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Research Article

Solar Drying and Sensory Attributes of Eland *(Taurotragus oryx)* Jerky

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A double-pass solar drier (DPSD) and a laboratory oven (LO) were used for thin-layer drying of eland and beef. Prior to drying, the physicochemical characteristics of the raw meat were determined, such as pH, dry matter content (%), Warner-Bratzler shear force (N), pigment concentration (mg·kg^{-1}), weight loss during cooking (%), water holding capacity (%), colour (L, a, b), and crude fat content (%). Both meats were pretreated with traditional jerky marinade (TM), TM with fresh pineapple juice (TMP), TM with honey (TMH), and TM with Coca Cola© (TMCCL) and compared to an untreated control (C). The sensory properties of the eland and beef jerky were assessed in a two-stage process. The surface colour values of the jerky samples were measured in the CIE L^* a^* b^* colour space and the effect of the different pretreatments on the overall combined colour (ΔE) was calculated. Significant differences ($p < 0.05$) between raw eland and beef samples were found in case of pH, pigment concentration, water holding capacity, crude fat content, and colour (L and b). Jerky from TMP pretreated meat had the highest scores for texture, colour, and taste. Generally, for both meats dried in both driers, TMH marinade was evaluated as the one with the highest total difference ΔE compared to meat dipped in TMP pretreatment, which had the lowest total difference ΔE.

1. Introduction

Drying, particularly open sun drying, agricultural products such as fruit, vegetables, or meat is one of the oldest and still widespread conservation techniques used for food processing [1]. Drying in the sun is still a popular method in many developing countries, chiefly where no cold chain is available. Although, from the point of view of the sensory properties, dried meat cannot be compared with fresh meat, most nutritional properties, in particular the protein content, remain unchanged through drying [2]. Dried meats are traditional in different parts of the world and they are known as "cecina" in Spain, "biltong" in South Africa, "bresaola" in Italy, or "jerky" in America [3, 4]. Nowadays, jerky is more of a convenient snack food with a great variety of products where safe preservation, flavour, and texture are important. The market for meat snacks has rapidly grown in the past decade, and of those meat snacks, meat jerky is very popular because it can be purchased easily in retail shops worldwide and has long shelf stability and high protein content [5]. In developing countries the consumption of dried meat (in fresh meat equivalency) has continuously increased from a modest average annual per capita consumption of 10 kg in the 1960s to 26 kg in 2000 and it is projected to reach 37 kg around the year 2030 [2].

The simplest method to make jerky is to cut meat into strips and dry it. More typically, spices or marinades are used to flavour the meat, and curing or smoking might be used in combination with drying to make jerky [4]. Jerky can be made from different animal species (beef, pork, fish, chicken, turkey, and/or venison) but more than 70% of jerky is produced from beef. Nowadays consumers are increasingly becoming concerned about healthy, natural, and safe products and the demand for these products is escalating.

Game meat and venison meet most of the criteria demanded by a discerning consumer [6]. One of the prospective venison and/or game animals is eland *(Taurotragus oryx)*. The eland is the largest kind of antelope comparable to the domestic ox not only in size but also in its placid nature and its meat is comparable to beef. Further, eland meat has a lower content of intramuscular fat, with fat content averaging around 2.4% [7]. Lower fat content is better from the point of view of drying (faster drying), the lower presence of pathogens [8], and healthiness (a desirable ratio of polyunsaturated and saturated fatty acids) [6, 9]. Finally, game meat was not associated with BSE. These properties make eland meat a good perspective as a source of human nutrition as well as an alternative product to traditional beef, even in the dried form.

There is a lack of any detailed research and information in the scientific literature on drying behaviour and drying pretreatments for jerky prepared from eland meat. It is also reasonable to investigate the solar drying process, mainly because dried meat is a potentially important part of the diet of rural inhabitants in developing countries where a connection to the electricity grid is unavailable. The advantages of solar driers, enabling them to compete with traditional open-to-sun drying techniques and/or conventional driers powered by energy from fossil fuels, have been previously reported in the literature [10–13]. This study focuses on the influence of different drying pretreatments on the behaviour of solar drying whilst processing eland and beef meat, the sensory properties, and the quality of the final product.

2. Materials and Methods

2.1. Meat Samples. Fresh beef (steer, *Bos taurus*, Fleckvieh Breed, 16 months old) from biceps femoris was purchased from the Institute of Animal Sciences (Prague (Uhříněves), Czech Republic). Fresh eland (steer, *Taurotragus oryx*, 16 months old) meat from biceps femoris was purchased from the school farm of the Czech University of Life Sciences Prague (Lány, Czech Republic). Both groups of animals had been fed with a similar diet based on a mix of corn silage, lucerne haylage, meadow hay, and barley straw ad libitum.

2.2. Physicochemical Characteristics of Raw Meat. Meat samples for physicochemical analysis were obtained 24 hours after slaughter, packed into low density polyethylene (LDPE) bags, and stored at 4 to 7°C for seven days. Data from a duplicate analysis for pH, dry matter content (%), Warner-Bratzler shear force (N), pigment concentration (mg·kg^{-1}), weight loss during cooking (%), water holding capacity (%), colour (L, a, b), and fat content (%) were averaged.

The pH value was measured 24 hours after slaughter using a Testo 205 pH meter (Lenzkirch, Germany). Analyses were done in triplicate.

The sea sand reference method ISO 1442:1997 [14] was used to dry 60 g of meat at 103 ± 2°C for 24 hours. Analyses were done in triplicate.

Shear force values were determined with a Warner-Bratzler shear attachment on a texture analyser (Instron Model 5544, software Series IX, Instron Co., USA). Samples of muscles were cleared from connective tissues and cut into pieces of 15 × 20 × 60 mm. Test speeds were set at 2 mm·s^{-1}. Data were collected and analysed from the shear force values to obtain the maximum force required to shear through each sample and were then converted into Newton (N). Analyses were done on four samples.

Haem pigments were extracted in a solution of acetone and HCl [15], and pigment concentration was determined using a UV-2900 PC spectrophotometer (Tsingtao Unicom-Optics Instruments Co., Ltd., China) and expressed as total haem pigments content [16]. Analyses were measured in two replications.

Samples of meat (separately for eland and beef) were placed in glass tubes, weighted, covered with aluminium foil, and placed in a water bath at a temperature of 80°C for 30 min. Water loss was measured gravimetrically. Analyses were done in two replications.

Water holding capacity was determined using the Grau and Hamm's filter paper press method modified by Brendl [17]. Meat and total fluid areas were measured with a Planix 7 digital planimeter (Tamaya Technics Inc., Japan) [18]. Analyses were done in twelve replications.

Reflectance was measured with a Minolta CM206d spectrophotometer (Minolta Co. Ltd., Japan). Muscle samples were cleared from connective tissues and cut crosswise. Data were obtained immediately from a freshly sliced cut of sample [16]. Measurements were done in triplicate. Reflectance was measured again after the drying procedure with twenty replications.

Fat content was obtained gravimetrically after extraction from dried samples with petrol ether for 4 hours according to the Soxhlet method [19]. Analyses were done in triplicate.

2.3. Sample Preparation and Drying Pretreatments. The meat samples used for the drying experiment were cleaned from connective tissues 24 h after the slaughter, packed into LDPE bags, and stored at 4 to 7°C for 7 days. Afterwards both meat samples were stored at −18°C for 4 days and then thawed at 4°C overnight. This semithawed meat was cut with a food slicer (Concept KP 3530, FS-82T) into uniform samples of size 5 × 80 × 25 mm. A sample size of 5 mm was cut through the fibre. Meat slices were vacuum-packaged (MAGIC VAC Champion, Elaem Nuova) in bags and stored at −18°C for 1 month for later use.

After one month of storage, the samples were thawed, treated in marinades, and subsequently dried in two driers. The following drying pretreatments were used in this study: traditional jerky marinade (TM), TM with pineapple juice (TMP), TM with honey (TMH), TM with Coca Cola (TMCCL), and control samples, without marinade (C).

Traditional jerky marinade [20, 21] consisted of 60 mL soy sauce (Kikkoman Foods), 15 mL Worcestershire sauce (Vitana, Czech Republic), 0.6 g black pepper, 1.25 g garlic powder, 1.5 g onion powder, and 4.35 g old hickory-smoked salt. Meat samples were dipped for 10 min at ambient temperature (24°C) in different marinades as presented in Table 1.

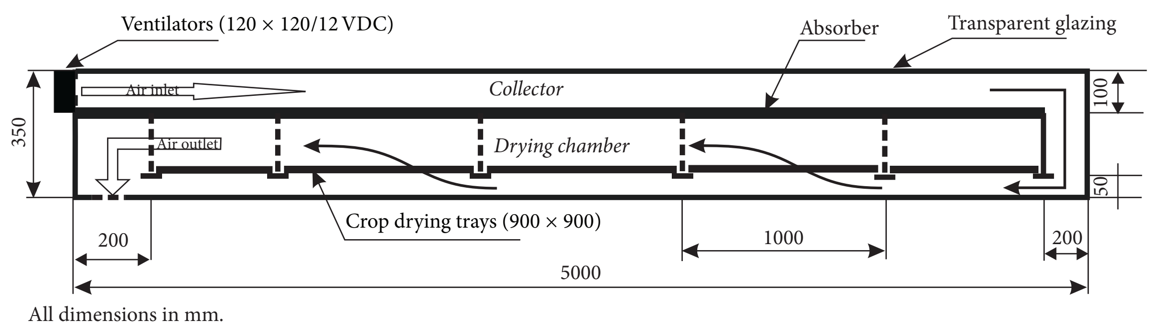
2.4. Drying Experiment. The fresh meat slices were dried out in a double-pass solar drier (DPSD) (Figure 1) designed at the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, and previously described by Banout et al. [22].

Table 1: Classification of pretreatments used.

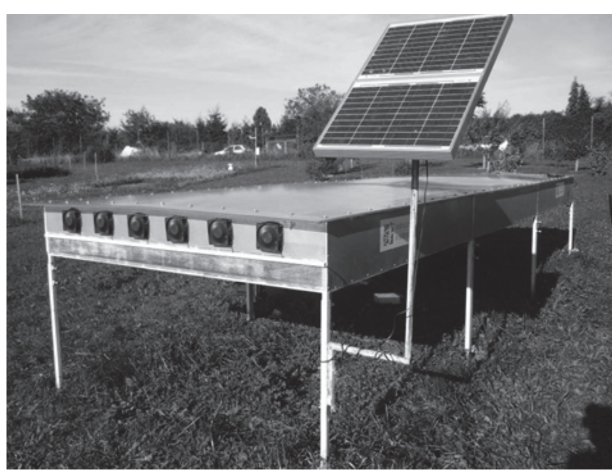
Pretreatment	Content
(1) TM	Traditional jerky marinade (TM)
(2) TMP	TM and freshly prepared pineapple juice (50% fresh pineapple juice/50% TM)
(3) TMH	TM and bee honey solution (50% bee honey solution/50% TM), bee honey solution (50% bee honey/50% distilled water)
(4) TMCCL	TM and Coca Cola (50% Coca Cola/50% TM), Coca Cola (The Coca-Cola Company). Ingredients of Coca Cola original: sugar, caramel colour E150d, caffeine, phosphoric acid, carbonated water, and flavour

Table 2: Climatic and drying conditions of all solar drying experiments (SD: standard deviations; A, B, C: set of experiments).

	A	B	C
	Mean ± SD	Mean ± SD	Mean ± SD
Average ambient temperature (°C)	24.3 ± 1.7	23.4 ± 1.4	25.5 ± 2.1
Average drying temperature (°C)	48.4 ± 6.0	46.4 ± 5.7	49.2 ± 5.2
Average ambient RH (%)	49.2 ± 8.7	51.3 ± 8.7	46.2 ± 7.7
Average RH of drying air (%)	18.2 ± 5.7	19.7 ± 6.7	17.7 ± 5.7
Average insolation ($W \cdot m^{-2}$)	552.3 ± 219.4	525.4 ± 194.1	615.3 ± 144.1
Average air flow speed in collector ($m \cdot s^{-1}$)	1.0 ± 0.3	0.7 ± 0.1	1.1 ± 0.1



(a)



(b)

Figure 1: Double-pass solar drier (DPSD) ((a) schematic diagram of DPSD, (b) photo of DPSD).

A total of three full-scale experimental sets for drying eland and beef were conducted from June to September at the Czech University of Life Sciences Prague (Czech Republic). The climatic and drying conditions are presented in Table 2. Each set of solar drying experiments took 2 days and always started at 10:00 AM and stopped at 6:00 PM. During the night, the samples were collected and placed in a room in closed plastic bags. The following operational parameters were measured every hour during the solar drying experiments:

Table 3: Parameters and orientation.

Parameter/orientation	0	100
General look	Like	Dislike
General likableness of taste	Like	Dislike
General likableness of meat taste*	Like	Dislike
Intensity of meat taste*	Slightly intensive	Extremely intensive
Intensity of fatty taste*	Slightly intensive	Extremely intensive
Colour intensity	Light	Dark
Colour likableness	Like	Dislike
Hardness	Very soft	Very hard
Chewiness	Very good	Bad
Fibrousness*	Soft	Chewy
Sappiness	Juicy	Dry
General structure	Excellent	Bad

*Parameters evaluated only by the first panel whose aim was to evaluate the difference between drying in DPSD and LO and differences between eland and beef.

(i) Drying air temperature (°C) and drying air relative humidity (RH) (%), Temperature-Humidity Logger S3121 (Comet System, Czech Republic)

(ii) Drying air velocity ($m \cdot s^{-1}$), Anemometer Testo 425 (Lenzkirch, Germany)

(iii) Weight loss of reference samples of meat slices (g), Balance Kern 572-30 (Kern & Sohn GmbH)

(iv) Ambient air temperature (°C), ambient air RH (%), Temperature-Humidity Logger S3121 (Comet System, Czech Republic)

(v) Global solar radiation ($W \cdot m^{-2}$), pyranometer CMP 6, along with a solar integrator (Kipp Zonen, Delft, Netherlands).

The solar drying of meat samples from both eland and beef was compared with drying in a laboratory oven (LO), standard dehydrator (Memmert UFE 500 GmbH + Co. KG, Germany), at a constant temperature of 55°C. Experiments conducted in the LO were replicated three times.

At the end of each drying test in the DPSD and LO the control samples of each meat were collected in triplicate and the dry matter content was estimated by the oven method at 105°C for 24 h (Memmert UFE 500 GmbH + Co. KG, Germany). Equation (1) was used to estimate dry matter content on the dry basis [11]:

$$MC_{db} = \frac{\text{water (kg)}}{\text{dry meat (kg)}} * 100\%. \quad (1)$$

The drying rate is an important parameter when assessing the drying process. Kituu et al. [23] evaluated the drying rate (DR) as the decrease of water concentration during the time interval between two subsequent measurements divided by the time interval. The drying rate (DR) is presented by the following equation:

$$DR = \frac{\Delta M}{\Delta T}. \quad (2)$$

2.5. Organoleptic Properties and Sensory Analysis. All the sensory analysis was in accordance with ISO 8586:2012 [24]. Two independent panels, first of 15 expert assessors and second of 22 assessors, were organized. Panellists were selected and trained. Each assessor evaluated the meat samples submitted on a paper tray designated by a digit code. The profile method with a 100 mm unstructured graphic scale was used for evaluation. The parameters evaluated are given in Table 3. The first panel ($n = 15$) evaluated four samples: (1) untreated control sample C of eland dried in DPSD, (2) untreated control sample C of eland dried in LO, (3) untreated control sample C of beef dried in DPSD, and (4) untreated control sample C of beef dried in LO. This sensory panel aimed to investigate if different drying devices and different kinds of meat can influence the results of a sensory profile analysis.

Based on the results of the first panel, the second assessment only focused on eland meat dried in the DPSD and the effect of different drying pretreatments on the organoleptic properties assessed by the 22-member panel. The panellists evaluated samples pretreated with (1) traditional marinade (TM), (2) TM with honey, (3) TM with pineapple, and (4) TM with Coca Cola. Sensory analyses were accomplished in 2 sessions (in separate days) within 1 month.

The surface colour values of the jerky samples were measured with a CM-2600d spectrophotometer (Minolta) in the CIE L^* a^* b^* colour space using Spectra Magic CM-S100w software.

To evaluate the effect of different pretreatments on the overall combined colour of dried meat, the ΔE index, as given by the following equation [25, 26], was calculated by taking the colour of the control sample (C) as the reference value:

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}, \quad (3)$$

where $\Delta L = L - L_{base}$, $\Delta a = a - a_{base}$, and $\Delta b = b - b_{base}$ and L, a, and b are the colour coordinates of the sample and L_{base}, a_{base}, and b_{base} are the colour coordinates of the control C sample.

Table 4: Results of physicochemical characteristics of raw meat (SD: standard deviations).

	Eland Mean ± SD	Beef Mean ± SD	p values
pH 24 hours after slaughter	5.50 ± 0.01	5.55 ± 0.01	0.001
Warner-Bratzler shear force (N)	68.84 ± 15.43	89.32 ± 19.68	0.155
Pigment concentration (mg·kg–1)	4339.36 ± 51.57	3482.41 ± 103.14	0.023
Weight loss during cooking (%)	27.23 ± 0.18	27.55 ± 0.42	0.461
Water holding capacity (%)	44.87 ± 2.17	52.13 ± 5.97	0.001
Water content (%)	75.05 ± 0.05	75.20 ± 0.11	0.121
Crude fat content (%)	0.84 ± 0.09	2.80 ± 0.53	0.021
Colour *L*	38.88 ± 2.59	42.41 ± 1.64	0.031
a	9.13 ± 1.05	10.33 ± 0.74	0.067
b	6.86 ± 1.02	9.71 ± 0.49	0.001

2.6. Statistical Analysis. Data were analysed with the IBM SPSS Statistics software version 22.0 (IBM, US). For the physicochemical characteristics of raw meat, the data were analysed using the independent samples t-test. Sensory data were analysed using a one-way ANOVA, in the case of the first panel, separately for the main effects of the meat drier by groups, and the kind of meat by groups, the second panel for the treatment by groups. A Tukey test was performed for the separation of mean differences with a 95% confidence level. The results of the sensory profile analysis for the parameter general likableness of taste within the first panel were transformed and processed by the Friedman test. Instrumentally measured colour was analysed by one-way ANOVA for the main effect of different treatments within a drying system, separately for eland and beef with the Tukey test as a post hoc test. The independent t-test was applied to compare different colour parameters within different drying systems, separately for eland and beef.

3. Results and Discussion

3.1. Physicochemical Characteristics of Raw Meat. The results of the physicochemical characteristics of raw meat are presented in Table 4. A comparison of eland and beef meat showed lower pH values in the eland sample, which, according to Huff-Lonergan and Lonergan [27] and Muchenje et al. [28], is one of the aspects related to the development of lower water holding capacity in eland. The Warner-Bratzler shear force for the beef samples was higher, but did not differ statistically from eland. A higher WB shear force for beef, when comparing beef with eland, was already published by Bartoň et al. [29]. Pigment concentrations in muscles of eland were higher and therefore it was darker (lower L value) with lower redness and yellowness. A significant difference was found for yellowness (b), caused by the low accumulation level of carotenoids in eland [30] compared to the high accumulation level in cattle [31]. These data are in accordance with a lighter colour found for beef compared to eland [29] and compared to other venison [32–34]. The muscles of eland contain less crude fat as noted by La Chevallerie et al. [7].

3.2. Drying Performance. The data presented in Table 2 show a relative uniformity, which is due to similar climatic conditions during each solar drying test. For further performance analyses, the data from experiment A were considered to represent optimal average values. Maximum solar radiation on the first day was 954.5 $W{\cdot}m^{-2}$ and on the second day it was 864.3 $W{\cdot}m^{-2}$ with an average for both days of 552.3 $W{\cdot}m^{-2}$. Ambient temperature varied during both days between 20.6 and 26.8°C, with an average of approximately 24.4°C, and ambient relative humidity between 35.7% and 64.1%, with an average of approximately 49.2%. The daily mean values of drying air temperature and relative humidity in the drier (DPSD) varied from 23.6 to 60.8°C and 11.7 to 62.8%, with their average values being 48.1°C and 18.4%. The drying temperatures measured in the solar drier were close to those recommended for the preparation of dried meat [8, 35]. The daily mean values of drying air velocity varied during both days, approximately 0.04 to 1.87 $m{\cdot}s^{-1}$ with an average of 1 $m{\cdot}s^{-1}$ in the collector part of the drier. The relatively large difference between the maximum and minimum drying air velocities was caused by the PV panel being directly connected to fans with no regulatory systems. The system regulates the airflow itself due to the position of the sun during the day. However, this disposition makes the airflow rate highly sensitive to actual insolation.

According to Kucerova et al. [36] where there was no statistically significant difference between the drying behaviour of eland and beef, Figures 2 and 3 present just eland meat dried in the DPSD and LO and the reduction of its moisture content over time.

From Figures 2 and 3, it is evident that, in general, a higher drying rate was achieved in the DPSD as compared to the LO.

Drying rates plotted with moisture contents for solar drying in the DPSD and drying in the LO are presented in Figures 4 and 5. The drying rates were higher at the beginning of the drying process and later decreased with decreasing moisture content. Similarly, as in the case of Figures 2 and 3, a higher drying rate was observed during solar drying of meat samples mainly in the initial stages. The drying rates were fitted by linear trend lines and DR equations (see (4),

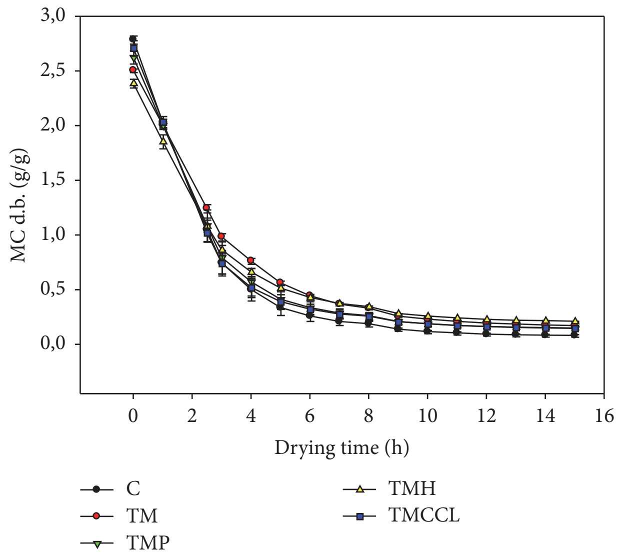


Figure 2: Changes in moisture content (d.b.) of control and pretreated samples of eland in drying time for a typical experimental run in DPSD.

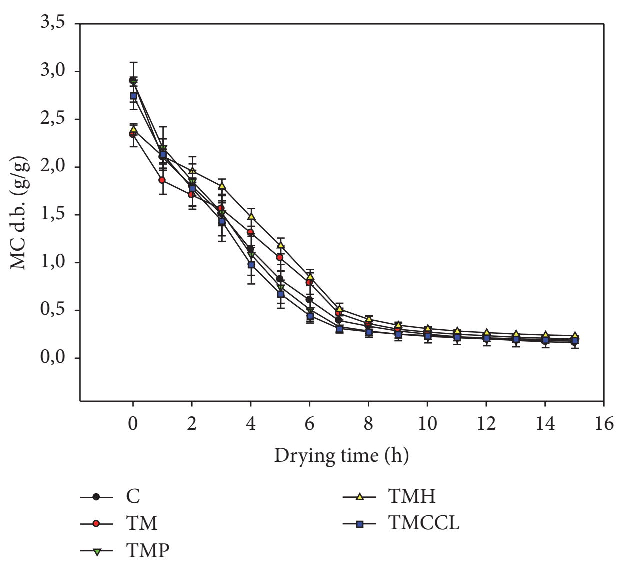


Figure 3: Changes in moisture content (d.b.) of control and pretreated samples of eland in drying time for a typical experimental run in LO.

(5), (6), (7), and (8)) were developed for solar drying and (9), (10), (11), (12), and (13) for LO drying, respectively:

$$\mathrm{DR_C} = 0.4637(M) - 0.0096 \quad (R^2 = 0.8553) \tag{4}$$

$$\mathrm{DR_{TM}} = 0.3438(M) - 0.0319 \quad (R^2 = 0.8351) \tag{5}$$

$$\mathrm{DR_{TMP}} = 0.4194(M) - 0.0314 \quad (R^2 = 0.7998) \tag{6}$$

$$\mathrm{DRT_{TMH}} = 0.3946(M) - 0.0637 \quad (R^2 = 0.8649) \tag{7}$$

$$\mathrm{DR_{TMCCL}} = 0.4441(M) - 0.0353 \quad (R^2 = 0.7943) \tag{8}$$

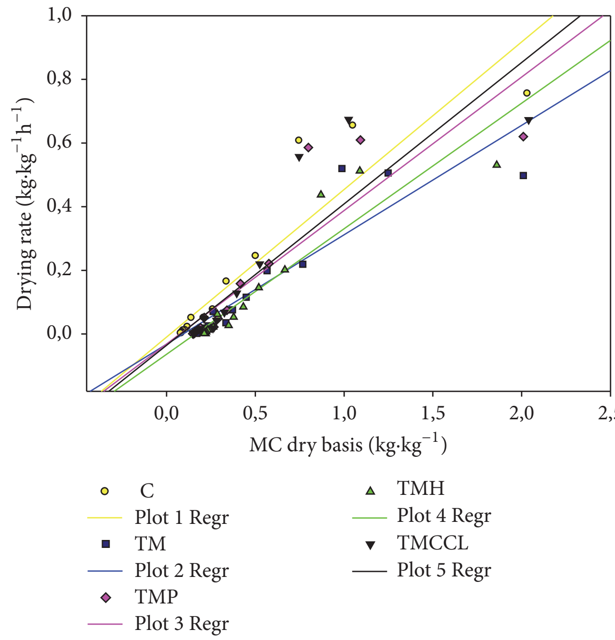


Figure 4: Drying rate curves of eland meat dried in a DPSD.

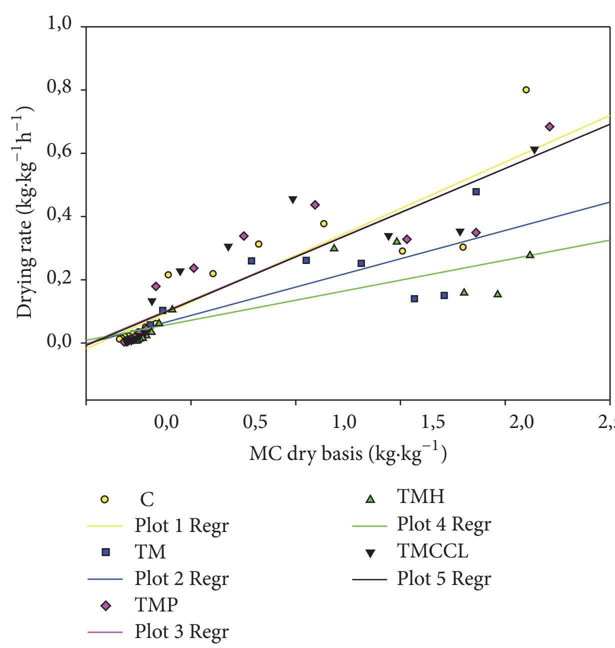


Figure 5: Drying rate curves of eland meat dried in a LO.

$$\mathrm{DR_C} = 0.2951(M) - 0.0179 \quad (R^2 = 0.7953) \tag{9}$$

$$\mathrm{DR_{TM}} = 0.1791(M) - 2.1887 \quad (R^2 = 0.6483) \tag{10}$$

$$\mathrm{DR_{TMP}} = 0.2786(M) - 0.0048 \quad (R^2 = 0.8236) \tag{11}$$

$$\mathrm{DR_{TMH}} = 0.1267(M) + 0.0088 \quad (R^2 = 0.6510) \tag{12}$$

$$\mathrm{DR_{TMCCL}} = 0.2798(M) - 0.0076 \quad (R^2 = 0.8171). \tag{13}$$

Table 5: Overall sensory evaluation of eland meat samples dried in DPSD ($n = 22$).

	Pretreatments							
	TM		TMP		TMH		TMCCL	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
General look	4.24^{a}	2.17	**3.24**^{a}	1.92	4.5^{a}	2.46	3.90^{a}	2.05
General likableness of taste	**2.65**^{a}	0.76	3.38^{ab}	1.83	4.61^{b}	1.69	4.34^{ab}	1.48
Colour intensity	5.46^{ab}	2.32	**4.97**^{a}	2.31	7.63^{c}	1.97	7.06^{bc}	1.87
Colour likableness	5.12^{b}	1.95	**3.64**^{a}	1.98	4.07^{ab}	1.81	3.81^{ab}	1.64
Hardness	5.42^{ab}	2.45	**5.11**^{a}	2.35	6.99^{b}	1.92	6.39^{ab}	2.07
Chewiness	4.96^{a}	2.04	5.23^{a}	1.88	5.55^{a}	2.5	5.96^{a}	2.18
Sappiness	5.56^{a}	2.3	5.72^{a}	2.09	5.59^{a}	1.76	5.45^{a}	2.52
General texture	4.83^{ab}	1.37	**3.89**^{a}	1.81	6.05^{b}	1.39	5.3^{ab}	2.14

$^{a-c}$Mean values with different superscripts within a same row are significantly different ($p < 0.05$). Extrabold type signs the best evaluated parameter for the pretreatment.

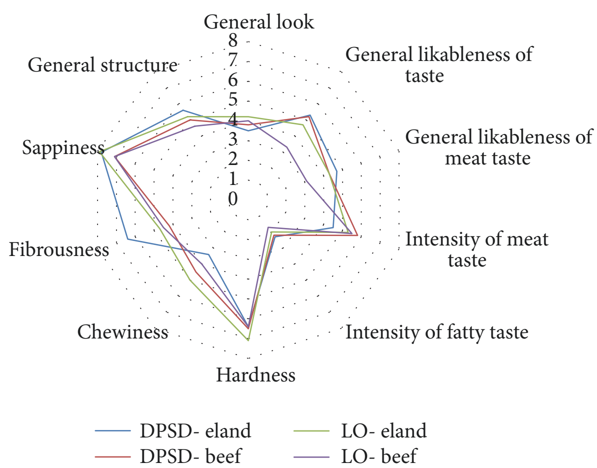


Figure 6: Sensory evaluation by profile method of control samples. C of both eland and beef meat dried in DPSD and LO ($n = 15$).

3.3. Sensory Analysis. The results of the first sensory panel are presented in Figure 6.

For the parameter general likableness of taste transformed by the Friedman test, the sample of beef meat dried in LO scored the highest, and differences between samples of beef dried in LO and eland dried in DPSD as well as beef dried in LO and beef dried in DPSD ($p < 0.05$) were found. This could be due to the lower drying rate in LO. According to Bejerholm and Aaslyng [37], it could affect the flavour and odour components, especially the humidity, which influences the odour, flavour, and colour of the meat where a high humidity will prevent Maillard reactions from taking place and will dilute the flavour and odour components.

All sensory attributes with higher water holding capacity (see Table 4) in beef can therefore be influenced by changes in the drying technique. On the other hand, eland meat dried in DPSD scored in the parameter general look; even the differences between samples were not significant. These findings are in accordance with data published by Speth [38], where eland meat is considered to be very similar to beef. Assessors could not distinguish differences in the intensity of fatty taste, even if beef meat contained more fat (as noticed in Table 4). In contrast they assessed the beef samples as juicier than the eland samples, which is in accordance with Ruiz-Carrascal et al. [39], who pointed out that intramuscular fat plays a decisive role in most features of dry-cured products directly linked to their sensory characteristics, such as marbling and juiciness. Consumers are concerned about diet and health and a fat low-content is desirable [40]; nevertheless juiciness, more precisely a higher fat content, could even affect the assessment of general likableness of taste. The most important sensory attributes of this type of snack food are texture, colour, and flavour all together. As determined by the selection of the raw material and the effect of numerous technological factors [41], generally it is not possible to state that there is a statistical difference ($p < 0.05$) between samples dried in DPSD and LO and between beef and eland meat. This result is in agreement with those obtained by Mapesa et al. [42] where beef dried in a solar drier was not statistically different ($p < 0.05$) from that dried in an oven. The difference between eland and beef was evaluated by Bartoň et al. [29] and their results on the texture are in agreement with the dried meat in this study.

Based on the first sensory analysis, in most cases there was no significant difference between beef and eland meat samples; the results from the second assessment are presented in Table 5.

The sample treated with traditional jerky marinade with fresh pineapple juice (TMP) was considered to be the best from the samples of eland meat dried in DPSD. This treatment scored in all categories. Fresh pineapple juice contains bromelain, which is known to degrade myosin [43]. Therefore, meat treated with fresh pineapple juice is more tender. This is also evident in the evaluation of the hardness of the meat samples or their general texture too. Even such parameters as chewiness or juiciness were not significantly different; they did not influence the result of the parameter general texture. The TMP sample also scored in the parameter colour likableness, whereas in the correlation with the results for colour intensity it is clear that a lighter colour is considered better, or rather the one with a more pleasant colour in terms of assessing meat.

Table 6: Colour of dried eland and beef in DPSD and LO ((a) eland; (b) beef).

(a)

	DPSD		
	L	a	b
C	$30.24 \pm 4.3^{b,c}$	5.07 ± 0.93^{d}	9.27 ± 2.19^{b}
TM	20.65 ± 2.74^{a}	$2.11 \pm 0.74^{a,b}$	6.03 ± 1.51^{a}
TMP	30.95 ± 4.23^{c}	$2.6 \pm 0.82^{b,c}$	4.54 ± 1.49^{a}
TMH	21.21 ± 3.5^{a}	1.44 ± 0.56^{a}	4.75 ± 1.14^{a}
TMCCL	$27.21 \pm 4.01^{b,c}$	2.25 ± 1.00^{b}	5.05 ± 1.84^{a}
	LO		
	L	a	b
C	29.98 ± 3.61^{b}	3.14 ± 1.04^{d}	5.17 ± 3.10^{a}
TM	28.80 ± 3.51^{b}	3.31 ± 1.30^{d}	10.46 ± 3.19^{b}
TMP	22.62 ± 4.44^{a}	$2.09 \pm 1.22^{a,b,c}$	6.89 ± 3.19^{a}
TMH	20.04 ± 2.31^{a}	1.26 ± 0.87^{a}	6.20 ± 1.39^{a}
TMCCL	22.32 ± 2.51^{a}	$2.46 \pm 1.22^{b,c,d}$	7.33 ± 2.20^{a}

[a–d]Mean values with different superscripts within the same column are significantly different ($p < 0.05$).

(b)

	DPSD		
	L	a	b
C	$25.20 \pm 3.95^{b,c}$	4.49 ± 1.15^{c}	$8.86 \pm 1.75^{c,d}$
TM	$22.83 \pm 4.74^{a,b,c}$	3.11 ± 1.12^{b}	$8.83 \pm 2.35^{c,d}$
TMP	25.71 ± 4.49^{c}	3.61 ± 1.37^{b}	$8.31 \pm 2.36^{c,d}$
TMH	20.41 ± 3.25^{a}	1.49 ± 0.6^{a}	$6.49 \pm 1.36^{a,b}$
TMCCL	30.3 ± 4.6^{d}	3.21 ± 1.6^{b}	4.76 ± 2.53^{a}
	LO		
	L	a	b
C	28.80 ± 3.63^{c}	4.45 ± 1.22^{c}	$7.99 \pm 2.61^{b,c}$
TM	$26.86 \pm 5.01^{b,c}$	4.09 ± 1.43^{c}	12.41 ± 3.44^{d}
TMP	$24.45 \pm 3.10^{a,b}$	$1.98 \pm 1.20^{a,b}$	5.12 ± 2.41^{a}
TMH	20.79 ± 3.33^{a}	1.64 ± 0.88^{a}	$6.96 \pm 1.86^{a,b}$
TMCCL	$24.35 \pm 3.22^{a,b}$	3.04 ± 1.31^{b}	9.06 ± 2.50^{c}

[a–d]Mean values with different superscripts within the same column are significantly different ($p < 0.05$).

As mentioned above, colour is one of the most important attributes of jerky [44] and is strongly associated with the concept of quality [45]. The meat of eland and beef contains a large quantity of free amino acids [29] that, in combination with the sugar in pretreatments, can, under relevant conditions of concentration, pH, and temperature, start Maillard reactions and form dark pigments [46]. A comparison of the colours of different treatments within a drying system for eland and beef is presented in Table 6.

The lightness value L and the value of the parameter a of the dried beef are similar to the values of beef jerky reported by Farouk and Swan [47]. It is also possible to compare some other colour values reported in the literature with the results of this study. The values of L, a, and b for beef jerky reported by Konieczny et al. [41] were 30.66, 13.42, and 4.24, respectively; for ostrich jerky, they were 27.2, 2.0, and 2.3, respectively [48].

The results of comparing the L, a, and b parameters within different drying systems separately for eland and beef are as follows. In the case of eland, significant differences ($p < 0.05$) between DPSD and LO were found in the C sample (a, b parameters), the TM sample (L, a, and b parameters), TMP, TMCCL (L, b parameters), and TMH (b parameter). Significant differences ($p < 0.05$) between DPSD and LO in the case of beef were also identified: sample C (L parameter), TM (L, a, and b parameters), TMP (a, b parameters), and TMCCL (L, b parameters). Thus, it is evident that the type of drier can influence the final colour of the product.

The total colour difference ΔE as determined by (3) can be classified analytically according to Cserhalmi et al. [49] as not noticeable (0–0.5), slightly noticeable (0.5–1.5), noticeable (1.5–3.0), well visible (3.0–6.0), and great (>6.0). The results of ΔE for eland and beef dried in DPSD and LO are presented in Figure 7.

Generally, for both meats dried in both driers, the TMH marinade was evaluated as the one with the highest total difference ΔE; in contrast meat dipped in the TMP pretreatment has the lowest total difference in ΔE. This result

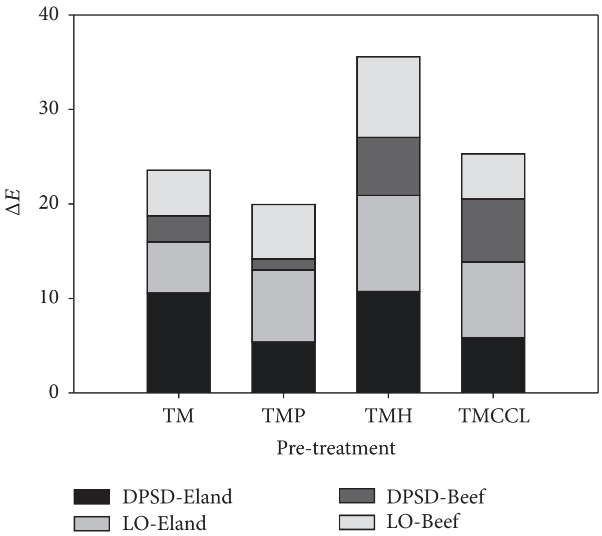


Figure 7: Total colour difference ΔE.

correlates with the result of the sensory panel, where the TMP sample was evaluated as the lightest one and therefore it is possible to point out that the assessors preferred lighter meat with a lower total colour change than the darker one.

4. Conclusion

This study brings new findings about the sensory analysis and organoleptic properties, including colour change whilst drying eland jerky, which might be important for possible industrial processing. Further, it can be concluded that solar drying technology brings compatible results as with a standard laboratory drier. Finally, the study indicates that the organoleptic properties of eland jerky are similar to widely recognized traditional beef jerky.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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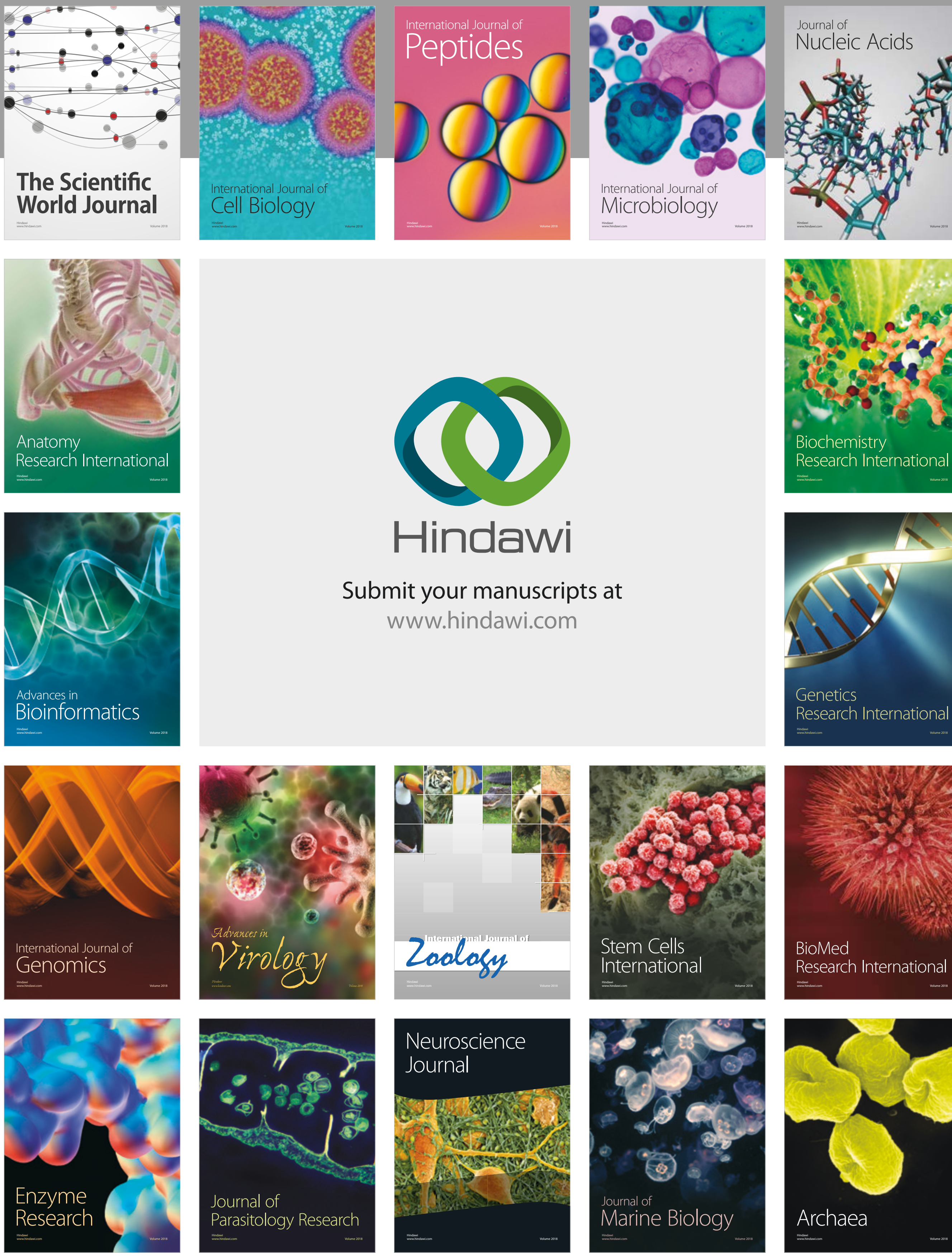

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