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Evaluation of Meat Products from a Prototype Spiral Grinding Plates

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Preliminary Evaluation of Restructured Beef and Lamb
Products Produced using Mincing Plates Developed by
Thompson Meat Machinery

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Preliminary evaluation of restructured beef and lamb products produced using mincing plates developed by Thompson Meat Machinery.

BACKGROUND TO THE RESEARCH

Thompson Meat Machinery Pty Ltd are currently developing new mincing methods for production of minced meat products which do not require binders to retain their shape, either raw or cooked. To assist in the design of mincing plates to produce minced meat products with optimum bind, a preliminary investigation was carried out with assistance from Thompson Meat Machinery at the Food Science Australia facility.

The purpose of this trial was to evaluate two mincing plates, by using them to process various meat trims. Beef and lamb trim (80 percent Chemical Lean [CL] and 90 percent CL) and beef knuckle muscle were used for the trial.

PRODUCT TREATMENTS

Beef:

A. Spiral – 90 CL Beef Trim

1. Mixed for 1 minute then filled into clear 150mm casing
2. Mixed for 1 minute then vacuum packed
3. Cut twice (2nd cut) then vacuum packed

B. Straight 2mm plate – 90 CL Beef Trim

1. Mixed for 3 minutes and filled into clear 150mm casing
2. Mixed for 6 minutes and filled into clear 150mm casing
3. Mixed for 3 minutes and vacuum packed
4. Mixed for 6 minutes and vacuum packed

C. FSA Kidney plate + straight 2mm plate – 80CL Beef Trim

1. No mixing, filled into clear 150mm clear casing
2. Mixed for 6 mins then filled into 150mm clear casing
3. No mixing, vacuum packed
4. Mixed for 6 minutes then vacuum packed

D. Straight 2mm plate – 80CL Beef Trim

1. No mixing, filled into 150mm clear casing
2. Mixed for 13 minutes then filled into 150mm clear casing
3. No mixing, vacuum packed
4. Mixed for 13 minutes then vacuum packed

E. Straight 2mm plate – 90CL Beef Aged Knuckle

1. No mixing, filled into clear casing
2. Mixed for 6 minutes then filled into 150mm clear casing
3. No mixing, vacuum packed
4. Mixed for 6 minutes then vacuum packed

Lamb:

F. Straight 2mm plate – 80CL Lamb Trim

1. No mixing, filled into 150mm clear casing
2. Mixed for 6 minutes then filled into 150 mm clear casing
3. No mixing, vacuum packed
4. Mixed for 6 minutes then vacuum packed

G. Straight 2mm plate – 90CL Lamb Trim

1. No mixing, filled into 150mm clear casing
2. Mixed for 6 minutes then filled into 150mm clear casing
3. No mixing, vacuum packed
4. Mixed for 6 minutes then vacuum packed

METHODOLOGY

Raw Material

Fresh (<48 h p.m.) beef and lamb trim (80CL and 90CL) and beef knuckle muscle provided by Thompson Meat Machinery were used to manufacture 100% meat slices and roasts. The meat was delivered chilled to Food Science Australia in Brisbane and used immediately for processing.

Thompson Meat Machinery supplied mincing equipment and mincing plates. They also supplied casings and the meat used in the trial. Thompson Meat Machinery also supplied four staff to observe the processing and evaluation of the products.

Preparation of Beef and Lamb Products (fresh and chilled for 24 hrs)

Raw beef or lamb meat was minced (2mm mincing plate), and the minced product was filled into casings. Chubs were removed from the chiller after 24 hours, and sliced into steaks and roasts for evaluation.

The following is a description of the four products.

1. 100% minced beef steaks: Sliced from chubs manufactured from raw minced beef (80CL and 90CL) with no binders added.
2. 100% minced lamb steaks: Sliced from chubs manufactured from raw minced lamb (80CL and 90CL) with no binders added.
3. 100% minced beef roasts: Chubs manufactured from raw minced beef (80CL and 90CL) with no binders added, which were then cut into roasting size portions of approximately 1 kg.
4. 100% minced lamb roasts: Chubs manufactured from raw minced lamb (80CL and 90CL) with no binders added, which were then cut into roasting size portions of approximately 1 kg.

Each steak was cooked at 180°C for four minutes each side and for a further minute on each side, using a Silex hotplate. The results of the visual assessment were recorded and a summary of these results is included in Table 1. Individual comments made by the four observers will be included in the Appendix of the report. Comments were noted and products allocated a score out of five for easy reference later (See Table 2).

Chubs used for roasts were chilled overnight. Roasts were prepared in a conventional oven to determine suitability of the products as roasting pieces.

Evaluation of Products

The following is a summary of the tests that were conducted on the two beef and two lamb products 24 hours after manufacture. General appearance was assessed visually, and raw bind strength was evaluated by physically holding the slice in one hand so that it hung suspended, then gently applying pressure until the bind fails. Overall bind strength was assessed subjectively and a percentage allocated.

Once cooked, the steaks were allowed to cool, sliced to determine the ease of cutting and allocated a score out of five, where 1 represented poor sliceability, and 5 represented excellent sliceability. Pieces of the steak were sampled and comments were tabulated with regard to flavour,

tenderness, juiciness, and texture. Finally, a score out of five was given to each product in order to rank the most acceptable treatment.

Some of the products were selected for roasting. These products were cooked in a conventional oven at 180°C for 35-45 minutes, then cooled for 5 minutes before slicing. Appearance of the roasted meat, particle size, and colour were noted before samples were sliced and tasted. A score out of five was then allocated.

RESULTS

Note that large pieces of raw beef trim were placed in the TMM mincer, with a 2mm spiral plate and blade. Due to the size of the meat pieces being forced through the small plate apertures, the plate broke. This was caused by not having a pre-breaker plate in use. As a result of the spiral blade failure, the remainder of the trial consisted of use of the straight 2mm plate only. To lessen the possibility of further damage, the meat trim was broken down into smaller pieces before being minced.

The Appendix contains the preliminary bind stability results of the minced beef and minced lamb steaks and roasts. Other factors for consideration were overall appearance, tenderness, juiciness, flavour and texture.

Comments:

i) Steaks produced from fresh minced beef and lamb chubs, cooked immediately after mincing.

The best response was given to the straight plate double-cut beef trim, mixed for 6 minutes, followed by the straight single-cut beef trim mixed for 6 minutes. It was thought that the spiral cut samples were of a more dry texture, and that the evaluation the following day would either prove or disprove this theory. The lamb samples were not satisfactory, as the level of cook loss was quite high compared to the beef samples. The lamb steaks appeared rubbery and chewy by comparison.

ii) Steaks produced from minced beef and lamb chubs stored at 0°C for 24 hours.

The five best cooked steak products were as follows;

1. 80CL Beef, minced through CSIRO kidney plate, then put through the Straight 2mm plate. Mixed for 6 minutes then extruded into a clear casing. (Rated 4 out of 5)
2. 90CL Beef, Spiral plate, second cut, mixed for 6 minutes, then vacuum packaged. (Rated 4 out of 5)
3. 80CL Beef, Straight plate cut, no mixing and extruded into oxygen permeable polyethylene casing provided by the client. (Rated 3.5 out of 5)

4. 80CL Beef, Straight plate cut, mixed for 13 minutes, then vacuum packaged. (Rated 3.5 out of 5)
5. 80CL Beef, minced through CSIRO kidney plate, then put through the Straight 2mm plate. Mixed for 6 minutes then vacuum packaged. (Rated 3.5 out of 5)

iii) Evaluation of Roasts produced from fresh minced meat chubs stored at 0°C for 24 hours.

The following treatments produced the most favourable beef and lamb roasts, with factors for consideration including overall appearance, tenderness, juiciness, flavour and texture. The higher the listed rating, the more favoured the product.

Beef:

1. 80CL Beef Straight plate cut (2mm), mixed for 6 minutes, then filled into a casing. (Rated 4 out of 5)
2. 90CL Beef Double cut Straight plate (2mm), mixed for 6 minutes, then vacuum packaged. (Rated 3.5 out of 5)
3. 90CL Beef Straight plate cut (2mm), mixed for 6 minutes, then filled into a clear casing. (Rated 3 out of 5)
4. 90CL Beef Spiral plate cut, mixed for 1 minute then filled into a clear casing. (Rated 2.5 out of 5)
5. 80CL Beef Straight plate cut (2mm), mixed for 13 minutes, then filled into a clear casing. (Rated 2 out of 5)

Lamb:

1. 80CL Lamb, Straight plate cut (2mm), mixed for 6 minutes, then filled into a clear casing. (Rated 3 out of 5)
2. 90CL Lamb, Straight plate cut (2mm), no mixing and vacuum packed. (Rated 2 out of 5)
3. 90CL Lamb, Straight plate cut (2mm), mixed for 6 minutes then vacuum packed. (Rated 1.5 out of 5)
4. 90 CL Lamb, Straight plate cut (2mm), no mixing and filled into a clear casing. (Rated 0.5 out of 5)

CONCLUSION

It appeared from preliminary results that some degree of binding occurred in steaks and roasts produced from minced meat, made using modified mincing plates. Further trials are required to quantify the bind strength of these meat products produced using the Thompson Meat Machinery mincing plates.

RECOMMENDATIONS

Food Science Australia recommends that Thompson Meat Machinery conduct further trials such as objective measurement of bind strength in both raw and cooked products manufactured from minced meat. The recommendation includes microbial trials and further assessment of different mincing blades to improve the binding ability of the minced and formed meat products. Further cooking and evaluation trials will also be required.

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APPENDIX 1.

Table 1. Steaks produced from fresh meat (cooked) – Evaluation of Steaks processed immediately after mincing.

| Treatment | Appearance | Slice test | Taste | Tenderness | Juiciness | Rating Out of 5 |
|--|--|--|---|------------------------------------|-------------------------------------|-----------------|
| 90CL Beef straight plate no mixing | Browned | Good initial cut, second cut showing average level of bind | Definitely steak like in flavour | Tender steak-like texture | Good mouthfeel - juicy | 3.5 |
| 90CL Beef spiral 2 nd cut no mixing | Relatively even cook throughout | Good 1 st cut with good bind, 2 nd cut shows less bind | Meatloaf-like texture, solid | Dense, slightly chewy | Dry | 2 |
| 90CL Beef spiral single cut mixed for 6 minutes | | Initial cut below average bind, 2 nd cut better | Steaklike in flavour | Good mouthfeel, not hard to chew | Medium dry | 3 |
| 80CL Beef straight double cut, mixed for 6 minutes | Visually the most appealing and meat like product | Smooth initial cut, 2 nd cut being excellent | Steak like with a medium/dry aftertaste | tender | juicy | 4 |
| 80CL Beef straight single cut, mixed for 6 minutes | | Initial cut and 2 nd cut good | Good mouthfeel, good flavour | Not too hard to chew | juicy | 2.5 |
| 90CL Beef spiral double cut, mixed for 6 minutes | | Initial cut good, 2 nd cut average | Very dry in taste, almost crumbly | Easy to chew, dry texture | Dry | 2 |
| 80 CL Lamb straight cut, mixed 6 minutes | Shrunk by one third, connective tissue visible in strands, uneven texture. Like hamburger patty. | First cut not good/clean | Mince-like, rubbery texture | chewy | Extremely oily, with dry aftertaste | 1.5 |
| 90CL Lamb straight cut, mixed 6 minutes | Uneven texture compared to beef | First cut good, 2 nd cut average | Great mouthfeel, good taste | Still a bit rubbery on the outside | juicy | 2 |

Table 2. Steaks produced from minced meat (stored at 0°C for 24hrs)

| | Treatment | Bind score | Wave test | Appearance | Slice rating | Taste | Tenderness | Juiciness | Rating out of 5 |
|---------------------------------|--|------------|---------------------------------|---|--------------------------|--|-------------------------------|--|-----------------|
| 90CL Beef | Spiral cut, 1 minute mix-casing | 50% | 4 waves | Fatty particles visible | Sliced well -2/5 | Dry aftertaste | Tough and rubbery, very chewy | Juicy | 2 |
| | Spiral cut, 1 minute mix - vac pack | 70% | 7 waves | Better shape, due to forming under vacuum packaging. Semi-marbled | Sliced well - 3/5 | bland | Good meaty texture | Moist, even though seeming a little overcooked | 2.5 |
| | Spiral cut, 6 minute mix, vac pack | 80% | 9 waves | Very natural appearance. | Sliced well - 3/5 | Very meaty like beef | Dry mouthfeel after chewing | A bit dry | 4 |
| | Straight cut 2mm, 3 minute mix - casing | 30% | 2 wave | Loose bind structure, casing lacks pressure of vac pack | Rough slice | discarded | discarded | discarded | 1 |
| | Straight cut 2mm, 6 minute mix - casingD | D | I | S | C | A | R | D | ED |
| | Straight cut 2mm, 3 minute mix - vac pack | 60% | 6 waves | Jagged cut surface, blotchy | Average sliceability 3/5 | discarded | discarded | discarded | 2.5 |
| | Straight cut 2mm, 6 minute mix - vac pack | 50% | 4 waves | Air pockets visible in meat, not as compact | Good slicing 4/5 | Meaty, but not textured like real steak | chewy | juicy | 3.5 |
| 80CL Beef (Polyethylene casing) | Straight cut 2mm, no mixing -casing | 60% | 6 waves | Air present, looser bind than with vac pack method | Sliced well 3.5/5 | Very pleasant product with no dry aftertaste. Very good. BEST SO FAR | Chewy, but not too bad | Good juicy flavour | 4 |
| 90CL Beef- frozen | Straight cut, no mixing | ----- | ----- | Full of air | 3/5 slice rating | Very dull | Not tender | Very dry | 1.5 |
| | Treatment | Bind Score | Wave Test | Appearance | Slice Rating | Taste | Tenderness | Juiciness | Rating out of 5 |
| 80CL Beef | CSIRO Kidney Plate, then Straight cut 2mm no mixing filled into casing | 25% | 1.5 waves | Not good- too much air content, not firm | Not scored | Not tasted | Not tried | Not tried | 1 |
| | CSIRO Kidney Plate, then Straight cut 2mm 6 min mix, then filled into casing | 30% | 2 waves | First cut terrible, uneven texture | 2/5 | Nice flavour and mouthfeel delicious! | tender | Very juicy | 4 |
| | CSIRO Kidney Plate, then Straight cut 2mm 6 min mix, vac pack | 70% | 7 wave | Fatty appearance, but firm | 2.5/5 good slice | Good with a good 'bite' | Firm but not chewy | juicy | 3.5 |
| 80CL Beef | Straight cut no mix, filled into casing | 10% | Not a good bind, bad appearance | Not rated | Not tried | Not tried | Not tried | Not tried | 1 |
| | Straight cut 13 min mix, filled into casing | 30% | 3 waves | Bad cut, too crumbly | 2/5 | Not tried | Not tried | Not tried | 1 |

Table 2. Steaks produced from minced meat (stored at 0% for 24hrs) continued....

| | Treatment | Bind Score | Wave Test | Appearance | Slice Rating | Taste | Tenderness | Juiciness | Rating out of 5 |
|-------------|--|------------|------------|---|------------------------------|---|-------------------|-----------|-----------------|
| 80CL Beef | Straight cut no mix, vac pack | 60% | 5 waves | Some air present, but not crumbly. Very fatty | Good first cut 2.5 | Not tried | Not tried | Not tried | 2 |
| | Straight cut 13 min mix, vac pack | 50% | 4 waves | Some air spaces texture rates 3.5/5 | Easily cut 3/5 | Good flavour | Soft and tender, | juicy | 3.5 |
| Beef Muscle | Straight cut 2mm 6 min mix, filled into casing | 50% | 3 wave | Not worth testing further | Easy to cut 3/5 | Not tried | Not tried | Not tried | 1.5 |
| | Straight cut 2mm no mixing, vac pack | 50% | 3 wave | Some air present | Moderately easy to cut 2.5/5 | Not tried | Very soft | Not tried | 1.5 |
| | Straight cut 2mm 3 min mix, in casing | negligible | Not tested | Not well bound | Not tried | Not tried | Not tried | Not tried | 1 |
| 80CL Lamb | Straight cut 2mm, no mix filled into casing | Not rated | D | I | S | C | A | R | D |
| | Straight cut 2mm, 6 min mix filled into casing | 40% | 2 waves | Not properly bound TRY AS A ROAST | Not sliced | Not lamb tasting! | Not tried | Not tried | .5 |
| | Straight cut 2mm, no mix, vac pack | D | I | S | C | A | R | D | ED |
| | Straight cut 2mm, no mix into casing | D | I | S | C | A | R | D | ED |
| 90CL Lamb | Straight cut 2mm, no mix filled into polyethylene casing | 30% | 1.5 wave | Dull colour TRY AS A ROAST | Fair slicing 2.5/5 | Not tried | Not tried | Not tried | 2.5 |
| 90CL Lamb | Straight cut 2mm, 6 min mix filled into casing | 10% | 0 waves | terrible | 1/5 for cut | Not tried | Not tried | Not tried | 1 |
| | Straight cut 2mm, no mix vac pack | 60% | 6 wave | Air present TRY AS A ROAST | 3/5 | Better than the 80 CL lamb, full of flavour with no taint | Moderately tender | juicy | 3.5 |
| | Straight cut 2mm, 6 min mix vac pack | 40% | 2 waves | OK TRY AS A ROAST | Sliced well 3.5/5 | Not tried | Not tried | Not tried | 2 |
| 95CL Beef | Straight cut 2mm, 6 min mix, filled into casing | 40% | 3 waves | Full of air, not solid like vac packed product. Like a hamburger patty. | 2/5 | Not tried | Not tried | Not tried | 1 |

Table 3. Evaluation of Roasts

| | Treatment | Bind | Appearance | Slice Rating | Taste | Tenderness | Juciness | Rating out of 5 |
|-----------|--|---|---|---|--|--------------------------|--|-----------------|
| 90CL Beef | Straight cut, 6 min mix into casing | Bind crumbled | Better -- fewer surface cracks. Dry appearance on outside | Bad -- lots of air present | Closer to typical beef roast than other, some liverish taste | Rubbery chew | Moist, but chewy | 3/5 |
| 80CL Beef | Straight cut, 6 min mix into casing | Well bound. The roll kept its shape and integrity | Resembles roast meat in appearance | Good slice -- easily cut. nice and smooth | Good taste, with a slight fatty aftertaste. Maybe try 85CL? | Moist | juicy | 4/5 |
| 90CL Beef | Double cut Straight plate 2mm, 6 min mix, vac pack | Maintained integrity did not shrink | No cracks, kept shape perfectly. Looks a little dry | Great to slice, although some air pockets visible | Good taste and texture, easy to chew | Moderately tender | A bit dry to quite dry. Try 85CL for moister product | 3.5/5 |
| 80CL Beef | Straight cut plate 2mm, 13 min mix into casing | Far too crumbly very little bind | Lots of cracks on surface, looks dry | Crumbled on slicing | Dry granular texture | Low degree of tenderness | Dry! | 2/5 |
| 80CL Lamb | Straight cut, 6 min mix into casing | Crumbly texture, too much air | Full of air pockets and blood spots | Held shape, though shrunken, crumbly | Bland taste, some taint (metallic) | chewy | moist | 3/5 |
| 90CL Lamb | Straight cut, 2mm, no mix vac packed | Not fully bound inside roast | Cracks on surface, but not as open | Terrible texture, hard to slice, large particles | Bland but not oily | Full of air, chewy | Too dry try using 85CL | 2/5 |
| 90CL Lamb | Straight cut, 2mm no mix into casing | Not well bound at all -- total waste of effort | vile | Falling apart | bland | yuk | yuk | .5/5 |
| 90CL Lamb | Straight cut 2mm, 6 min mix vac pack | Need a tighter bind, too loose -- | Meaty appearance. Too much air | Good cut but too grainy | Bland flavour | chewy | Dry and bland | 1/5 |