PE4.13 Change in form and function of hot-boned sheepmeat forequarter 41.00

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***Abstract*— The ability to shape meat is becoming increasingly important for the red meat and food service industry, as it offers the opportunity to satisfy current consumer demands by portion control and the delivery of a consistent product for both raw and cooked meat. The aim of this experiment was to evaluate the effect of a meat shaping device on the form and function of hot boned mutton and lamb forequarters and the use of a commercial protein binder. In addition a comparison between a specific forequarter cut that a processor currently uses as a reformed product (a partial forequarter based on m. *supraspinatus,* m. *infraspinatus* and m. *biceps brachii*) and a full forequarter. There was a significant (*P* < 0.05) change in circumference and length after reforming. Pictorial images show that overall both the mutton and lamb forequarters held their shape well. The use of a commercial protein binder in conjunction with the meat shaping device was also mostly successful.**

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***Index Terms*—form, function, shape.**

I. INTRODUCTION

The application of hot boning of sheep carcases for the retail market is not extensive [1]. There are many economic benefits for using hot boning which include: increased meat yield, energy savings, chiller space minimisation, reduced labour and time [2]. The use of hot boning can have major constraints, such as an increased risk of shortening in muscles [3], which can be minimised by the use of electrical stimulation.

Hot-boning allows each muscle to be separated from the carcase pre-rigor and treated optimally according to its intrinsic properties [4]. This process could also aid in the shaping of some cuts which add value and enhance eating quality of traditional hot-boned products.

In recent years consumers have become increasingly health conscious and there has been a large growth of 'healthier options' within the food industry [5]. The red meat industry is faced with the challenge of not only competing with other meat sources such as the chicken, pork and seafood, but also delivering convenient and healthy food products at competitive prices.

A recent survey of food service providers [6] highlighted that the food services industry has a demand for portion controlled products. This is largely driven by the need to reduce labour, improve time management, minimize wastage and improve the consistency of the product. One of the biggest demands was the ability to deliver consistent steaks. The capability to shape and portion meat gives the industry the tools to deliver a more consistent product for both cooked and raw meat and respond to changes in consumer demand.

The aim of this experiment was to evaluate the effect of a meat shaping device on the form and function of hot boned mutton and lamb forequarters and the use of a commercial protein binder. Additionally, a comparison was undertaken between a full forequarter excluding the shank, neck and trimmed fat (HAM 5280) and a partial forequarter (based on m. *supraspinatus,* m. *infraspinatus* and m. *biceps brachii*) which is currently used by the co-operating processor.

II. MATERIALS AND METHODS

A. Animals

Ten sheep and ten lamb carcases were randomly selected from the day's kill of a commercial processor. Only carcases with a fat score of 2 or less were selected, this fat score is based on the GR measurement (total tissue depth ≤ 10mm) which was measured with a GR knife. The sheep and lambs were from different consignments and hence were of varying backgrounds, to represent the variation of animals typically processed by the Australian abattoir.

B. Treatments and sampling

All forequarters were hot boned and the twenty mutton forequarters and twenty lamb forequarters were collected. Left and right sides were then randomly allocated to one of two treatments: 1) Full forequarter excluding the shank, neck and trimmed fat (HAM

5280) and; 2) Processor specification – a partial forequarter based on m. *supraspinatus,* m. *infraspinatus* and m. *biceps brachii* (Partial). All samples were given a light dusting of a commercial protein binder before been placed through the shaping device.

C. *Measurements*

The following was then recorded:

- Initial and final weight of sample
- Initial and final length of sample
- Initial and final circumference of sample
- A photo diary to record the change in form and function

Meat samples were placed through SmartShape prototype (licensed as SmartShape) under development by Meat & Livestock Australia and Meat & Wool New Zealand. The prototype has a flexible inner sleeve and once the forequarters were placed in the flexible sleeve, air pressure was applied to stretch and shape the meat. Samples were ejected from the SmartShape machine into tuber packaging sleeve. Once the meat shaping process was complete the samples were frozen at -22º C.

D. *Cooking methods*

Samples were cut while frozen into both 15 mm and 2-3 mm wide slices. The 15 mm samples were cooked on a clam grill at 220ºC for 5 minutes and the 2-3 mm samples cooked at 220ºC for 1 minute. A photo diary of each sample was recorded (Figures 1 and 2) to show the change in form and function and to demonstrate the usefulness of the commercial protein binder in this type of production using the SmartShape machine.

E. *Statistical methods*

A linear mixed model using restricted maximum likelihood (REML) within ASReml [7] was used to analyse all data. The model contained fixed effects for forequarter type (full or partial).

III. RESULTS AND DISCUSSION

The mean, standard deviation and range of carcase and mutton forequarter traits is shown in Table 1 and for lambs in Table 2. The mutton carcases were on average fat score 2 with a range from fat score 1-2 which were consistent with the aim to select leaner carcases that would require less trimming.

Table 1. Mean, standard deviation (SD) and range for GR and forequarter traits (mutton carcases).

Trait	Mean	SD	Range
GR (mm)	6.3	1.59	3-8
Initial weight (kg)	1.46	0.20	1.09-1.86
Final weight (kg)	0.91	0.25	0.57-1.30
Initial length (cm)	21.7	4.19	15-27
Final length (cm)	24.1	6.03	16-31
Initial circumference (cm)	22.5	3.46	17-28
Final circumference (cm)	20.9	1.43	18-22

In comparison to the mutton forequarter, the lamb forequarters were on average lighter and leaner, but were of similar dimensions before and after reforming.

Table 2. Mean, standard deviation (SD) and range for GR and forequarter traits (lamb carcases).

Trait	Mean	SD	Range
GR (mm)	4.1	0.72	3-5
Initial weight (kg)	1.34	0.07	1.24-1.49
Final weight (kg)	0.79	0.30	0.40-1.27
Initial length (cm)	22.7	5.22	16-34
Final length (cm)	24.9	5.75	17-35
Initial circumference (cm)	21.5	3.43	16-26
Final circumference (cm)	20.5	1.99	17-22

The partial mutton forequarters had significantly ($P < 0.05$) lighter weight and smaller circumference compared to the whole mutton forequarters. On average there was a significant percentage increase ($P < 0.05$) in length for both mutton forequarter cuts after stretching/shaping. The lamb forequarter partial cuts also had significantly ($P < 0.05$) lighter weight then the whole sample. However, there was no significant difference ($P > 0.05$) in length or circumference between the whole and partial cuts. This shows that for both the mutton and lamb forequarters the preparation of a partial cut as expected resulted in a lighter cut weight meaning that a larger proportion of the original forequarter is downgraded and goes into trim. However, the meat from the partial cut is leaner and thus more likely to attract a higher price, counteracting the downgrade of the extra trim. Overall, the change in length and circumference shows that there was a change in shape of the product tested.

Table 3. Predicted means (av. s.e.d.) as a percentage for a decrease in weight (relative to the untrimmed weight) and circumference, and increase in length for mutton and lamb forequarters.

	Full	Partial	*Ave s.e.d.*
Mutton			
Decrease in weight (%)	22.8a	52.6b	*2.2*
Increase in length (%)	16.5a	3.5b	*2.6*
Decrease in circumference (%)	13.8a	-2.2b	*2.2*
Lamb			
Decrease in weight (%)	21.2a	61.3b	*3.2*
Increase in length (%)	12.5a	7.9a	*4.2*
Decrease in circumference (%)	5.8a	0.60a	*4.3*

Means followed by a different letter in a row (a, b) are significantly different ($P < 0.05$).

In Figures 1 and 2, images of the two types of forequarters are shown, along with slices from the forequarters after reforming using the shaping device (for brevity only this sample of photos is included).

Figure 1. Partial forequarter: A) boneless partial forequarter, B) after sample has been through SmartShape, C) sliced samples, D) cooked 15 mm samples and E) cooked 2 mm samples.

Figure 2. Whole forequarter: A) boneless full forequarter, B) after sample has been through SmartShape, C) sliced samples, D) cooked 15 mm samples and E) cooked 2 mm samples.

Observations from the photos recorded on all samples show that overall both the mutton and lamb forequarters held their shape relatively well. This indicates that once the meat has been frozen, the round shape given by the Smart Shape machine is maintained. Image C in Figures 1 and 2 show that slices based on the partial forequarter contain less fat than those based on a full forequarter.

Observations on the effectiveness of the commercial protein binder showed that it was mostly successful in binding the forequarter muscles together. However, there was some variation and it is suspected that this was due to inconsistencies in the application of the protein binder due to the complexity of the arrangement of the forequarter muscles. Pre-experimentation studies indicated that forequarter muscles would not satisfactorily bind without the use of a protein binder

IV. CONCLUSION

The SmartShape prototype is able to successfully reshape odd shaped sheepmeat primals such as the forequarter into a user friendly round shape. After freezing and slicing these samples are able to maintain the round shape. Observations from the use of a commercial protein binder in conjunction with the meat shaping device indicate that care needs to be taken in the application of the binder to ensure that the meat will bind successfully. This type of technology could prove to be invaluable to the processing industry as it is an effective way of reforming odd shaped pieces of meat into one uniform shaped product. This Smart Shape machine has the potential to add value, control portion size and provide a consistent raw and cooked product for consumers which would be of benefit to both the food service and retail industries.

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REFERENCES

[1] Waylan, A. T., & Kastner, C. L. (2004). Hot boning and chilling. In W. Jensen, C. Devine and M. Dikemann. Encyclopedia of Meat Sciences (Vol. 2) (pp. 606-613). Elsevier Science.

[2] McPhail, N. G. (1995). Implementation of hot boning. *Meat 95, The Australian Meat Industry Research Conference*. (pp. 5-6) 10-12 September 1995 Gold Coast, Australia.

[3] Devine, C. E., Hopkins, D. L., Hwang, I. H., Ferguson, D. M., & Richards, I. (2004). Electrical stimulation. In W. Jensen, C. Devine and M. Dikemann. Encyclopedia of Meat Sciences (Vol. 2) (pp. 413-423). Elsevier Science.

[4] White, A., O'Sullivan, A., Troy, D. J., O'Neill, E. E. (2006). Effects of electrical stimulation, chilling temperature and hot-boning on tenderness of bovine muscles. *Meat science.* 73, 196-203.

[5] Desmond, E., & Troy, D. J. (2004). Nutrient claims on packaging. In W. Jensen, C. Devine and M. Dikemann. Encyclopedia of Meat Sciences (Vol. 2) (pp. 903-910). Elsevier Science.

[6] http://www.mla.com.au/TopicHierarchy/InformationCentre/FoodQualitySafetyAndValueAdding/Valueadding/Market+Research.

[7] Gilmour, A.R., Gogel, B.J., Cullis, B.R., Welham, S.J. & Thompson, R. 2002). 'ASReml User Guide Release 1.0. (VSN International Ltd: Hemel Hempstead, HP1 1ES, UK).

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