional information

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