Meat Research News Letter

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Meat Research Laboratory

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Date 29th September 1978 **Number** 78/4

FACTORS AFFECTING THE QUALITY OF TALLOW

The production of high quality tallow is dependent on good processing and storage procedures. Poor handling at any stage in production will result in a low value product. The objective of this Newsletter is to identify the main problems that can occur at each stage of processing, and to suggest solutions which will ensure a good result.

Australian meatworks produce tallow by three different methods:

1. BATCH WET RENDERING

Batch wet rendering is not widely used today because of the many problems associated with it. However, because it can be used in the recovery of saveall tallow it is worthy of brief comment.

Problems

- Prolonged boiling of saveall fats causes water hydrolyses of the tallow, increasing the already high concentrations of free fatty acids. The prolonged boiling is often the result of attempts to destabilize the firm emulsions which bind the tallow.

Solution

- If an emulsion forms, the pH should be lowered to values of between 4 and 5 with the use of acid so that the emulsion will disperse quickly.

2. CONTINUOUS WET RENDERING

Continuous wet rendering involves a short water/raw material contact time and consequently there is less opportunity for water-catalysed degradations of tallow quality. Wet rendering produces a mixture of solids, tallow and water which contains dissolved and suspended solids. In most modern plants, tallow is separated from the hash in a two stage centrifugal process. The first stage removes the solids while the second stage separates the tallow from the stick water (dissolved solids solution) and sludge.

Problems

- Water and fines can be carried through with the tallow into the storage container. Cloudy or hazy tallow will result and storage stability will be poor.

Solution

- A centrifuge of adequate capacity must be used in the second stage. This will result in clear, bright tallow.

3. DRY RENDERING

Dry rendering is the method most widely used by Australian meatworks and the one which can present the greatest problems. There are two types of dry rendering: batch and continuous.

Problems

- Tallow with high concentrations of free fatty acids will result if cookers are overloaded or loaded too slowly.

- High raw and bleached red colour will result from over cooking, intermittent cooking, agitators not working efficiently, or agitators being turned off before the steam has been shut down.

- Tallow is separated after dry rendering by draining and pressing, and settlings sour rapidly when wet, especially if the percolator pan is kept continuously warmed by steam. Tallow and fines in the pan contain anaerobic bacteria which multiply rapidly, and release fat splitting enzymes. Thus the free run tallow from successive cooks, although sterile at discharge, will be contaminated with these anaerobes and enzymes and a free fatty acid problem can develop in the settling and storage tanks.

- Hydraulic pressing, even if inefficient, will only affect tallow yield. Screw pressing, on the other hand, can cause scorching of the tallow through frictional heat if not correctly set up. Both raw colour and bleachability of the tallow will be adversely affected by overheating.

Solutions

- Cookers should be loaded to the recommended level. They should not be loaded intermittently or loaded too slowly.

- Cooking temperature should be monitored, especially in the final stages of water removal where temperature increases rapidly.

- Settlings should be cleaned from the percolator pan daily. Pressing equipment should be correctly set up and maintained.

GENERAL

Two stages in tallow processing - the *removal of impurities*, and *storage* - pose the most problems for abattoir management.

REMOVAL OF IMPURITIES

Before tallow can be stored, the fines left in the tallow after draining and pressing must be removed. The fines consist of suspended particles of meal and may be separated from dry tallow by settling. Contaminating pigments may also need to be eliminated.

Gravity Settling

Gravity settling may be used, provided the fines are dry and settle quickly. When the settling tank is filled the temperature of the tallow should be raised to 90-95°C and checked with a thermometer located preferably about one foot from the bottom of the tank and away from the steam coils. Once the desired temperature is reached, the heat should be turned off. It may not be necessary to heat the tallow if the settling tank can be filled with minimum delay after rendering. Heating causes convective movement of the tallow which of course interferes with settling.

Problems

- If the fines are dry, they can be settled over a long period of time (8-24 hours) without affecting tallow quality. However, if they are wet (e.g. as a result of incomplete rendering, or through water or brine washing) the fines must be settled within two hours.

- Prolonged water contact with the tallow will result in an increase in FFA through water hydrolysis which is accelerated in the presence of salt.

Solution

- Load the cooker to the recommended level to avoid overloading and maintain efficient end point control to ensure complete water removal during rendering.

- Lag the settling tank with insulating material or relocate it to a warm part of the plant to reduce cooling of the tallow during settling.

- Don't water wash tallow unless it is necessary. Only dark coloured tallow or tallow with fines which are difficult to settle should be washed, and only if washing significantly reduces the settling time, is not likely to produce emulsions, effectively removes fines, or reduces colour.

- Use a scroll or disc centrifuge to speed up the settling process. Settling tanks will not be needed, and tallow yield will be improved. Dry fines can be separated more efficiently with a centrifuge if they are fully wetted to increase their density by introducing a metered stream of water into the centrifuge feed pipe. Wetting of the fines does not create a problem with the tallow because of the short contact time. Gut tallow can also be washed by this method.

- An alternative to gravity or centrifugal settling of dry fines is filtration. The efficiency of filtration depends on flow rate, surface area of the filter, percentage of fines and packing characteristics of the fines. Filter aids such as diatomacious earth have been used successfully and recent work with bentonite (a locally mined earth) looks promising. The big disadvantages in using filter aids are their cost, and the need to dispose of the spent earth.

Tallow Washing

Tallow, rendered from finely ground raw material or gut offal, or tallow which contains wet fines, may present settling problems. If the impurities will not settle or are dissolved in the oil, e.g. pigments, some form of washing is required.

Problems

- If tallow washing is not done properly it can lead to an increase in the FFA of the tallow and cause tallow losses during draining of the washing medium because of emulsification.

Solutions

- Before attempting any washing method in the byproducts plant, a preliminary test should be done in the laboratory to determine whether washing will form emulsions and to indicate the amount of various chemicals required to obtain a good break and rapid settling of the insoluble impurities or dissolution of suspended water soluble impurities. The best method is always the simplest one that works.

- The tallow should be heated and held within the temperature range of 80-100°C. Lower temperatures will allow bacteria and free enzymes to degrade the tallow.

- The contact time should be no longer than that required to dissolve or coagulate and settle the impurities. The longer the water and fines are in contact with the tallow, the higher will be the FFA and tallow colour. Even at temperatures which would inactivate the bacteria and enzymes, prolonged contact with water and fines promotes FFA production.

- Mixing should be just sufficient to bring both liquids into contact. Emulsification will result from over-energetic mixing.

- If separation of tallow and washing medium does not take place within two hours, use another method or use a centrifuge.

- Tallow washing is best done in conjunction with a disc or polishing centrifuge. This produces a clear, bright oil, significantly reduces the contact time, and eliminates bulky settling tanks.

STORAGE

Clean, dry tallow stored at the correct temperature will keep well. Abuse of tallow during processing and storage will result in reduced shelf life.

Problem

- In addition to hydrolysis, tallow is subject to oxidative deterioration and colour fixation when exposed to air, high temperatures, and light during processing and storage. Oxidative enzymes, trace metals and organic metal complexes such as haemoglobin accelerate oxidation. Severe oxidation produces short chain fatty acids, further increasing FFA content.

Solution

Oxidation can be inhibited by taking the following precautions:

i) Store tallow at the lowest practical temperature.

ii) Ensure proper coil installation which will prevent scorching of tallow during storage.

iii) Avoid repeated heating and cooling of tallow as this further lowers its resistance to hydrolysis and oxidation.

iv) Avoid unnecessary aeration:

Use rubber ferrets in conjunction with compressed air (not just air alone) to transfer residual tallow left in lines after pumping. Run tallow inlet pipes to the base of the storage tanks or at least direct the flow towards the walls.

v) Conserve the natural antioxidants contained in tallow. Naturally occurring phosphatides, tocopherols and carotenoids give tallow built in resistance to oxidation. Extensive washing, aeration and overheating of tallow will deplete or destroy them.

vi) If prior arrangements can be made with the tallow buyer, use approved synthetic antioxidants. Often they are not permitted because they may mask the true quality of tallow. When used as intended, i.e. to stabilize tallow during extended storage, they can be a valuable aid in maintaining quality.

vii) Never use copper or zinc where contact with tallow is likely (this includes brass). As little as 1ppm of copper in tallow will result in rancidity in a very short time.

viii) Store dark and light tallows separately. Tallows with low and high FFA should also be separated. Do not blend them.

ix) Store tallow away from light. Storage vessels should be covered to keep out light and prevent airborne moisture, fines and dust from contaminating the oil. Inspection hatches at the top of the vessel should be kept closed.

x) Each time a storage vessel is emptied, inspect it and have it cleaned if necessary.

Storage Conditions

If the storage vessel is partially full and is to be topped up daily, the tallow in the tank should be kept liquid by maintaining the temperature between 60°C and 70°C. Agitators should be switched off overnight and the steam should be turned down so that any remaining fines or moisture will settle during the night. These can be run off next morning. Keeping the tallow liquid prevents layering of solid fat where the interface between each layer may contain souring water and fines.

Short Term Storage

Storage of tallow in full tanks for one to three weeks may be done safely by holding the temperature in the tank between 55°C and 65°C.

Long Term Storage

Full storage tanks not requiring loadout for three to four weeks or longer should be drained of sludge and allowed to cool to ambient temperature. Of course this will depend on the size of the storage vessel. Very large quantities of tallow in storage are often kept liquid because of the extra time required to remelt the tallow before loadout. It is sometimes recommended that the tallow be heated to 100°C or higher to pasteurize it before extended storage, but if the tallow is clear this is not necessary. Remelting of tallow for loadout must be done slowly to avoid localised high temperatures. At least 24 hours' notice should be given to the operator so that he has sufficient time to do so.

Meat Research Abstracts

a CSIRO Meat Research Laboratory Information Service for the Australian Meat Industry.

Below are some abstracts of recent publications which may be of interest. Copies of publications are restricted to the Australian meat processing industry and can be obtained by completing the attached form. Payment must be made in advance.

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* 1. "RELATIONSHIPS BETWEEN TIME OF STUNNING AND TIME OF THROAT CUTTING AND THEIR EFFECT ON BLOOD PRESSURE AND BLOOD SPLASH IN LAMBS," by A.H. Kirton, W.H. Bishop & M.M. Mullord. *Meat Science(2)* (1978). 8p

A study based on 84 electrically stunned lambs showed that those gash stuck (transverse incision of the extended neck which almost simultaneously severs the trachea, oesophagus, common carotid arteries and jugular veins and the spinal cord at the occipito-atlantal junction) immediately after removal of the electrical applicator had a lower incidence of blood splash than lambs gash stuck five to eight seconds after stunning. Lambs whose throats were cut immediately before the application of the electrical current had the lowest incidence of blood splash. None of the splash observed was of commercial significance. Systolic blood pressure recordings were made on a further 12 lambs of a similar age, 10 of which were electrically stunned and two shot with a captive bolt pistol. Blood pressure changes observed were related to the blood splash results obtained in the first trial. Electrical stunning raised blood pressures to an average of 3.5 times normal in lambs allowed to recover from stunning. A further seven young unweaned lambs which were electrically or percussion stunned showed a similar pattern of blood pressure change to that reported for older lambs following stunning, except that lower maximum pressures were reached. The authors interpret the results of the present trials as indicating that the application of electrical current to the heads of lambs results in damage to small vessels prior to the elevation of blood pressure. This damage may become apparent in the dressed carcass and organs as small haemorrhages. The subsequent rise in blood pressure following stunning then exacerbates the leakage of blood into tissues and it becomes more apparent in the form of discrete haemorrhages or blood splash.

2. "THE COLD FACTS - INDUSTRIAL MEAT REFRIGERATION," by C. Bailey. *Meat*, May 1978. 4p

Survey measurements carried out by the MRI over the last seven years have shown unambiguously that the majority of refrigeration systems operating in the UK meat industry do not achieve the final product temperatures anticipated by their operators. The design and/or operation of the systems must therefore be at fault, and the evidence of many hundreds of technical enquiries received at the Institute shows that the problem often starts with an insufficiently exact analysis of the factors involved by either the meat or refrigeration industry.

Product temperature requirements are always the prime consideration in the design of the process in all other applications of food refrigeration, and it is incredible that the meat industry has remained unique with refrigeration systems constructed in a rather arbitrary manner without adequate design data.

An examination of the pattern of current refrigeration installations for the UK market shows that problems can arise from a lack of understanding by both customer and contractor. The meat producer approaches the refrigeration contractor with a requirement for meat cooling which is usually geared only to a preconceived operating schedule.

Actual examples of poorly designed commercial systems encountered by the MRI are given to exemplify these problems.

3. "CHEMICAL AND PHYSIOLOGICAL ASPECTS OF PIG STUNNING IN RELATION TO MEAT QUALITY - A REVIEW," by P.G. van der Wal. *Meat Science(2)* (1978). 12p

A survey of research undertaken at the Research Institute for Animal Husbandry 'Schoonoord' is given in which different stunning methods have been evaluated with respect to metabolic, meat quality and economic aspects. These data have been supplemented from the literature. The overall conclusion is that electrical stunning (300V) with short stunning time and a minimal lapse of time between stunning and sticking, offers the best prospects in relation to pork quality. Electrical stunning is thus recommended for pigs in industrial scale slaughtering.

4. "ENERGY USE IN ABATTOIRS AND THE POTENTIAL FOR ENERGY CONSERVATION BY WASTE HEAT RECOVERY FROM POLLUTION CONTROL DEVICES," by A. Graham. *Food Technology in Australia*, March 1978. 4p

Energy use and concervation in the Australian meat industry has received little attention in the past. Undoubtedly this is because, even though energy consumption is about 4 MJ/kg dressed carcass weight, its cost is less than 5% of the total operating expenses.

Recent environmental protective legislation has, however, created a situation in which energy conservation is an attractive and economic possibility. In particular, devices necessary for the control of odour pollution lend themselves readily to inclusion in waste heat recovery systems.

5. "AIR THAWING OF BEEF QUARTERS," by S.J. James, P.G. Creed & T.A. Roberts. *J. Sci. Fd Agric.* 1977, *28*. 11p

An experimental study of thawing beef hind and forequarters of different weights in air has been made with respect to thawing time, weight loss, appearance and changes in bacterial numbers. From the experimental results a mathematical model and a computer programme have been developed to predict thawing times of quarters under other thawing conditions. Percentage weight losses varied from 1.2 when thawing at 5°C to 2.4 at 30°C. The appearance of quarters thawed at 5°C and 10°C was satisfactory for normal use while a darkening of the lean and a drying out of thin sections made those thawed at 20°C and 30°C only suitable for processing. The mean bacterial counts (expressed in $\log_{10}/cm^2$) were always below 4.75 on quarters thawed at 5°C but they increased as the temperature of the thawing media was raised, means in excess of 7.0 being recorded on hindquarters thawed at 30°C.

6. "STUDIES SHOW ADVANTAGES AND SAFETY OF VACUUM-PACKAGED MEAT," *The National Provisioner*, July 15, 1978. 8p

At present more than half of all the beef shipped out of processing plants in the United States is vacuum-packaged. The so-called "boxed beef" method creates substantial economies in the operation of the plants which mean lower prices to the consumer.

This form of packaging markedly extends shelf life because the exclusion of air retards the growth of putrefactive organisms as well as pathogens, particularly *Salmonella* which is a facultative anaerobe. At the same time, vacuum-packaging favors growth of lactic acid-forming bacteria. The slightly acid media these produce and certain metabolites which they release further retard the undesirable organisms. The meat juice which occasionally forms on the surface of vacuum-packaged beef is, therefore, in effect a preservative medium.

A high surface count of bacteria does not necessarily mean a proportionate high count of *Salmonella*. Moreover, unless meat has begun to spoil or has been treated with a proteolytic enzyme, those organisms do not penetrate to the interior.

The outbreaks of *Salmonellosis* which do occur usually result from improper cooking and handling, not from prior contamination of meat. This is evident from details of *Salmonellosis* outbreaks traced to meat occurring in the past few years, as described in the *Morbidity and Mortality Weekly Report*. The Center for Disease Control has no evidence of outbreaks of *Salmonellosis* from eating vacuum-packaged fresh beef.