# SENSORY EVALUATION OF LIVER/MEAT PÂTÉ MADE FROM FRESH OR FROZEN ELAND MEAT AND BEEF*

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Small animal producers in Europe can financially benefit if they sell not only carcasses or dissected cuts, but also processed meat and edible offal in value added products such as traditional and popular pâté. In particular, when introducing a new exotic species like eland (*Taurotragus oryx*) to the market, the sale of low valued cuts with higher collagen content is problematic. Therefore, we aimed to evaluate the sensory traits of several pâtés made from liver and less valuable fresh or frozen meat cuts (neck, brisket and plate) of eland and cattle. Four batches of pâté made from fresh and frozen material (45 and 90 days) were tested by 35 panellists using sensory profiling method with 14 descriptors. Two pâté batches consisted of chicken liver and beef or eland meat. Another two were made from eland or beef liver together with eland meat. Pâté made from fresh material, including chicken or eland or beef liver, together with eland meat or beef showed the main differences in textural characteristics such as friability, overall texture being better scored for pâté which includes chicken liver. Chicken liver also resulted in a higher intensity of colour. Freezing of material (meat and liver) before processing into pâté resulted in worse scoring of the final product. Chicken liver batches scored better in sensory traits of overall appearance, pleasantness of taste, colour and intensity of colour, colour hue and textural friability, overall texture and of pleasantness of consistency. Pâté made from chicken liver from frozen material also had lower off-flavour. This pilot study showed that pâté from fresh eland meat and chicken liver scored the best in most of the sensory traits. Freezing and storing meat and liver before processing resulted in worse scores, especially in olfactory, visual and textural traits. The use of chicken liver instead of eland or beef liver to process pâté improves sensory traits.

antelope, chicken liver, organoleptic traits, processed product

doi: 10.2478/sab-2019-0011
Received for publication on February 13, 2018
Accepted for publication on July 11, 2018

## INTRODUCTION

Game meat is known for its low intramuscular fat content, with an excellent proportion of fatty acids both from wild (Hoffman et al., 2015) or farmed ungulates (Barton et al., 2014). Therefore, it is being recommended to human consumers as a healthy alternative to livestock meat (Simopoulos, 2000; Cordain et al., 2002). Demand for game meat is steadily increasing, as documented in Europe by the import of deer meat from New Zealand (Deer Industry New Zealand, 2013). Production itself can significantly contribute to a nation's economy (Hoffman, Wiklund, 2006), but the highest demand is still for valuable cuts. Nevertheless, processed products made from secondary quality cuts, trimmings and offal can have an important marketable potential. Edible offal of wild game represents an attractive source of nutrients (Magwedere et al., 2013). In Europe they are preferably processed into meat products. Varieties of liver/

* Supported by the Internal Grant Agency of the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague (IGA), Projects No. 20175014 and No. 20185017, and by the Ministry of Education, Youth and Sports of the Czech Republic (S grant).

meat pâtés are a typical example. These are traditional and favoured products in many European countries, including the Czech Republic. They can be made from a great variety of ingredients. Traditionally, liver and meat from goose or pig are used in the production of liver pâté (F e i n e r, 2006; G u e r r e r o - L e g a r r e t a, 2012). In addition to this, liver and meat from goat (D a l m a s et al., 2011), foal (L o r e n z o et al., 2014), ostrich (F e r n a n d e z - L o p e z et al., 2004), poultry (T e r r a s a et al., 2016) and game species can be used for liver pâté processing.

Common eland (*Taurotragus oryx*) is a large African ruminant which is comparable to middle-sized breeds of cattle, but their fattening is slower than that of cattle (B a r t o n et al., 2014). Eland meat was traditionally valued for its quality and taste in South Africa (L a m b r e c h t, 1983) and is known for its low intramuscular fat and favourable fatty acid profile (v o n L a C h e v a l l e r i e, 1972; Barton et al., 2014; H o f f m a n et al., 2015). Little is known about processed eland meat and offal products. V a n Z y l (1962) described how eland meat can be easily processed into biltong, and B a n o u t et al. (2012) used eland meat to evaluate solar drying to produce jerky. Eland was also recommended for domestication in Africa due to its taming potential (S c h e r f, 2000). Several elands were also introduced to the former Czechoslovakia in the early 1970's (V a g n e r, 1974) and served as the core of successful husbandry among zoos there. According to K o t r b a, S c e v l i k o v a (2002), farming of eland for economical purposes can be organised in Central Europe with just a few specifics if compared to cattle.

The eland farm at the Czech University of Life Sciences Prague (CULS) has sold more than 50 young males that were slaughtered for meat production. Practice showed that more valuable meat cuts (e.g. loin, tenderloin, rump, shoulder) can be sold relatively easily to the consumer. On the other hand, parts with higher collagen content (i.e. less valuable) were sold with difficulty; therefore, to deep-freeze and later process them into meat products would be the solution for small producers. Thus, we aimed to test the sensory traits of different pâtés made from liver and less valuable meat cuts (fresh or stored frozen before processing) from eland and beef cuts (e.g. neck, brisket or plate).

## MATERIAL AND METHODS

### Animals used, processing and treatments

The Faculty of Tropical AgriSciences runs an eland farm with a capacity of 50 elands at the CULS farm estate at Lány for meat production, educational, and research purposes. Elands were kept under condition similar to cattle husbandry, slaughtered and processed at a slaughter house, as described by B a r t o n et al. (2014). In total, meat from five elands (from neck, ribs and plate) and liver for processing were vacuum packed in plastic bags, kept at 4°C, and transported the second day after slaughter to the Alimpex-maso s.r.o. pâté processing factory (Alimpex Food, a.s., Prague, Czech Republic). Beef meat (from neck, ribs and plate) and liver, as well as chicken liver were purchased from a commercial distribution network. This material was on the shelf the second day after slaughter, which was the same period as in the case of the eland. The eland and beef meat cuts were divided into three parts, mixed proportionally and homogenised. This was done in a Mainca bowl cutter (22 litres bowl, maximum batch 15 kg) (Granollers, Spain) equipped with 3 knives on the head of its shaft. The first part was processed into pâté together with liver as 'fresh'after 5 days of refrigeration at 4°C; the second part and all the liver were stored frozen for 45 days and then processed; the third part and all the liver were stored frozen for 90 days before processing. Before processing into pâté, all frozen material was thawed for two days at 4°C in the fridge.

Chemical analyses followed on the fresh meat after homogenisation before processing into pâté, and analyses of pâté were done after all the ingredients were mixed before being processed thermally. To analyse moisture according to ISO 1442:1997, the meat was dried with sea sand. Measurement of each sample was repeated three times. Crude fat was extracted from dried samples with petroleum ether using Soxhlet extractor and analysed gravimetrically according to I S O 1 4 4 4 : 1 9 9 6. To determine the crude protein content, Kjeldahl method was performed according to I S O 9 3 7 : 1 9 7 8 using a Kjeltec Foss 2200 apparatus (FOSS A/S, Hillerød, Denmark). Measurement of each sample was repeated two times. The average sample of eland meat after homogenisation contained 74.71% moisture, 2.07% fat and 22.19% protein. Beef after homogenisation contained 73.23% moisture, 4.49% fat and 21.06% protein. The pâté recipe for each batch contained 1.25 kg of liver (chicken, eland, beef as described in Table 1), 1.25 kg of shortened pork lard, 1.015 kg of front processing meat (eland or beef), 1.25 kg of broth, 0.14 kg of additive mixture (Natura Food Additives a.s., Prague, Czech Republic), 0.235 kg of flavouring, 0.0375 kg of nitrite curing mixture, and 0.0375 kg of (common) salt, making a total of 5 kg of the product. The additive mixture was composed of starch, milk proteins, sugar, stabilising agents (E 451, E 452), and antioxidant (E 301).

Different pâté batches were processed in the following way. The homogenised meat was pre-cooked in transparent casings 70 mm in diameter; they were filled manually up to 1 kg per each casing. Then they were cooked in a steam chamber for 4 h using 78°C hot steam. The technological limit of pasteurisation was 30 min. Any escaped liquid was also utilised later during processing. The liver was homogenised with a nitrite

Table 1. Combinations of material (meat and liver) used to process 12 pâté batches in the experiment

| Pâté batch | Liver | Meat | Storage of material (in days) |
|---|---|---|---|
| CHL-Beef/0 | chicken | beef | 0 |
| CHL-Eland/0 | chicken | eland | 0 |
| EL-Eland/0 | eland | eland | 0 |
| BL-Eland/0 | beef | eland | 0 |
| CHL-Beef/45 | chicken | beef | 45 |
| CHL-Eland/45 | chicken | eland | 45 |
| EL-Eland/45 | eland | eland | 45 |
| BL-Eland/45 | beef | eland | 45 |
| CHL-Beef/90 | chicken | beef | 90 |
| CHL-Eland/90 | chicken | eland | 90 |
| EL-Eland/90 | eland | eland | 90 |
| BL-Eland/90 | beef | eland | 90 |

CHL = chicken liver, EL = eland liver, BL = cattle liver, Beef = cattle meat (neck, brisket and plate), Eland = eland meat (neck, brisket and plate)

curing mixture till 20°C when small bubbles appeared on the surface. Then pork fat was added (50–70°C) and chopped for 30–60 s. Gradually 1/3 of broth was added (60–80°C), chopped for 30–60 s, then the additive mixture and cooked meat flavouring were added, and finally the rest of the broth. The temperature of the final processed pâté batch was optimally 35–42°C. Then each batch was placed into bowls, sealed with aluminium foil and pasteurised. Each batch consisted of 5 kg material in total to prepare pâté which was afterwards filled in 100 g commercial containers sealed by aluminium foil, pasteurised, marked and stored refrigerated at 4°C until sensory analysis.

**Sensory analysis**

The sensory analysis of samples was carried out at the sensory analytical laboratory of the CULS under the conditions of ISO 8589:2007. A group of 35 experienced panellists (students and employees) of the Department of Quality of Agricultural Products were involved in the experiment. The panellists were

Table 2. Sensory characteristics evaluated by the panellists and orientation of graphical scales

| Descriptor | Rating 0 mm | Rating 100 mm |
|---|---|---|
| Overall appearance | very bad | excellent |
| Pleasantness of colour | rejectable | very pleasant |
| Colour hue | pink | brown |
| Intensity of colour | imperceptible | very strong |
| Uniformity of colouring | uneven | uniform |
| Pleasantness of smell | rejectable | very pleasant |
| Intensity of smell | imperceptible | very strong |
| Pleasantness of taste | rejectable | very pleasant |
| Overall intensity of taste | imperceptible | very strong |
| Intensity of salty taste | imperceptible | very strong |
| Intensity of other taste | imperceptible | very strong |
| Intensity of off-flavour | imperceptible | very strong |
| Pleasantness of consistency | disgusting | very pleasant |
| Overall texture | very tough | very tender |
| Friability | very friable | compact |

Table 3. Chemical composition of all pâté batches

| Pâté | Moisture content (%) | Protein content (%) | Fat content (%) |
|---|---|---|---|
| CHL-Beef/0* | 64.07 | 13.00 | 21.40 |
| CHL-Eland/0 | 64.73 | 13.60 | 20.10 |
| EL-Eland/0 | 66.00 | 13.50 | 19.30 |
| BL-Eland/0 | 64.50 | 13.30 | 20.50 |
| CHL-Beef/45** | 57.89 | 10.70 | 29.58 |
| CHL-Eland/45 | 58.26 | 10.60 | 29.10 |
| EL-Eland/45 | 46.26 | 15.20 | 37.17 |
| BL-Eland/45 | 47.45 | 15.30 | 35.39 |
| CHL-Beef/90*** | 57.46 | 10.80 | 25.89 |
| CHL-Eland/90 | 63.35 | 10.90 | 24.01 |
| EL-Eland/90 | 57.68 | 11.80 | 29.40 |
| BL-Eland/90 | 58.98 | 11.50 | 28.70 |

CHL = chicken liver, EL = eland liver, BL = cattle liver, Beef = cattle meat (neck, brisket and plate), Eland = eland meat (neck, brisket and plate)

storage of material (meat and liver) as follows: *0 = fresh, **45 = frozen for 45 days, ***90 = frozen for 90 days

selected, trained and monitored according to ISO 8586:2012 and had special sessions for training in the evaluation of meat products and in the understanding of all attributes. Sensory quality was assessed using the sensory profiling method (ISO 13299:2016). The evaluated sensory traits and the orientation of linear unstructured graphical 100 mm scales are given in Table 2. Samples were coded using three-digit, randomly generated numbers and served according to ISO 6658:2017. Drinking tap water and white bread were given to the panellists as neutralisers between tasting the samples. There were three panel sessions organised with the same number and identity of panellists receiving always 4 samples, each represented one specific pâté batch.

**Statistical analyses**

All analyses were performed using SAS software (Statistical Analysis System, Version 9.4; SAS Institute Inc., Cary, USA). Data normality was assessed by plotting histograms and normal probability plots. Four different tests were performed (Shapiro–Wilk, Kolmogorov–Smirnov, Cramér-von Mises and Anderson–Darling). All sensory traits were included as dependent variables and were analysed separately using the Generalized Linear Mixed Model (GLMM). The explanatory variables included in analyses were categorised according to the composition of pâté batch with four levels (CHL-Beef, CHL-Eland, EL-Eland, BL-Eland) and storage length (fresh (0 days), 45 days, and 90 days) (Table 1). The interaction between composition*storage was also included in the analysis. To account for repeated evaluation by the same panellist over the experimental period, analyses were performed with PROC MIXED, using the individual panellist as a random factor. Differences between the effects were tested using the $F$-test. For multiple comparisons, we used the Tukey-Kramer adjustment.

## RESULTS

The basic chemical composition of produced pâté batches is presented in Table 3. The four different combinations of meat and liver used as fresh or frozen for 45 days and 90 days were used to produce twelve batches of pâté altogether. All were scored by 35 panellists using 15 organoleptic descriptors. Two pâté batches consisted of chicken liver and beef (CHL-Beef) or eland meat (CHL-Eland). The last two were made from eland (EL-Eland) or beef liver (BL-Eland) together with eland meat. For the significance of all tested effects for all sensory traits (namely composition, storage, and their interaction) see Table 4. Pâté made from fresh material (including chicken or eland or beef liver together with eland meat or beef) predominantly showed differences in textural characteristics, namely in friability and overall texture. Furthermore, two pâté batches made with chicken liver had higher score in pleasantness of taste and also the intensity of colour was higher than in those with beef or eland liver ($P < 0.05$, Fig. 1). Other characteristics including intensity of off-flavour, overall appearance, pleasantness of colour, colour hue and pleasantness of consistency did not show differences ($P > 0.05$, see Fig. 1 for details). Freezing the material (meat and liver) before

Table 4. Significance (P) of the tested effects for all evaluated sensory descriptors

| Descriptor | Effect | Num DF | Den DF | *F*-value | *P* < 0.05 |
|---|---|---|---|---|---|
| Overall appearance | composition | 3 | 400 | 27.13 | < 0.0001 |
| | storage | 2 | 400 | 11.00 | < 0.0001 |
| | interaction | 6 | 400 | 4.94 | < 0.0001 |
| Pleasantness of colour | composition | 3 | 400 | 34.37 | < 0.0001 |
| | storage | 2 | 400 | 6.10 | 0.0025 |
| | interaction | 6 | 400 | 4.97 | < 0.0001 |
| Colour hue | composition | 3 | 400 | 30.94 | < 0.0001 |
| | storage | 2 | 400 | 3.49 | 0.0314 |
| | interaction | 6 | 400 | 28.34 | < 0.0001 |
| Intensity of colour | composition | 3 | 400 | 34.49 | < 0.0001 |
| | storage | 2 | 400 | 9.37 | 0.0001 |
| | interaction | 6 | 400 | 4.75 | 0.0001 |
| Uniformity of colouring | composition | 3 | 400 | 6.41 | 0.0003 |
| | storage | 2 | 400 | 1.37 | 0.2541 |
| | interaction | 6 | 400 | 1.75 | 0.1089 |
| Pleasantness of smell | composition | 3 | 400 | 7.57 | < 0.0001 |
| | storage | 2 | 400 | 3.93 | 0.0204 |
| | interaction | 6 | 400 | 2.44 | 0.0250 |
| Intensity of smell | composition | 3 | 400 | 5.90 | 0.0006 |
| | storage | 2 | 400 | 1.62 | 0.1986 |
| | interaction | 6 | 400 | 0.33 | 0.9213 |
| Pleasantness of taste | composition | 3 | 400 | 30.31 | < 0.0001 |
| | storage | 2 | 400 | 5.30 | 0.0053 |
| | interaction | 6 | 400 | 1.99 | 0.0656 |
| Overall intensity of taste | composition | 3 | 400 | 2.22 | 0.0857 |
| | storage | 2 | 400 | 0.58 | 0.5631 |
| | interaction | 6 | 400 | 2.41 | 0.0267 |
| Intensity of salty taste | composition | 3 | 400 | 2.72 | 0.0440 |
| | storage | 2 | 400 | 0.22 | 0.8062 |
| | interaction | 6 | 400 | 1.45 | 0.1939 |
| Intensity of other taste | composition | 3 | 400 | 12.79 | < 0.0001 |
| | storage | 2 | 400 | 0.77 | 0.4659 |
| | interaction | 6 | 400 | 0.54 | 0.7808 |
| Intensity of off-flavour | composition | 3 | 400 | 20.29 | < 0.0001 |
| | storage | 2 | 400 | 1.20 | 0.3027 |
| | interaction | 6 | 400 | 0.82 | 0.5533 |
| Pleasantness of consistency | composition | 3 | 400 | 22.42 | < 0.0001 |
| | storage | 2 | 400 | 0.33 | 0.7180 |
| | interaction | 6 | 400 | 6.69 | < 0.0001 |
| Overall texture | composition | 3 | 400 | 46.79 | < 0.0001 |
| | storage | 2 | 400 | 11.58 | < 0.0001 |
| | interaction | 6 | 400 | 2.13 | 0.0488 |
| Friability | composition | 3 | 400 | 31.45 | <0.0001 |
| | storage | 2 | 400 | 1.13 | 0.3248 |
| | interaction | 6 | 400 | 7.05 | <0.0001 |

Legend: Num DF- 'numerator degrees of freedom'; Den DF- 'denominator degrees of freedom' as expressed descriptors for F-distribution and F-tests.

processing into pâté resulted in worse scoring of the final product. Batches with chicken liver scored better in sensory evaluation of overall appearance, pleasantness of taste, colour and intensity of colour, colour hue, textural friability, overall texture and pleasantness of consistency ($P < 0.05$, Fig. 1). Pâté made with chicken liver from frozen material also had lower intensity of off-flavour. Freezing and storing the meat and liver before processing resulted in a worse score, especially in olfactory, visual and textural descriptors. This can be improved by using chicken liver instead of eland or beef liver for pâté processing.

## DISCUSSION

No significant differences were found when assessing the intensity of salty taste and smell; thus we can conclude that both effects (composition and storage) did not play any role.

### Intensity of off-flavour

The effect of composition was significant in the intensity of off-flavour ($P < 0.0001$) when frozen materials were used. Pâté with eland liver showed stronger off-flavour when compared to pâté with chicken liver. Chemical changes such as proteolytic degradation and lipid oxidation occur in meat and meat products during storage (B e l i t z et al., 2009). Off-flavour can be connected to the aging of game meat, as showed in the study of N o r t h , H o f f m a n (2015) and reviewed in N e e t h l i n g et al. (2016). In relation to this study, we suppose eland liver to most likely have a similar effect on the product. On the other hand, based on the results of the study of E s t e v e z et al. (2005),

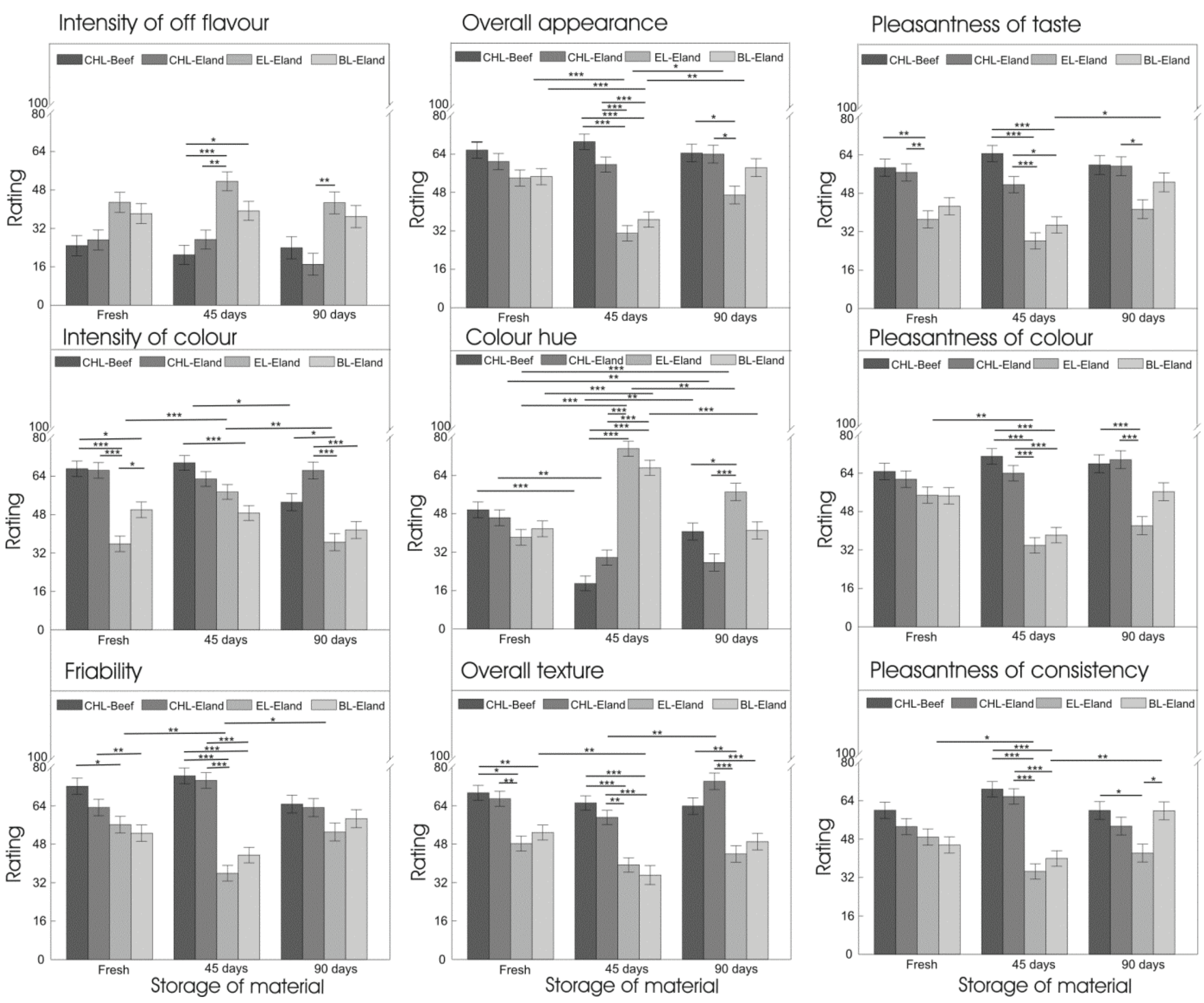


Fig. 1. The LSMeans (± standard error) of scored sensory characteristics including twelve batches of pâté. Asterisks above line connecting two bars symbolise significant differences as follows: *$P \leq 0.05$, **$P \leq 0.01$, ***$P \leq 0.001$
CHL = chicken liver, EL = eland liver, BL = cattle liver, Beef = cattle meat (neck, brisket and plate), Eland = eland meat (neck, brisket and plate)

we also supposed that off-flavour can be masked by the addition of flavourings to the product. Liver is more perishable than meat and it is better to process it immediately or freeze. During the liver and meat freezing, water present inside the tissues turns into crystals of ice; thus capillaries used previously for transport of gall liquid are damaged. Bitter off-flavour in the final product can be caused by gall liquid which had penetrated into liver tissue (F e i n e r, 2006). This intensity of off-flavour is higher in beef liver than in chicken, and also with the increasing age of the animal.

#### Intensity of colour

The intensity of colour significantly differed in both effects and their interaction (Fig. 1). It was found that pâté with chicken liver was perceived with more intensive colour than pâté where ruminant liver was used for processing. Pâté made from eland liver and meat had the lowest scores in all three series. These pâtés clearly showed the effect of refrigeration storage. We suppose that game meat, and especially game liver, contains higher amount of iron (P u r c h a s, B u s b o o m, 2005), which probably resulted in lower colour intensity of such processed product.

#### Friability

Friability is an important product characteristic which also showed differences in the effect of storage, and the interaction of effects, where samples with chicken liver were more compact than pâté made from the ruminant liver. Pâté made from eland liver and meat showed the highest friability, most probably due to the lower fat content which is necessary for the compact structure in the batch made from fresh material. L a t o c h et al. (2016) used inulin as the pork fat replacement in guinea fowl pâté, which resulted in hardness and chewiness and was more compact. The pâté batch made from frozen eland material for 45 days was scored as more friable, but the fat content was the highest in this batch. Normally, higher fat content of pâté decreases hardness of the product (E s t e v e z et al., 2005), causing better spreadability, but is less suitable for dietary purposes.

#### Overall appearance

Overall appearance was significantly influenced by the effect of composition, storage, and their interaction. Although fresh products did not differ significantly, the effect of composition was evident after storage. Overall appearance is evaluated by the visual sense; the results correspond to the colour hue, intensity and pleasantness of colour. L a t o c h et al. (2016) used replacement and decrease of fat by inulin, but did not find a difference in appearance with control. The pâté batch made from frozen eland material for 45 days was scored as more friable but the fat content was the highest in this batch. Pâté made from the chicken liver received similar scores as the pâté made from ruminant liver. There was a higher numerical difference between chicken and ruminant liver varieties when frozen liver was used instead of fresh. A m a r a l et al. (2015) also reported worse appearance scores with the storage of lamb pâté.

#### Colour hue

Colour hue was significantly influenced by composition, storage, and their combination (Table 4, Fig. 1). The chicken liver varieties differed from ruminant liver varieties in use of frozen materials. Chicken liver varieties were pinker while eland and beef liver varieties were darker, close to a brown colour. The effect of storage was evident mainly in pâté made from eland liver and meat, and particularly in all varieties which was also described for pâté from foal (L o r e n z o et al., 2014). Storage of meat and liver gave the pâté a brownish hue.

#### Overall texture

Overall texture significantly differs in the effect of composition, storage and their interaction. Samples differed according to the type of liver used. Samples with ruminant liver and meat were tougher than those made with chicken liver. Texture tends to be tougher with longer freezing storage of raw materials. It can be explained by the suitable choice of technological processing.

#### Pleasantness of taste

Pleasantness of taste clearly showed a significant effect resulting from composition and storage (Table 4). Pâté made from eland liver and meat showed the lowest score when made from fresh or frozen materials, but no differences were found between pâté where chicken liver and beef or eland meat was used. Batches with chicken liver were scored higher. A higher pleasantness of taste of the batches with chicken liver corresponds to the fact that the batches with ruminant liver showed stronger intensity of off-flavour. Ruminant liver often carries some off-flavour due to a relatively higher slaughter age of the animal than with chicken or pigs (F e i n e r, 2006).

#### Pleasantness of colour

Pleasantness of colour was significantly influenced by the effect of composition, storage and also by their interaction. No differences were found between samples made from fresh materials just after storage. P o l a k et al. (2011) found improved colour in chicken liver pâté with the usage of pasteurisation instead of sterilisation.

**Pleasantness of consistency**

Results of pleasantness of consistency confirmed that the chicken liver batches showed a better score than those batches made with ruminant liver. As with other textural characteristics, pleasantness of consistency is connected with the content of fat or collagen (Feiner, 2006). Thus pâté recipes can be modified relatively easily to fit more into the requirements of potential customers.

## CONCLUSION

Pâté made from fresh material (including chicken or eland or beef liver together with eland meat or beef) showed the main differences in textural characteristics and intensity of colour, such as friability; overall texture always scored better for pâté with chicken liver. Freezing the material (meat and liver) before processing into pâté resulted in worse scoring of the final product (better scored for batches with chicken liver) for sensory evaluation of overall appearance, pleasantness of taste, colour and intensity of colour, colour hue and textural friability, overall texture and pleasantness of consistency. Pâté made with chicken liver from frozen material also had lower off-flavour. Above all, we can conclude that pâté from fresh eland meat and chicken liver had the best sensory scores in most of the sensory descriptors. Freezing and storing the meat and liver before processing resulted in worse scores, especially in olfactory, visual and textural evaluations. This can be improved by using chicken liver to process pâté instead of eland or beef liver. Therefore, it can be recommended to small producers to process pâté from fresh material, where the use of chicken liver could improve textural characteristics like friability and overall texture of the final product.


## ACKNOWLEDGEMENT

We are grateful to Jiří Patrovský and Daniel Waage from Natura Food Additives, a.s. for their assistance in preparing the standardised recipe, provision of pâté additives and manufacturing of pâté samples. We acknowledge Dr. Ludmila Prokůpková for her valuable comments, help with methodology, and interpretation of results. Our thanks go to butcher Radek Stibor and Jiří Hora for eland carcass processing. We are grateful to two anonymous reviewers for their suggestions and comments.


## REFERENCES


Amaral DS, Silva FAP, Bezerra TKA, Arcanjo NMO, Guerra ICD, Dalmas PS, Madruga MS (2015): Effect of storage time and packaging on the quality of lamb pate prepared with 'variety meat'. Food Packaging and Shelf Life, 3, 39–46. doi: 10.1016/j.fpsl.2014.10.004.

Banout J, Kucerova I, Marek S (2012): Using a double-pass solar drier for jerky drying. Energy Procedia, 30, 738–744. doi: 10.1016/j.egypro.2012.11.084.

Barton L, Bures D, Kotrba R, Sales J. (2014): Comparison of meat quality between eland (Taurotragus oryx) and cattle (Bos taurus) raised under similar conditions. Meat Science, 96, 346–352. doi: 10.1016/j.meatsci.2013.07.016.

Belitz HD, Grosch W, Schieberle P (2009): Food chemistry. Springer-Verlag, Berlin.

Cordain L, Watkins BA, Florant GL, Kelher M, Rogers L, Li Y (2002): Fatty acid analysis of wild ruminant tissues: Evolutionary implications for reducing diet-related chronic disease. European Journal of Clinical Nutrition, 56, 181–191. doi: 10.1038/sj/ejcn/1601307.

Dalmas PS, Bezerra TKA, Morgano MA, Milani RF, Madruga MS (2011): Development of goat pâté prepared with 'variety meat'. Small Ruminant Research, 98, 46–50. doi: 10.1016/j.smallrumres.2011.03.016.

Deer Industry New Zealand (2013): Venison. Deer Industry News, 63, 21–22.

Estevez M, Ventanas S, Cava R (2005): Physicochemical properties and oxidative stability of liver pâté as affected by fat content. Food Chemistry, 92, 449–457. doi: 10.1016/j.foodchem.2004.08.014.

Feiner G (2006): Spreadable liver sausage and liver pâté. In: Feiner G (ed.): Meat products handbook: Practical science and technology. Woodhead Publishing Limited, Sawston and CRC Press LLC, Boca Raton, 451–476.

Fernandez-Lopez J, Sayas-Barbera E, Perez-Alvarez JA (2004): Quality characteristics of ostrich liver pâté. Journal of Food Science, 69, 85–91.

Guerrero-Legarreta I (2012): Canned products and pâté. In: Hui YH, Aalhus JL, Cocolin L, Guerrero-Legarreta I, Nollet LM, Purchas RW, Schilling MW, Stanfield P, Xiong YL (eds): Handbook of meat and meat processing. CRC Press, Boca Raton, 337–349.

Hoffman LC, Wiklund E (2006): Game and venison – meat for the modern consumer. Meat Science, 74, 197–208. doi: 10.1016/j.meatsci.2006.04.005.

Hoffman LC, van Schalkwyk DL, McMillin KW, Kotrba R (2015): Intramuscular fat characteristics of Namibian common eland (Tragelaphus oryx). African Journal of Wildlife Research, 43, 312–320. doi: 10.3957/056.045.0312.

ISO 937:1978. Meat and meat products – Determination of nitrogen content (Reference method). International Organization for Standardization, Geneva, Switzerland.

ISO 1444:1996. Meat and meat products – Determination of free fat content. International Organization for Standardization, Geneva, Switzerland.

ISO 1442:1997. Meat and meat products – Determination of moisture content (Reference method). International Organization for Standardization, Geneva, Switzerland.

ISO 8589:2007. Sensory analysis – General guidance for the design of test rooms. International Organization for Standardization, Geneva, Switzerland.

ISO 8586:2012. Sensory analysis – General guidelines for the selection, training and monitoring of selected assessors and expert sensory assessors. International Organization for Standardization, Geneva, Switzerland.

ISO 13299:2016. Sensory analysis – Methodology – General guidance for establishing a sensory profile. International Organization for Standardization, Geneva, Switzerland.

ISO 6658:2017. Sensory analysis – Methodology – General guidance. International Organization for Standardization, Geneva, Switzerland.

Kotrba R, Scevlikova P (2002): The evaluation of antelope breeding and the proposal of the economic use in the Czech Republic. Agricultura Tropica et Subtropica, 35, 129–137.

Lambrecht FL (1983): Game animals: A substitute for cattle? Rangelands, 5, 22–24.

Latoch A, Glibowski P, Libera J (2016): The effect of replacing pork fat of inulin on the physicochemical and sensory quality of guinea fowl pate. Acta Scientiarum Polonorum – Technologia Alimentaria, 15, 311–320. doi: 10.17306/J.AFS.2016.3.30.

Lorenzo JM, Pateiro M, Garcia Fontan MC, Carballo J (2014): Effect of fat content on physical, microbial, lipid and protein changes during chill storage of foal liver pâté. Food Chemistry, 155, 57–63. doi: 10.1016/j.foodchem.2014.01.038.

Magwedere K, Sithole F, Hoffman LC, Hemberger YM, Dziva F (2013): Investigating the contributing factors to postmortem pH changes in springbok, eland, red hartebeest and kudu edible offal. Journal of the South African Veterinary Association, 84, 1–7. doi: 10.4102/jsava.v84i1.919.

Neethling J, Hoffman LC, Muller M (2016). Factors influencing the flavour of game meat: A review. Meat Science, 113, 139–153. doi: 10.1016/j.meatsci.2015.11.022.

North MK, Hoffman LC (2015): Changes in springbok (Antidorcas marsupialis) Longissimus thoracis et lumborum muscle during conditioning as assessed by a trained sensory panel. Meat Science, 108, 1–8. doi: 10.1016/j.meatsci.2015.05.004.

Polak T, Zlender B, Lusnic M, Gasperlin L (2011): Effects of coenzyme Q10, α-tocopherol and ascorbic acid on oxidation of cholesterol in chicken liver pate. LWT – Food Science and Technology, 44, 1052–1058. doi: 10.1016/j.lwt.2010.10.010.

Purchas RW, Busboom J (2005): The effect of production system and age on levels of iron, taurine, carnosine, coenzyme Q10, and creatine in beef muscles and liver. Meat Science, 70, 589–596. doi: 10.1016/j.meatsci.2005.02.008.

Scherf DB (2000): World Watch List for domestic animal diversity. FAO, Rome.

Simopoulos AP (2000): Human requirement for n-3 polyunsaturated fatty acids. Poultry Science, 79, 961–970. doi: 10.1093/ps/79.7.961.

Terrasa AM, Dello Staffolo M, Tomas MC (2016): Nutritional improvement and physicochemical evaluation of liver pâté formulations. LWT – Food Science and Technology, 66, 678–684. doi: 10.1016/j.lwt.2015.11.018.

Vagner JA (1974): The capture and transport of African animals. International Zoo Yearbook, 14, 69–74.

van Zyl JHM (1962): The meat production of South African game animals: 1. The Eland. Fauna and Flora, 13, 35–40.

von La Chevallerie M (1972): Meat quality of seven wild ungulate species. South African Journal of Animal Science, 2, 101–103.

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