Edible Surface Coatings For The Reduction Of Weight Losses From Carcasses And Cuts - 2

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SUMMARY: Hot, dry carcasses on completion of a 20 hour chill, even under carefully controlled conditions, lose from 1-3% of carcass weight due to evaporation (Powell and Griffiths, 1988). A 2% weight loss represents a loss of $A60 million to the Australian meat industry,

Carcasses treated with a 0.5% emulsion of glycerol monostearate (GMS) were shown to have lower weight losses; brighter colours of lean and fat tissues; and softer, more pliable surfaces than the untreated ones - through seven days post-mortem. Microbial growth on the surfaces of the treated carcasses was greater than that of the control carcasses. The addition of 0.5% acetic acid to the GMS emulsion resulted in no significant differences for bacterial growth between the treated and control carcasses. The resultant GMS film did not affect the aroma, flavour or overall acceptability for lamb. It was not possible to detect the presence of added GMS or stearic acid to those already present in meat. A significant reduction in weight loss for beef, lamb, calf and pig carcasses resulted from the application of such a treatment. Surface coatings with GMS as the moisture barrier for the retardation of weight losses are not as effective as those which use cetyl/stearyl alcohols.

INTRODUCTION: Hot, dry carcasses retain water when washed at the end of the slaughter line, lamb carcasses by 1.0% and beef by 0.3% (Powell and Griffith, 1988). On completion of the overnight chill (20 hours), even under carefully controlled conditions, weight losses will average 3% for sheep and 2% for beef (Cain, et al., 1984). A 2% weight loss represents a loss of $A60 million to the Australian meat industry, based on the 1988 Australian meat production (AMLC, 1989) of two million tonnes, valued at $A3 billion.

Over a period of three to five days in the chiller, the white fat on the surface of a carcass turns yellowish brown and become quite hard due to dessication. The red pigments in the muscle concentrate at the muscle surface and give the carcass a blue/black appearance. Meat and fat showing these conditions are usually trimmed before sale, as the quality of meat purchased by the consumer is primarily judged on its appearance, or "bloom," in which the colour of the fat tissue and lean are major factors.

In recent years, two mechanical refrigeration systems have been introduced commercially to reduce carcass weight loss during the first 20 hour chilling period. In the United States, the chlor chill/spray chill process is used, while in Denmark and Sweden, blast chill tunnels are used, (predominantly for pig carcasses). These processes are effective only during the initial chill period and have no lasting effect.

The application of approved, edible, coating substances that reduce the loss of moisture and bloom from fresh fruit, vegetables and confectionery has been widely adopted (Kester and Fennema, 1988). The retention of moisture and bloom helps to maintain a fresh appearance in these foods throughout the distribution chain.

The first published work on the use of edible coatings for the reduction of weight losses from carcasses was published in the Douglas Encyclopaedia 1905 and stated, "This was an improved process for applying hot tallow to the surface. In the old process, hot tallow was blown from the mouth onto the carcass." Theoretical studies on rates of evaporation of water from surfaces and the diffusion of water through monolayers with various materials, including the higher fatty alcohols, were conducted by Powell and Griffiths (1935) and Sebba and Rideal (1941).

In 1960, Anderson was granted a patent for the coating of meat with a thin film of either a long-chain, fatty alcohol or fatty acid. The patent claimed a 50% reduction in loss of moisture over 24 hours. P.H. McKee Inc. (Lazarus et al., 1975) then obtained

USDA approval for the application of calcium alginate films to carcass meat (Flavor-Tex(B) process). Due to the relatively high cost of an alginate film and the low cost of meat in Australia, CSIRO commenced a program to investigate the potential of alternative edible coatings which would reduce moisture loss from carcass meats. In 1988 (Powell and Griffiths, 1988) reported on the efficacy of the relatively inexpensive long-chain, fatty alcohols which have GRAS (Generally Regarded As Safe) status.

Roth and Loncin (1984) reported on the efficacy of glycerol mono-stearate to act as a barrier to moisture vapour when spread as a thin film on the surface of a material having a high moisture content. In the present paper the utility of emulsions based on glycerol monostearate (GMS) as the active ingredient to reduce weight loss from carcass meat is described. GMS has wide acceptability in many foodstuffs and has the Food Additive Code Number (E number) 471.

EXPERIMENTAL: The aqueous emulsions at concentrations from 0.1 to 5% were prepared by the procedures of Chislett & Wolford (1976) and Flack (1976). The emulsifier system consisted of Polysorbate 60 (Tween 60) and sorbitan monostearate. The ratio of the GMS to the emulsifier was 1:0.3. Emulsions with the GMS content greater than 5% v/v were too viscous for practical use. In our trials the GMS emulsion was sprayed on a carcass immediately after the carcass was washed. The spray system used a mechanical water pump adjusted to a line pressure of 700 kpa. Consecutive sides of sheep sides were sprayed with 1 and 2 litres of GMS emulsions at concentrations of 0.25, 0.5, 1.0 and 2.0%.

To determine the influence of the GMS treatment on bacterial growth, 4 x 5 cm2 samples of surface tissue were incised aseptically from each side 24 and 168 hours after spraying (Table 2). Total aerobic plate counts (TAPC) on Tryptone-Soya-Yeast-Glucose(TSYG) agar were recorded, after 3 days at 25° C.

Organoleptic effects of the GMS/AcOH emulsions were assessed using minces of loins of lamb, which were slaughtered at a commercial meatworks. After final inspection, the lambs were split and assigned to a specific treatment of 2 litres of either 0.0, 0.5, 1.0 or 5.0% GMS and 0.5% AcOH emulsion. After overnight chilling and ageing of the carcasses for 7 days, the loins were removed and prepared for panel assessment (Powell and Griffiths, 1988). Meat samples were taken from the carcasses treated with two applications of the 5% emulsion of GMS and sent to CSIRO Food Research Laboratory, North Ryde for analyses of residues of the added GMS (Glass and Christopherson (1969) and Fogarty, et al., (1990)).

RESULTS AND DISCUSSION: Effect of the GMS Treatment

(a) Optimisation of concentration

Dilute aqueous emulsions of GMS sprayed onto lamb, beef or pig carcasses considerably reduced weight loss during chilling and storage at refrigeration temperatures (Tables 1 & 2). The reduction in dehydration resulted in sides having a superior appearance to that of control sides which were only sprayed with water (Table 3).

When consecutive sides of sheep were passed through a carcass washer and sprayed with 2 litres of a GMS emulsion at concentrations of either 0, 0.25, 0.5, 1.0 or 2.0%, the weight losses were 2.2, 1.45, 1.3, 1.1 and 0.7% respectively. The four GMS treatments were significantly different to the control (P) but there was no significant difference between three GMS treatments - (0.25, 0.5 and1.0%).

(b) Microbiological Status

The total aerobic plate and coliform counts for carcasses treated with the GMS were significantly greater than those of the control carcasses at any time during a seven day storage period in a chiller at 0°C (Tables 1 & 4). When carcasses were sprayed with a GMS emulsion containing 0.25 and 0.5% v/v acetic acid (AcOH), there were no significant differences in the total plate counts between the treated and control carcasses.

(c) On Storage Life

Sides of sheep were sprayed with water or the 0.5% GMS/AcOH emulsion and then held for extended periods in a CSIRO chiller at 0°C. On each occasion, visible colonies of organisms appeared on all carcasses between 26 and 30 days of storage.

Since there was no significant difference between the treatments, microbial shelf life is not reduced by the treatment.

(d) Sensory Panel Assessment

A sensory assessment procedure was developed and shown by the flavour/odour group at CSIRO (Ford and Park, 1980) to have high levels of discrimination. Samples were prepared as stewed ground beef with a fat content of 10%, served hot without salt and evaluated by comparative techniques.

When samples were prepared from lamb carcasses which were treated with the recommended dosage (2 litres of a 0.5% emulsion) a trained sensory panel was unable to detect any odour or flavour differences. Even at elevated dosage rates (two applications of a 5% emulsion), a trained panel was still unable to detect a difference (Table 5) between the treated and control samples.

(e) GMS Residue

Samples were hydrolysed and analysed for fatty acids using HPLC (Glass and Christopherson (1969) and Fogarty, et al., (1990)). There were no significant differences in the fatty acid profile for any of the treatments; the HPLC traces were virtually identical. Other samples were analysed by TLC for GMS. Again, the intensity of the detected spots in the chromatogram were identical.

CONCLUSIONS: Carcasses treated with a 0.5% emulsion of glycerol monostearate (GMS) were shown to have lower weight losses; brighter colours of lean and fat tissues; and softer, more pliable surfaces than the untreated ones - through seven days post-mortem. The addition of 0.5% acetic acid to the GMS emulsion resulted in no significant differences in bacterial growth between the treated and control carcasses. The resultant GMS film did not affect the aroma, flavour or overall acceptability for lamb. The cost of the ingredients of the spray are, approximately $A0.20 for beef carcasses and $A0.07 for lamb and pig carcasses. Spraying can be automated.

Edible surface coatings which use GMS as the moisture barrier for the retardation of weight losses from carcasses and primals, are not as effective as those which use cetyl/stearyl alcohols (Powell and Griffith 1988). The GMS/AcOH emulsion is almost twice as expensive as that of the fatty alcohols.

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Table I : Application rates (litres) of glycerol mono-stearate emulsion used for weight loss, bacteriological and organoleptic assessment of beef, sheep,lamb and pig sides and/or carcasses.

| Experiment No. | Animal | No. of carcasses | Chiller Temp (C) | Volume (l) | Conc. (%) |
|---|---|---|---|---|---|
| 1 | Beef | 6 | 3-5 | 2 | 0.25 |
| 2 | Beef | 6 | 3-5 | 2 | 0.5 |
| 3 | Beef | 6 | 3-5 | 2 | 1.0 |
| 4 | Lamb and Sheep | 6 | 0 | 2 | 0.25 |
| 5 | " | 6 | 0 | 2 | 0.5 |
| 6 | " | 6 | 0 | 2 | 1.0 |
| 7 | " | 6 | 0 | 2 | 3.0 |
| 8 | Calves | 20 | 3-5 | 2 | 0.5 |
| 9 | Pigs | 20 | 3-5 | 2 | 0.5 |
| | | | Bacteriological | | |
| 1 | Sheep | 30 | 0 | 2 | 0.25 - 1.0 |
| 2 | Sheep | 12 | 0 | 2 | 0.5 |
| | | | Sensory | | |
| | Sheep | 12 | 0 | 2 | 0.1,0.5,1.0 |
| | Lamb | 12 | 0 | 2 | 0.5,1.0,5.0 |

Table II: Mean percentage weight losses of sides, or carcasses, of lambs, sheep, cattle and pigs after application of water (control) or glycerol mono-stearate (GMS) emulsions, chilling and holding at refrigeration temperatures.

| Expt No. | Animal | Hot weight of side/carcassss (kg) | | Loss at 24 h (%) | | loss at 168 h (%) | |
|---|---|---|---|---|---|---|---|
| | | $H_2O$ | GMS | $H_2O$ | GMS | $H^2O$ | GMS |
| 1 | Lambs | 18.0 | 18.9 | 1.9 | 0.9 | 4.9 | 2.9 |
| 2 | Sheep | 22.1 | 23.2 | 2.2 | 1.3 | 5.2 | 3.1 |
| | Calves | 35.6 | 36.8 | 2.7 | 1.8 | 6.8 | 4.2 |
| 3 | Beef | 95.5 | 97.5 | 1.8 | 1.0 | - | - |
| 4 | Pigs | 38.3 | 36.7 | 2.3 | 1.5 | - | - |

* each side or carcass was sprayed with 2l of either water or a 0.5% emulsion of GMS/AcoH

Table V: Mean panel scores for flavour1 and aroma1 of boiled minces from lamb sides sprayed with glycerol mono-stearate (GMS) emulsions of varying concentrations

| GMS conc. (%) | Meat aroma[1] | Meat flavour[1] | Other aroma[1] | Other flavour[1] | Acceptability[2] |
|---|---|---|---|---|---|
| 0 | 4.41 | 4.73 | 2.01 | 2.02 | 5.32 |
| 1.5 | 4.35 | 4.66 | 1.99 | 2.06 | 5.45 |
| 1.0 | 4.43 | 4.70 | 2.00 | 2.02 | 5.33 |
| 5.0 | 4.36 | 4.76 | 2.20 | 2.13 | 5.30 |

1 = intensity was scored 1 = none to 9 = very strong
2 = acceptability was scored 1 = very poor to 9 = very good

Table III: Appearance* of sides or carcasses of beef and pigs after application of water (H2O) or 0.5% glycerol mono-stearate (GMS) after 24 h at 0)C

| Animal | Lightness ($L^*$) | $a^*$ | $b^*$ |
|---|---|---|---|
| Beef carcasses | | | |
| $H_2O$ Fat | $74.8^1$ | 2.2 | $17.9^1$ |
| GMS fat | $77.2^2$ | 2.5 | $14.8^2$ |
| $H_2O$ Lean | $29.4^1$ | 18.3 | $7.0^1$ |
| GMS Lean | $35.5^2$ | 19.4 | $9.6^2$ |
| Pig carcasses | | | |
| $H_2O$ Skin | $61.6^1$ | $13.6^1$ | $10.7^1$ |
| GMS Skin | $73.7^2$ | $6.4^2$ | $5.8^2$ |
| $H_2O$ Neck | $26.3^1$ | 17.9 | 8.1 |
| GMS Neck | $30.7^2$ | 18.4 | 8.3 |

* Minolta Chroma Meter CR 200

Table IV: Total aerobic plate counts of sheep sides after application of water (H2O) or glycerol mono-stearate (GMS) and held at 50C

| Treatment | Init Count | 24 hr Count | 168 hr Count |
|---|---|---|---|
| $H_2O$ | $4.2 \times 10^2$ | $7.5 \times 10^2$ | $6.6 \times 10^{6a}$ |
| GMS | $4 \times 10^2$ | $6.8 \times 10^4$ | $1.3 \times 10^7$ |
| GMS and 0.25% AcOH* | $4.3 \times 10^2$ | $2.8 \times 10^3$ | $1.5 \times 10^{6b}$ |
| GMS and 0.5% AcOH | $2.8 \times 10^2$ | $8.3 \times 10^2$ | $5.1 \times 10^{5b}$ |

* AcOH is acetic acid