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SENSORY EVALUATION OF KANGAROO MEAT

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SUMMARY

Grilled kangaroo meat was evaluated by consumer taste panel to determine the magnitude of pre-harvest effects on meat quality. Discriminant analysis resulted in the weightings of 0.20 for tenderness, juiciness and flavour, and 0.40 for overall acceptability. These weightings were used to combine the results into the one dimension of palatability. Flavour was found to be the predominant factor influencing the acceptability of grilled kangaroo, showing a high correlation ($r = 0.89$) with overall acceptability. A muscle by species interaction was seen to be significant ($p < 0.01$) for palatability, as well as muscle by dressed weight. Red kangaroo cuts were evaluated as being more palatable than Western Grey cuts, while heavier carcasses yielded tougher meat from the leg muscles, but not from the loin fillet.

Keywords: consumer taste panel, kangaroo, meat quality

INTRODUCTION

Kangaroo meat for human consumption is an emerging Australian industry that is currently based on the field harvesting of wild populations of animals. The very nature of field harvesting introduces a number of variables that can potentially influence the resultant meat quality of the product: these factors have an impact both pre- and post-harvest. This trial focused on the pre-harvest factors influencing kangaroo meat quality, as judged by consumer based taste panel assessment of the product. Post-harvest handling and procedures were kept as constant as possible for all the sample animals. Kangaroo meat is currently gaining in popularity on the Australian domestic market, a market in which consumers are increasingly discriminating against poor quality meat.

MATERIALS AND METHODS

Background

Sample animals were harvested from the Hallett region of South Australia, (2 hours north of Adelaide). Vegetation was relatively sparse, and total rainfall for the 3 months preceding this experiment was less than 100mm. Ambient late summer temperatures (both nights) ranged from 17 to 23^0C. Animals (n=36) were field harvested over two nights using standard procedures for the harvesting of kangaroo game meat. Muscles were collected from the processing plant after 9 days of ageing. Two species of kangaroo were sampled (n=18 per species), the Western Grey (WG: *Macropus fuliginosus*) and the Red (R: *Macropus rufus*), (dressed weights - WG: mean 28kg, range 14-45kg; R: mean 21kg, range 15-30kg). The two species did not show differences in maturity when comparing similar dressed weights. Equal numbers of each sex were obtained for each species (n=9).

Sample preparation and evaluation procedures

The sample preparation and sensory procedures followed those used by Meat Standards Australia (MSA) for beef and lamb (Polkinghorne *et al*. 1999).Three muscles were collected for sensory assessment from each animal (*M. biceps femoris* - silverside, *M. adductor* - topside and *M. longissimus dorsi* - loin fillet), plus a fourth which was used as an initial sample for the sensory panels (*M. gluteus medius* - rump). As many of the muscles were too small to form a sensory sample, muscle binding enzyme powder was used (Pearl “E” Protein Active Meat Binder, Earlee Products Pty. Ltd., Brisbane Australia) to combine L and R side muscles from each animal. For binding, muscles were thawed rapidly (microwave) to -5°C and then thawed to above 1°C within 5 hours. The binding procedure was then carried out without delay, and the samples quickly refrozen to -20°C. After binding, muscles were then sliced across the fibre direction into steaks of a consistent 20mm thickness, all of similar diameter (~50mm), in preparation for grilling.

Sensory evaluation procedures

The results of MSA with beef and lamb sensory trials, showed sensory evaluation using untrained consumers to be an effective alternative to trained taste panels (Polkinghorne *et al.* 1999). Consumer taste panels require many more participants due to the higher level of variation associated with untrained consumers, but yield results that are relatively unbiased and directly relevant to industry.

A total of 7 samples were offered to each consumer (6 plus the starter muscle) per session. Each session/panel consisted of 12 people with 12 panels conducted in total. Therefore, 144 people-assessments were conducted, totalling 864 individual samples (without the starter steak).

Steaks were randomised across all panels and tasters. Panellists were informed of the randomised nature of samples and that the samples were grilled kangaroo, but further details were not disclosed until after the panels had been completed. Sample cooking was by grilling 6 steaks simultaneously on a Silex double clam grill, at a temperature of 200°C. All samples were cooked for 2.25 min, with 2 min rest at room temperature before halving each steak for serving.

Sample evaluation

Each steak was evaluated separately for tenderness, juiciness, flavour and overall acceptability by vertically marking unstructured 100mm horizontal lines (each converting to a score out of 100). The lines were anchored by the words not tender/very tender for tenderness, not juicy/very juicy for juiciness and dislike extremely/like extremely for both flavour and overall acceptability. Consumers were also requested to rate the eating quality of their steak on a four level ranked scale, from unsatisfactory, good everyday, better than everyday to premium product. A blank box was included at the foot of the evaluation sheet, allowing separate comments to be made on any steak if desired.

Statistical analysis

Statistical analysis of the data was performed with the SAS statistical package (SAS Institute, version 6.12). The four sensory dimensions were combined to give a single dimension of palatability, or the 'KMQ4' score, through the use of the discriminant analysis function in SAS. This formulated weightings for each dimension of eating quality based on the rank score given to each sample (Polkinghorne *et al.* 1999). The mixed model covariance-test procedure was used to model the data, with palatability, tenderness, flavour, juiciness or overall acceptability as the dependent variable. All possible variables and logical interactions were tested. In all models, both animal and taster (within session) were included as random effects.

RESULTS

Discriminant analysis resulted in the weightings of 0.20 for tenderness, juiciness and flavour, and 0.40 for overall acceptability. These weightings were used to multiply each dimension, which, upon addition of the four, resulted in the palatability score. Testing the four original dimensions with discriminant analysis, it was calculated that 67% of the results were effective in determining the ranking score for each sample. Palatability alone correctly ranked 60% of the rankings. Tenderness tested alone correctly ranked 41% of samples, juiciness 32%, flavour 53% and overall acceptability 65%. Scores for all four eating quality dimensions ranged from 0 to 100, and ranking scores for overall eating quality ranged from 1 to 4. This is a reflection of the increased variability associated with the use of untrained panellists.

Table 1. F ratios for the effect of muscle, species, dressed weight, species x muscle and dressed weight x muscle, after adjustment for session and serving order effects. Results are also adjusted for the random effects of animal and taster (within session). Values shown with $^{\Phi}$ have a P<0.05.

	Tenderness		Juiciness		Flavour		Overall Acceptability		Palatability	
Effect	NDF/DDF	F ratio	NDF/DDF	F ratio	NDF/DDF	F ratio	NDF/DDF	F ratio	NDF/DDF	F ratio
Muscle	2/644	3.75^{Φ}	2/647	0.97	2/646	3.77^{Φ}	2/640	1.77	2/638	0.65
Species	1/644	51.46^{Φ}	1/647	16.46^{Φ}	1/646	5.26^{Φ}	1/640	14.56^{Φ}	1/638	30.9^{Φ}
Dressed weight	1/644	3.94^{Φ}	1/647	4.81^{Φ}	1/646	0.26	1/640	0.33	1/638	0.15
Species x Muscle	2/644	17.48^{Φ}	2/647	2.65	n.a.	n.a.	2/640	4.63^{Φ}	2/638	7.91^{Φ}
Dressed weight x Muscle	2/644	3.2^{Φ}	n.a.	n.a.	2/646	3.03^{Φ}	2/640	3.22^{Φ}	2/638	3.21^{Φ}

The interaction of dressed weight by muscle was not included in the model describing juiciness, and the interaction of species by muscle was not included in the model describing flavour.

Table 2. Significant effects least squares means (units from 0 to 100 points)

	Sp.	Muscle	LSmean	Std.err
Juiciness	R		61.84	1.25
	WG		55.37	1.25
Flavour	R		60.60	1.53
	WG		55.90	1.53
Flavour		*add*	57.44	1.44
		b.fem	59.39	1.44
		l.dorsi	57.93	1.44

Table 3. Significant interactions least squares means (units from 0 to 100 points)

	M. adductor		*M. biceps femoris*		*M. long. dorsi*		
	Red	WGrey	Red	WGrey	Red	WGrey	Std.err.
Tenderness	70.1	41	66.9	43.7	77.5	66.6	2.4
Overall acceptability	63.6	50.9	62.4	53.6	61.4	58.6	2.1
Palatability	64.5	50.1	63.1	52.7	63.6	59.5	1.7

Table 4. Significant effects and interaction regression estimates for dressed weight by muscle.

	add	*b. femoris*	*l. dorsi*	St.err.
Tenderness	-0.43	-0.23	0	0.17
Flavour	-0.07	-0.38	0	0.17
Overall acceptability	-0.28	-0.43	0	0.18
Palatabilty	-0.29	-0.32	0	0.14

Table 5. Correlation matrix of the four dimensions of eating quality and palatability

	Tenderness	Juiciness	Flavour	Overall acceptability	Palatability
Tenderness	1.00				
Juiciness	0.48	1.00			
Flavour	0.44	0.39	1.00		
Overall acceptability	0.56	0.48	0.89	1.00	
Palatability	0.75	0.68	0.86	0.94	1.00

The regression coefficient for juiciness with respect to dressed weight was 0.29 (standard error 0.13). Serve order was significant for tenderness and palatability models.

DISCUSSION

Table 5 shows the correlations between the different dimensions of eating quality including palatability. This correlation matrix is thus a measure of the sensitivity that consumers have shown for each of the eating quality dimensions. Between tenderness, juiciness and flavour correlations were all <0.5, indicating that consumers were able to discriminate between these dimensions when judging samples. Flavour and overall acceptability were, however, more highly correlated (r=0.89). Consumers' acceptability of kangaroo meat is therefore strongly driven by the flavour attributes of the product, in contrast to beef studies where tenderness is of greatest importance (pers. comm. J.M. Thompson 2002).

The decrease of 7% of correct allocation into ranking groups using palatability alone is quite acceptable, considering that palatability is a combination of four separate dimensions. Similar results have been obtained with beef using untrained consumers (pers. comm. J.M. Thompson 2002).

Analysis of the palatability scores showed there to be significant species by muscle interaction ($p < 0.01$). Palatability scores for Western Greys were lower for all muscles as compared with Reds (see table 3). Palatability scores were similar for all cuts in the Red kangaroo, but the palatability score for the loin fillet was higher in the Western Grey. This species by muscle interaction was also observed for tenderness and overall acceptability when each was analysed in isolation, with Reds scoring higher for both dimensions across all muscles. Differences in tenderness between muscles in the carcass may be explained by such differences as connective tissue content. Palatability was significantly affected by the interaction between dressed weight and muscle ($P<0.05$). Palatability scores for the silverside and topside cuts decreased in heavier dressed carcasses (around 0.3 units decreased palatability with every kg increase in dressed weight, see table 4). Not surprisingly a similar relationship was found for tenderness, flavour and overall acceptability. However, there was a negligible effect of dressed weight upon the palatability score for the loin fillet. For tenderness, topside had the highest negative correlation (-0.43) with dressed weight, followed by silverside (-0.23). Again, the effect was not apparent in the loin fillet, a result that could be explained by the presumed lower content of connective tissue in this muscle. Flavour was reduced in the silverside with increased dressed weight, whereas the topside and loin fillet showed negligible differences. In terms of overall acceptability, silverside showed the strongest effect, followed by topside, with a large part of this evaluation being due to the high negative tenderness correlations.

The observations of decreased tenderness with increasing dressed weight may be explained by increased levels of connective tissue or increased cross-linking of collagen in the leg muscles of the kangaroo as the animal matures, thus increasing the strength and resistance to damage of the muscles. A heavier animal needs to deliver a greater force through its locomotive muscles to move; in the kangaroo this is directed through hopping, and through the need for muscles to resist the strain of landing. The explanation of the interaction of dressed weight with flavour is likely to be more complex: possible biochemical changes occurring in the more heavily exercised leg muscles may influence flavour relative to that observed in the more supportive musculature of the back. The decrease in flavour with increasing dressed weight could be based on the assumption that heavier animals are generally older. In other species, meat flavours usually intensify with increasing age (Lawrie 1991), and in many cases this leads to reduced consumer acceptance. The flavour of Red kangaroo cuts was evaluated more favourably than those from Western Greys. This difference may be due to differences in dietary selection between the species.

Analysis of juiciness found neither the interaction between muscle and species nor dressed weight and muscle to be significant. The most important effectors of juiciness were species and dressed weight. Table 2 shows the effect of species, with Reds scoring over 6 points higher juiciness than Western Greys ($p<0.01$). This parameter increased with greater dressed weight (males and females pooled), with scores increasing by ~0.3 units per kg increase in carcass weight. Using dressed weight as a crude indicator of kangaroo age, we conclude that older animals are more likely to yield juicy cuts of meat. The increased juiciness of larger carcasses may result from a decrease in evaporative loss from the larger carcass mass; however, leaving the skin on the carcasses in the chiller minimises this loss.

Although a significant difference in flavour existed between species, the relative importance of this flavour difference was quite low (table 1). Flavour is an attribute of eating quality that is traditionally difficult to link with causal factors, as these are usually subtle in nature. The added complexity with kangaroo is that many consumers compare the flavour with other meats and as such it is considered at times to be stronger in flavour. This leads to some consumers defining the product as having a 'gamey' type flavour, which is often discriminated against. No significant difference was found in flavour between sexes, in contrast to other species (Lawrie 1991).

The fact that taste panel session was found to influence all modelled dimensions ($p < 0.01$) showed that groups scored differently over the 12 taste panel three month period. However, this effect is minor, and is adjusted for in the models. The serving order of steaks exerted a significant effect on tenderness and palatability ($p < 0.05$). Scores decreased slightly within session. Consumers were possibly becoming slightly fatigued, potentially due to the novel aspect of kangaroo meat. This effect was also adjusted for in the models.

CONCLUSION

The particular muscle, species and dressed weight of the carcass, all influenced the eating quality of grilled kangaroo meat significantly. Significant species by muscle interactions were found for the characteristics of tenderness, overall acceptability and also for the integrated dimension of palatability. Tenderness, flavour, overall acceptability and palatability were all influenced significantly by the interaction between dressed weight and muscle. The overall acceptability score was seen to be the most important aspect influencing the consumer ranking of product, with flavour contributing most to overall acceptability, suggesting that the potential of kangaroo meat as a viable product is strongly dependent on the unique flavour characteristics of the muscle.

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