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EFFECT OF SELECTED AUSTRALIAN AND AMERCAN PROCESSING CONDITIONS ON THE THAW LOSS, COOKING LOSS AND TOTAL LOSSES FROM BEEF

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2. Background

Complaints were received from American end-users about excessive thawing and cooking losses from frozen Australian insides (M.semimembranosis and Adductor) and outsides (Biceps femoris and M.semimembranosis). The American processors believed that poor processing conditions in Australia were responsible for the large variable losses recorded during thawing & cooking of these Australian meats. A literature search was unable to explain why there should be such large differences.

3. Objectives

Investigate the relationship(s) if any, between the processing conditions which are applied to animals, carcases & meat in Australia and the yield (water losses) from these same frozen meats during thawing and cooking in America.

4. Methods

Cattle & Meat Selection. Cattle (46) were selected from northern Australia (a tropical climate) and a second lot (33) from southern Australia (a cool temperate climate). The cattle were typical for this trade, 6 tooth (about 36 months of age) and weighed between 250 and 280 kg. The carcases from the northern group were effectively stimulated at an abattoir with a high voltage stimulation unit (800 volts, 14.3 pulses/sec for 60 seconds) while those from the southern group were stimulated with a high voltage side stimulator (800 volts, 14.3 pulses/sec for 90 seconds). After splitting each side was randomly allocated to either a fast or a slow chiller (nominally 15^0C & 23^0C deep butt temperature at 20 hr post-slaughter). Another group of sides were re-hung from the sacrosciatic ligament (Tenderstretch method) and chilled in the fast chiller. All sides were boned at 24 hr and the insides and outsides were individually identified, weighed and cartonned. Cartons of meat were frozen either in a blast freezer, air temperature -30^0C & with air velocity of 3 mps for 48 hr or in a freezer store, air temperature -30^0C & with 0.1 mps air velocity. Each outside was cut in half when frozen and labelled either anterior or posterior.

Thawing. The primals were held in the freezer at -20^0C for six months. Prior to thawing the primals were randomly allocated to one of three thawing conditions: - (1) In air at 0^0C for 96 hr, (2) In air at 10^0C for 48 hr, (3) Inside a bag placed into running water at a temperature of $12\text{-}15^0$C for 16 hr. Treatment (1) often resulted in incomplete thawing. The thawed primals were re-weighed.

Cooking. The pH of each cut was determined after thawing and prior to cooking. A thermocouple was inserted into the centre of all primals prior to placing in cook bags. The insides and some of the half-outsides were cooked to "medium", that is, when the core temperature reached 65^0C the primal was removed from the oven (forced fan type) and stored at ambient temperature for a minimum of 30 min. During this period the internal temperature of the primals continued to increase before it started to decrease; the maximum temperature is defined as the "final core temperature". After cooling the meat in a chiller at 0^0C for 48 hr the bags were opened and the cooked meat was cleaned of fat, dried and then re-weighed.

The remaining half-outsides were cooked in one of three cooking conditions – at either a slower or faster rate to the core temperature of 65^0C or at the "medium" cook rate to a core temperature of 75^0C.

The **"medium" rate of cooking** was an air temperature of 55^0C for 2 hr and then at 77^0C until the core temperature was reached;
The **"slow" rate of cooking** was the following air temperatures for intervals of 2 hr at 40, 45, 50, 55, 60, 65 and then 70^0C for the remainder of the cook;
The **"fast" rate of cooking** was an air temperature of 85^0C for 2 hr and then at 77^0C for the remainder of the cook; and
The "medium" cook rate to a core temperature of 75^0C was achieved by 2 hr at 55^0C, then at 77^0C until the first primal reached 60^0C and then 90^0C for the remainder of the cook.

The experimental design was a Balanced Incomplete Block. The data was analysed by Analysis of Covariance, where maximum core temperature, deep butt temperatures and pH were included as potential covariates.

5. Results and Discussion

Within American processing plants the main factors which are likely to influence total losses/yields from frozen Australian primals are:

(1) Rate of thaw or the frozen primals, (2) The degree of pumping of the primals with brines, (3) the rate of cooking, and (4) the final end temperature after cooking.

It was decided not to pump the primals in these trials because to do so may mask the primary effects of thawing and cooking. Thus only items 1, 3 & 4 were investigated.

Variations that occur in practice in Australia that could affect the thaw and cook yield from frozen primals include:
(1) Animal type (steer, cow, bull, etc); (2) Age of the animal (collagen content and type); (3) Amount of stress and hence the ultimate pH of the meat; (4) Electrical stimulation or not; (5) Rate of chilling of the sides of beef; (6) Conventionally hung sides (achilles tendon) or tenderstretched; (7) Amount of subcutaneous, inter- and intra-muscular fat; and (8) Rate of freezing of the primals.

Within the constraints of time and money only the following extreme range of processing conditions which can occur in Australia were investigated:

(4) Electrical stimulation or not; (5) Slow chilling and fast chilling; (6) Achilles tendon and Tenderstretched hung sides; (8) Fast freezing and Slow freezing.

A search of the published research findings, revealed that no investigations had examined the combined effects of the above conditions on the thaw and cooking losses from insides and outsides.

However, it is widely known that better yields of processed meat products are obtained from meat and meat emulsions which have elevated pH. For example, bull meat commands a premium over steer and cow meat because it has a higher pH and is leaner. While there was no attempt to select primal cuts on the basis of pH, the primals which were collected had a range of pH from 5.3 to 6.2. This range again demonstrated the relationship between pH and cooking.

From a 1993 survey of Australian chillers, it was demonstrated that there were quite wide variations in the rate at which Australian meat plants chilled their sides of beef from hot to cold. The results from this work demonstrated that the influence of the rate of chilling on total loss from thawing and cooking was of minor significance.

Since the work only focussed on steer meat, the variation between steer, cow and bull insides and outsides of the same pH, chemical lean and weight range is not known. It is well known that as the chemical lean content within muscle goes down the total losses go up. However, this relationship is usually for subcutaneous and intermuscular fat. The relationship between various levels of intramuscular fat (marbling) within primals of the same weight range and pH is not known. No attempt was made to analyse for the effect of animal age (collagen).

It is well known by processors who cook meat that failure to implement a strict program to weight range cuts prior to cooking will result in very large cooking losses.

6. Conclusions

1. Final core temperature of the cooked meat was found to have a greater influence on the variability associated with total losses than all of the other factors combined.
   Cooking is by far the most important factor that affects yield of cooked meat. Its impact on variability is far greater than that of any factor that can be controlled by Australian processors.
2. pH was the next most important factor followed by
3. The rate of thaw.
4. The rates of chilling and freezing had no significant, statistical effect.

Over all pH ranges, it is possible to predict the total loss from its relationship with the final core temperature.
If the core temperature is (1) 65°C, total loss is 26%; (2) if 70°C, total loss is 31%; and (3) if 75°C, total loss is 37%.

Over all temperature ranges the predicted losses from insides for a given pH are:
(1) at pH 5.4, total loss is 27%; (2) at pH 5.6, total loss is 25%; (3) at pH 5.8, total loss is 24%; and (4) at pH 6.0, total loss is 23%.

This investigation with frozen insides and outsides demonstrated that about the only variability in the total losses (thawing and cooking) which can be attributed to Australian processing of the beef results from variation in the pH of the meat.

It is likely that the main variability associated with American processing (thawing and cooking) of frozen insides and outsides results from temperature over-runs with many of the primals in the cook. This is probably due to size variation within a batch and can be controlled by sorting the primals by weight, prior to the commencement of the cook. Have the processors failed to implement a strict program to weight range cuts prior to cooking? Rate of thawing has very little effect on the overall losses.

Processing of beef in Australia via the tenderstretch method will improve yields (reduce losses) but it will not over-ride the major effects of temperature over-runs caused by variations in weights and/or cooking.

Factors which Affect Total Losses (Insides & Outsides)