Assessing the acceptability of processed goat meat

H.R. Breukink and N.H. Casey*
Department of Livestock Science, Faculty of Agriculture, University of Pretoria, Pretoria 0002, Republic of South Africa

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The possible upgrading of meat of mature does to an acceptable product through processing was investigated using chemical, physical and sensory evaluation techniques. Twelve goat does (six-tooth) were slaughtered and processed into vienna sausages and cured and smoked buttocks. These were compared with viennas in which lean beef replaced the goat meat and identically cured and smoked beef silverside (*M. semitendinosus*), respectively. Both the unprocessed and processed meats were analysed for their protein, fat, moisture and ash contents. The shear force, expressible moisture and iodine number of the fat in the products were also determined. A taste panel could distinguish between the goat and beef viennas and rated the overall palatability of the goat product less acceptable ($P<0,01$) than the beef. The cured, smoked goat buttock was rated more acceptable ($P<0,01$) than the beef silverside and has the potential of being a delicacy.

Die moontlike opgradering van bokvleis na 'n aanvaarbare produk deur prosessering is ondersoek met behulp van chemiese, fisiese en sensoriese evalueringstegnieke. Twaalf sestand-bokooie is geslag en die vleis is na weense worsies en gepekelde en gerookte boudjies verwerk. Hierdie produkte is met weense worsies, waarvan die bokvleis met beesvleis vervang is, en gepekelde en gerookte beesdy (*M. semitendinosus*) vergelyk. Die ongeprosesseerde sowel as die geprosesseerde vleis is vir proteïen-, vog-, vet- en asinhoud ontleed. Die snyweerstand, uitpersbare vog en jodiumgetal is ook bepaal. 'n Proepaneel kon tussen die weense worsies van bok- en beesvleis onderskei en het die bokworsies minder aanvaarbaar gevind ($P<0,01$). Die gepekelde en gerookte bokboudjies is meer aanvaarbaar as die soortgelyke beesdy gevind ($P<0,01$). Gepekelde en gerookte bokboudjies het die potensiaal om as 'n lekkerny gereken te word.

Keywords: Goat meat, processing.

* Author to whom correspondence should be addressed.

Introduction

South Africa presently has a goat population of three million in the areas under control of the Livestock and Meat Marketing Board of the Republic of South Africa. Since 1984 the number of goats slaughtered for both the controlled metropolitan and rural markets has increased steadily to 212734 in 1987 of which only 9% were kids (RSA Livestock and Meat Statistics, 1988). The rapidly expanding population requires relatively low priced, high quality meat products which can be obtained by upgrading low quality meat through processing. At present, penetration of the fresh meat market by goat is hampered by preconceived preferences for lamb and mutton, although in certain sectors of the population kid is regarded as a suitable substitute for the more expensive lamb (Heinze, Smit, Naudé & Boccard, 1986). Savell, Smith, Dutson, Carpenter & Duter (1977) found goat to be less desirable than beef and pork in flavour, aroma, tenderness and juiciness. Age also affects palatability – the meat of older goats being darker and less tender, but more juicy and flavoursome than kid (Smith, Carpenter & Shelton, 1978). Substituting lean beef in various proportions with Angora meat in frankfurters reportedly has little effect on the overall satisfaction of the product (Eggen, Smith, Carpenter, Berry & Shelton, 1973; Marshall, Smith, Dutson & Carpenter, 1977).

This study investigated the possibility of upgrading goat meat through processing to a high quality marketable product. Two products were made, namely a smoked leg and vienna sausages, and were compared with similar beef products using physical, chemical and sensory evaluation techniques.

Materials and Methods

Carcasses

Twelve six-tooth African goat does, produced on the veld in the Roedtan area of the Northern Transvaal, were electrically stunned and slaughtered by severing the jugular vein. Prior to slaughtering, a live empty body mass was measured – feed and water having been withheld overnight. Immediately after slaughter, carcasses were electrically stimulated using a low voltage 'Tender Pulse' stimulator (21 V rectangular wave 60 Hz, voltage 110 volts 0,25 A, 65 W). Other masses recorded were those of the warm carcass and cold carcass following chilling (3°C for 18 h, 94% RH) and those of the two halves after being split carefully down the centre on a band saw. The kidneys were removed. Both the left and right buttocks were removed by cutting horizontally through meat and bone just cranial to the *tuber coxae*. The remainder of the right half was deboned and the masses of bone and meat were recorded. The deboned meat of each goat was then minced once only through a 3-mm sieve and mixed thoroughly by hand. A sample of approximately 100 g was analysed for moisture, protein, fat and ash content (AOAC, 1985). The balance of the meat was pooled and stored frozen (−18°C) in plastic bags for 26—28 days until required for further processing (Verma, Alarconrojo, Sedward & Lawrie, 1985). Dressing percentages and percentage moisture losses during chilling were calculated. The meat yield from the remainder of the carcass, excluding the buttocks, was measured and expressed as a meat to bone ratio.

The mass of each buttock was recorded after sectioning, and the buttock was then severed at the knee below the

patella. The tail fragment was removed between the sacrum and the first coccygeal vertebra. The 24 buttocks were then individually labelled and left in the chiller for a further three days to allow the surface to dry off before processing.

Products

Two products were manufactured under controlled conditions according to standard formulations (Bizerba Sausage Production Manual, 1986) in a small commercial unit where strict quality control is applied. Vienna sausages were made from the deboned, coarse minced meat and a cured and smoked product from the buttocks. Viennas were compared chemically, physically and using sensory evaluation with viennas manufactured according to the same formulations, with lean beef replacing goat. The buttocks were compared with cured and smoked beef manufactured from the eye of the silverside (*M. semitendinosus*).

Formulations used for the meat products

Vienna sausages: Vienna sausages were manufactured from a fine emulsion in the following manner:

The pooled coarse-minced goat meat was allowed to thaw and was mixed thoroughly by hand again. A 5 kg batch was cut slowly in a bowl cutter (9 blades, 20 l) for 30 bowl revolutions to a coarse emulsion. Finely chopped pork speck (2,5 kg), Prague powder^R, (20 g kg^{-1} lean = 0,1 kg), phosphate binder (3 g kg^{-1} lean = 0,015 kg) and spice (6 g kg^{-1} lean = 0,03 kg) were added. Fine ice (2,5 kg) was also added to drop the temperature to 0°C and less. The bowl cutter was then run at 3000 r.p.m. for 80 bowl revolutions until a fine emulsion had been achieved. The temperature was taken to ensure that it had not risen above 12°C. The batter was then stuffed into sheep casings (22—24 calibre) using a hydraulically-operated sausage filler, hand-twisting the casing into 15 cm sausage lengths. The sausages were smoked in a smoker (Bizerba GBSA 750 SRK) at a temperature which fluctuated between 65°C and 70°C, using wattle wood spenders, for 1,5 h to attain the desired light-tan colour. After smoking, the products were cooked in water (70°C, 5 min), refrigerated overnight at 4°C, packed in plastic bags and kept refrigerated for 7 days before evaluation.

Beef viennas were manufactured in the same manner using deboned forequarter and trimmings of grade B1 beef.

Cured and smoked product: A cured and smoked product was manufactured from the buttocks as follows:

The pelvic bone was carefully removed, working from the medial plane, and the femur was left *in situ*. Since goats have a poor distribution of subcutaneous fat, little fat-trimming was needed, except on the inside of the leg where it was trimmed to 3 mm. The buttocks were then injected pneumatically with brine (250 ml/buttock) and thereafter submerged in the brine for 72 h to obtain a good brine penetration from the surface. The wet-cure brine consisted of 800 g Prague powder^R, 50 l water, 44 g salt (NaCl), 500 g Rosalin, and 1,25 kg seasoning or a commercial spice mix.

The seasoning was made by boiling 300 g pepper corns, 200 g mustard seed, 60 g marjoram, 100 g cinnamon sticks, 100 g pimento corns, 200 g juniper berries, 30 g cloves
of garlic and 20 g bay leaves in 25 l of water in a stainless steel container for 45 min. The extract was diluted to 50 l and the Prague powder^R, salt and Rosalin were added. The meat was wind-dried before smoking at a low temperature (30—35°C) in a chamber with open flutes for 20 h to obtain a rich red-brown colour (Oreshkin, Borisova, Tchubarova, Gorabtov, Permyakov, Schnyrov & Burnstein, 1986), using a mixture of hickory and wattle spenders. Thereafter the buttocks were cooked in water (78°C) for 30 min/500 g, wind-dried at room temperature and hung in a chiller (10°C). These were compared with cured and smoked beef silverside from grade B1 carcasses.

Chemical, physical and sensory evaluation

Vienna sausages were compared chemically and physically by measuring the percentage protein, moisture, fat and ash (AOAC, 1985), degree of saturation of the fat (iodine number, Wijs method), shear force, degree of juiciness through expressible water (Mansanto Tensometer), pH and the a_w (water activity).

Shear force was measured on the Warner–Bratzler shear apparatus. Viennas were pre-heated to 10°C and 60°C in polyethylene bags immersed in a water-bath. Temperature equilibrium was checked using a temperature probe. Seven sausages of each type were removed one at a time, placed between the blades of the apparatus and the average of three measurements per sausage was recorded.

Expressible water (or fluid) was measured by applying a pressure of 900 kg on a 0,5 g sample of product between sheets of Whatman No. 2 filter paper (Sanderson & Vail, 1963) at room temperature of 25°C. All masses and differences were recorded carefully. Ten samples of each type were drawn and three readings taken per sample.

The pH was measured as an average of three readings of an emulsion of approximately 10 g of the ground meat and product in distilled water (Korkeala, 1986). The pH meter was calibrated using pH 7 and pH 4 buffer solutions.

Water activity (a_w) was measured on 0,1 g samples placed in crucibles that were well sealed (Brockman, 1970; Leistner & Rödel, 1976) and connected to the a_w apparatus (model Novasina Eeja 6; −20°C to 80°C; 0—100% RH). Measurements were taken after a 24 h stabilizing period at constant temperature (20°C) and expressed as percentage relative humidity.

Sensory evaluation was done under controlled conditions on both the vienna sausages and the cured, smoked product by a panel of six trained persons. Samples were prepared by pre-heating the products to 60°C submerged in water. Uniform cubes (1,5 cm^3) were cut and wrapped in aluminium foil. Two samples of each species' product were presented to each panel member

in random sequence. The tests were repeated on four consecutive days under white incandescent lighting. Mouths were rinsed with cold water (20°C) between samples. The degree of juiciness, tenderness, tastiness, aroma and residue was indicated on a 5 cm line (unstructured scale) on which the lower end (0) indicated the lowest assessment and the upper end (5) the highest. The position indicated was given a value measured in centimetres from the zero end. The taste panel was not requested to identify the aroma. The results were analysed and compared statistically on a General Linear Model procedure (Jellinek, 1985).

Results and Discussion

Although the goats were all mature does from the same farm, a wide range of empty body masses occurred (22,9 ± 8,06 kg), which was reflected in the range of cold carcass masses (10,78 ± 2,13 kg) (Table 1). The mean buttock mass, obtained by severing cranially to the *tuber coxae* and below the *patella*, was 1,03 ± 0,17 kg and comprised 19,04 ± 2,76% of the side mass. The mean meat to bone ratio of the remainder of the carcass was 3,86 ± 0,74%. Goat meat had a greater fat content with a higher variance than the beef used to manufacture the viennas, being 20,9 ± 2,1% and 19,2 ± 0,4%, respectively (Table 2). The lower fat, moisture and ash content of the beef resulted in the protein content of 18,6 ± 0,3% being higher ($P < 0,0002$) than that of the goat (16,7 ± 1,1%). Goat fat was more saturated than that of beef ($P < 0,0425$) as indicated by the respective iodine numbers. Final pH of goat meat taken 18 h *post mortem* was normal and uniform (5,78 ± 0,06) (Table 1).

Goat vienna sausages (Table 3) had a greater fat ($P < 0,0001$) and lower moisture ($P < 0,0071$) content than the beef sausages which can be ascribed to the fact that the formulations had not been balanced for their protein, fat and moisture contents. This would have defeated the objective of testing the acceptability of goat

Table 1 Mean and standard deviation (SD) of empty body mass, carcass parameters and pH

Parameters	Mean	SD
Mass (kg):		
empty body	22,90	8,06
warm carcass	11,38	2,11
cold carcass	10,78	2,13
right half	5,23	1,12
left half	5,55	1,06
meat (right half)	3,33	8,69
bone (right half)	0,87	0,17
buttock [a]	1,03	0,17
Dressing % (cold)	42,77	3,46
Meat: bone [b]	3,86	0,74
pH at 3°C (18 h)	5,78	0,06
pH of beef	5,73	0,00

[a] Buttock mass excludes hock portion.
[b] Meat to bone ratio excludes buttocks.

Table 2 Chemical analysis of unprocessed goat meat and beef

Parameter	Mean	SD	F	P > F
% Protein				
Goat	16,68	1,10	17,96	0,0002**
Beef	18,64	0,29		
% Moisture				
Goat	60,46	2,72	0,16	0,6904
Beef	59,99	6,00		
% Fat				
Goat	20,93	2,11	3,96	0,0564
Beef	19,19	0,44		
% Ash				
Goat	1,16	0,37	2,78	0,1068
Beef	0,90	0,05		
Iodine number				
Goat	40,26	4,77	4,77	0,0425*
Beef	45,58	0,49		

* $P < 0,05$; ** $P < 0,01$.

Table 3 Analysis of variance of chemical and physical parameters of goat and beef vienna sausages

Parameter	Mean	SD	F	P > F
Chemical				
% Protein (wet)				
Goat	9,84	0,18	16,83	0,0148*
Beef	10,67	0,30		
% Moisture				
Goat	55,56	1,62	25,71	0,0071**
Beef	60,42	0,38		
% Fat (wet)				
Goat	28,56	0,09	1640,84	0,0001**
Beef	23,83	0,18		
% Ash				
Goat	2,39	0,18	0,02	0,9054
Beef	2,38	0,15		
Iodine number				
Goat	46,64	0,29	14,54	0,0189*
Beef	47,55	0,29		
Physical				
Shear force				
Goat (10°C)	3,84	0,32	51,389	0,0001**
Beef (10°C)	3,01	0,29		
Goat (60°C)	2,64	0,37	17,47	0,0003**
Beef (60°C)	2,11	0,30		
Goat	3,24	0,70	16,50	0,0002**
Beef	2,56	0,54		
Expressible moisture				
Goat	18,21	2,56	53,21	0,0001**
Beef	26,88	2,75		
Water activity (a_w)				
Goat	95,67	0,06	97,95	0,0006**
Beef	96,13	0,06		
pH				
Goat	6,23	0,02	699,63	0,0001**
Beef	5,92	0,02		

* $P < 0,05$; ** $P < 0,01$.

meat *per se* in a vienna sausage. The iodine number of both species' viennas was higher than that of the raw meat probably owing to the pork speck in the formulation. The iodine number of the goat vienna was still slightly lower than that of the beef ($P < 0,0189$).

Physically the species' viennas differed highly significantly in all parameters (Table 3). Shear force was greater in both the cold and warm goat viennas. In both species, shear force dropped sharply between 10 and 60 °C. Beef viennas had the higher expressible moisture ($P < 0,0001$) and higher a_w measurement ($P < 0,0006$). The differences can be related back to compositional differences which again are due to the characteristics of the raw meat used.

In sensory evaluation terms, the goat and beef vienna sausages and the smoked goat buttock and beef silverside (Table 4) showed a highly significant difference with respect to aroma, tenderness, juiciness and tastiness. Organoleptically, goat viennas were rated to have a less desirable aroma than beef, but were more tender, thereby opposing the results determined for the sausages on the Warner–Bratzler shear force apparatus. In the study by Eggen *et al.* (1973), a 5% replacement of lean beef by goat meat could be detected in frankfurters. The results suggested that up to 20% replacement of beef by goat would have little effect on cooking yield, flavour desirability or overall satisfaction. Beef viennas were more juicy. If the expressible fluid from the Carver Press is an indication of juiciness, these results are of the same order, indicating beef to be more juicy. Goat had a higher fat content (28,6%) than beef (23,8%) which may mean that fat did not contribute to juiciness sufficiently to influence the rating in favour of goat. Pooled, the goat and beef viennas differed highly significantly ($P < 0,0001$) with beef being preferred.

Table 4 Sensory parameters of goat and beef vienna sausages and cured and smoked buttock and silverside

Parameter	Mean	SD	F	P > F
Vienna sausages				
Aroma				
Goat	3,70	0,25	112,23	0,0001**
Beef	4,21	0,22		
Tenderness				
Goat	2,94	0,42	9,18	0,0032**
Beef	2,67	0,47		
Juiciness				
Goat	3,40	0,32	32,02	0,0001**
Beef	3,77	0,31		
Tastiness				
Goat	3,76	0,23	96,98	0,0001**
Beef	4,23	0,24		
Residue				
Goat	0,05	0,10	0,22	0,6401
Beef	0,04	0,08		
Pooled aroma, tenderness, juiciness and tastiness				
Goat	3,45	0,45	19,00	0,0001**
Beef	3,72	0,71		
Smoked products				
Aroma				
Goat	4,05	0,27	7,84	0,0062**
Beef	3,89	0,29		
Tenderness				
Goat	2,95	0,50	33,10	0,0001**
Beef	2,37	0,49		
Juiciness				
Goat	3,16	0,32	154,91	0,0001**
Beef	1,88	0,64		
Tastiness				
Goat	4,02	0,24	38,76	0,0001**
Beef	3,71	0,24		
Residue				
Goat	0,14	0,17	0,04	0,8419
Beef	0,15	0,23		
Pooled aroma, tenderness, juiciness and tastiness				
Goat	3,54	0,60	50,04	0,0001**
Beef	2,96	0,97		

* $P < 0,05$; ** $P < 0,01$.

A constraint to using meat from mature does in viennas is the aroma and tastiness imparted to the product. The taste panel was not requested to identify the flavours, but clearly preferred that of the beef product. Blending goat and beef as demonstrated by Eggen *et al.* (1973), could overcome this constraint.

Regarding the cured and smoked products, goat buttocks received higher ratings ($P < 0,01$) in terms of aroma, tenderness, juiciness and tastiness than the beef silverside (Table 4). No difference in residue could be detected. Pooled, the goat was rated 3,54 with a standard deviation of 0,60 on the scale of 0 to 5, as opposed to the $2,96 \pm 0,97$ rating of beef. The results suggest that smoked and cured goat buttock, or leg of goat has the potential of being a delicacy and could compete comfortably with other products such as smoked beef and pork gammon.

Conclusion

The meat of mature does imparts detectably different palatability characteristics to vienna sausages which may be unaccceptable to specific consumers. A cured and smoked leg has the potential of being a highly acceptable consumer commodity.

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References

AOAC, 1985. Official methods of analysis (13th edn.). Association of Official Analytical Chemists, Washington DC.

BIZERBA SAUSAGE PRODUCTION MANUAL, 1986. Confidential manual to and by courtesy of Freddy Hirsch Bizerba-Scales (Pty) Ltd., P.O. Box 2554, Cape Town 8000, RSA.

BROCKMAN, M.C., 1970. Development of intermediate moisture foods for military use. *Food Technol.* 24, 896.

EGGEN, N.R., SMITH, G.C., CARPENTER, Z.L., BERRY, B.W. & SHELTON, M., 1973. Composition of Angora goat carcasses. *J. Anim. Sci.* 37, 260.

HEINZE, P.H., SMIT, M.C., NAUDÉ, R.T. & BOCCARD, R.L., 1986. Influence of breed and age on collagen content and solubility of some ovine and goat muscles. *Proc. 32nd Meet. Eur. Meat Res. Workers*, INRA, Theix, France.

JELLINEK, G., 1985. Sensory evaluation of food: Theory and practice. Ellis Horwood series of publications in Food Science and Technology. Chichester, England.

KORKEALA, H., 1986. Determination of pH in meat. *Meat Sci.* 18, 121—132.

LEISTNER, L. & RÖDEL, W., 1976. Intermediate moisture foods. Eds. Davies, R., Birch, G.G. & Parker, K.J., Applied Science Publications, London. p. 66.

MARSHALL, W.H., SMITH, G.C., DUTSON, J.R. & CARPENTER, Z.L., 1977. Mechanically deboned goat, mutton and pork in frankfurters. *J. Food Sci.* 42, 193—196.

ORESHKIN, E.F., BORISOVA, M.A., TCHUBAROVA, G.S., GORABTOV, V.M., PERMYAKOV, E.A., SHNYROV, V.L. & BURNSTEIN, E.A., 1986. Conformational changes in muscle proteins of cured beef during heating. *Meat Sci.* 16, 297—307.

RSA LIVESTOCK AND MEAT STATISTICS, 1988. Published by the Meat Board, P.O. Box 40051, Arcadia 0007, RSA.

SANDERSON, M. & VAIL, G.E., 1963. Determining meat juiciness. *J. Food Sci.* 28, 590.

SAVELL, J.W., SMITH, G.C., DUTSON, T.R., CARPENTER, Z.L. & DUTER, D.A., 1977. Effect of electrical stimulation on palatability of beef, lamb and goat meat. *J. Food Sci.* 42, 702—706.

SMITH, G.C., CARPENTER, Z.L. & SHELTON, M., 1978. Effect of age and quality level on palatability of goat meat. *J. Anim. Sci.* 46, 1229—1235.

VERMA, M.M., ALARCONROJO, A.D., SEDWARD, D.A. & LAWRIE, R.A., 1985. Effect of frozen storage of minced meats on the quality of sausages prepared from them. *Meat Sci.* 12, 125—131.