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The effect of the diet supplementation with linseed and rapeseed on the physico-chemical and sensory characteristics of ostrich meat*

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The aim of the study was to evaluate the effect of the dietary linseed and rapeseed supplements on the physico-chemical and sensory properties of ostrich meat. The experiment was carried out on forty growing ostriches raised in five groups (control and with 4 and 8% linseed and 5 and 10% rapeseed of the diet). The diet with rapeseed did not affect the physico-chemical properties of meat, while 4% linseed in a diet had positive influence on flavour ($P<0.001$) and cooking loss ($P<0.05$), that are important from the consumer point of view. Higher amounts of linseed (8%) in the diet caused changes in pH24 and increasing fat content in meat.

KEY WORDS:linseed / meat /ostrich /rapeseed

Over the last decade there is observed a growing interest in *Ratitae* farming, mainly ostriches [Sales *et al.* 1999, Horbańczuk and Sales, 2001, Cooper and Horbańczuk 2004, Kawka *et al.* 2007] that provide dietetic meat, valuable skins as well as feathers

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and eggs [Sales and Horbanczuk 1998, Cooper *et al.* 2007, 2008, Horbańczuk *et al.* 2007, Poławska *et al.* 2011]. The higher demand for ostrich meat is associated among others with growing interest for searching on the meat market alternative type of red meat from not traditional animal species after second outbreak of BSE in European cattle [Horbańczuk *et al.* 2008]. Although some research on the nutritive value of ostrich meat has been carried out [Sales 1996, Horbańczuk *et al.* 1998, Paleari *et al*. 1995, Fisher *et al.* 2000, Hoffman *et al.* 2005, 2008, Majewska *et al.* 2009] a relatively little information is found regarding the physical and sensory characteristics of ostrich meat after plant oil introduction into the birds' diet. This issue seems to be interesting and important for industry as well as for consumers since using different oil seeds additives in bird's diet may affect both technological parameters of ostrich meat or its sensory properties. Thus, the aim of the study was to evaluate the effect of the dietary linseed and rapeseed supplementation on the physicochemical and sensory characteristics of ostrich meat.

Material and methods

Birds and diets

The experiment was carried out on forty ostriches raised in five groups (8 birds in each group) on a commercial farm in Stypułów in western Poland (the farm is under scientific supervision of the Institute of Genetics and Animal Breeding of the Polish Academy of Sciences). Since month 5 of age the birds were kept on 5 pelleted diets (Tab. 1) offered according to 2% body weight (BW). Control diet (C) was made of

Table 1.Components and chemical composition of diets

Component (g/kg, approx.)	Diet/Group[1]				
	C (n=8)	L4 (n=8)	L8 (n=8)	R5 (n=8)	R10 (n=8)
Barley	330	340	385	395	340
Wheat (12% CP)	355	290	165	240	185
Wheat bran	160	190	245	175	250
Soybean meal (45.5% CP)	105	90	75	90	75
Linseed	-	40	80	-	-
Rapeseed	-	-	-	50	100
Vitamin-mineral premix	50	50	50	50	50
Dry matter	885	886	888	891	894
Crude protein	151	151	151	150	152
Crude fat	21.5	39.4	57.9	42.4	64.5
Crude fibre	45.3	50.4	57.7	49	54.3
Ash	68	68	68	76	76
Starch	414	386	344	381	330
Energy (MJ/kg)	11	11	11	11	11

[1]C – control group; L4 – diet with 4% of linseed; L8 – diet with 8% of linseed; R5 – diet with 5% of rapeseed; R10 – diet with 10% of rapeseed. CP – crude protein.

barley, wheat, wheat bran and soybean meal (Tab. 1). Experimental diets were made on the basis of control diet, a part of which was replaced (w/w) with linseed (4 or 8% – diet L4 and L8, respectively) or rapeseed (5 or 10% – diet R5 and R10, respectively). All diets were iso-proteinous (about 150 g crude protein/kg) and iso-energetic (about 11 MJ/kg) and were balanced in relation to the content of amino acids to meet the recommendations for ostrich [Horbańczuk 2002].

At the age of 12 months and reaching about 95 kg of live body weight the birds were fasted for 24 hours, electrically stunned and slaughtered at the commercial abattoir in western Poland with UE certificate. Carcasses were maintained at room temperature (15°C) for 1h, then chilled at 4°C for 24 hours and divided into cuts. Then samples were taken from *gastrocnemius pars interna* (GN) muscle from the left leg and directly transported to the laboratory for the analyses of physico-chemical and sensory parameters.

Muscle chemical composition

The chemical composition of muscle samples was determined by the spectrometer of close infra-red radiation (NIR Flex Solids N500) on the basis of elaborated in other studies calibration for feeds and ostrich meat using reference methods of determination of chemical composition [AOAC 1995].

Physical properties

pH measurements. The pH was measured at 45 minutes (pH45), 24 and 72 hours (pH24 and pH72, respectively) *post mortem* with a pH meter (Radiometer PHM 80 Portable, Denmark) equipped with a combination electrode with a temperature correction system and a digital display. The measurements were done according to Polish Standard [PN-ISO 2917, 2001] in *M. Gastrocnemius pars interna.*

Colour measurements. Instrumental colour measurements were recorded 30 min *post mortem* for L* (lightness; 0: black, 100:white), a* (redness/greenness; red – positive values, green – negative values) and b* (yellowness/blueness; yellow- positive values, blue – negative values) using Minolta Matters CR 400 camera. Standardization of the apparatus was done in relation to black and white colour standard references with the following coordinates X=78.5,Y=83.3 and Z=87.8 (for D65 illuminant and 10^0 standard observer) – Majewska *et al.* [2009].

Water holding capacity (WHC). WHC was determined by the blotting method according to Grau and Hamm [1952] as modified by Pohja and Ninivaara [1957]. A muscle sample of approximately 5 g was placed on blotting-paper and then squeezed by glass plates with force around 5 kg during 5 minutes. Sample was then weighted. WHC was expressed as the ratio of the weight of muscle sample before and after squeezing.

Drip loss. A muscle sample of approximately 100 g was placed in a plastic bag and left hanging in a refrigerator at 4°C for 48 h. The amount of drip loss was calculated from the difference in weight before and after storage.

Cooking loss. Muscle samples of approx. 200 g were broiled in conventional oven (pre-heated 175°C) to internal temperature of 75°C. Cooking loss was expressed as a percentage of the initial sample of weight.

Warner-Bratzler shear force (WB). The same muscle samples that were used to determine the cooking loss were used for assessment of WB. The muscle samples were refrigerated (4°C) and stored over-night before WB was determined. A load cell of 2.000 kN was attached to the model ZWICK/ROELL Z0.5 texture machine. Mean maximum shear force values were calculated from the recorded shear force values for seven cylindrical cores (wide 12.7 mm) from each muscle sample (slice of 1.5-2.0 cm in thickness) and used in the statistical analyses.

Sensory analysis

Sensory analysis was carried out by a six-person trained panel according to the guidelines for sensory analyses (Polish Standard PN-ISO 4121, 1998). The muscle samples were cut into steaks and broiled to an internal temperature of 75°C. Then, fat and connective tissue were removed, samples were cut into blocks of 2 cm^3, wrapped in pre-labelled foil and incubated. Panellists assessed 6 samples per session. The samples were evaluated under white light conditions. The panel members were given bitter tea to cleanse the palate. The evaluation of meat was performed using a 5-point scale (1 point – the lowest score, 5 points – the highest score) including the following sensory attributes: aroma, juiciness, tenderness and flavour.

Statistical

The statistical analysis was carried out with the Statistical Analysis System (SAS ver. 9.2). The diet was used as the main factor in the analysis of variance. The significance of differences between means was tested with the Tukey-test.

The research obtained acceptance of the Local Ethics Commission for Experimentation with animals No 27/2009.

Results and discussion

Moisture, protein, fat and ash content of *gastrocnemius pars interna* muscle (GN) are presented in Table 2. No significant differences were found in moisture as well as in protein and ash content between feeding groups. The results of the study are within a range for ostrich meat (moisture 76-78%, protein content 20-22% and ash content 0,3-1,2%) reported by Sales [2002], Hoffman *et al.* [2005] and Majewska *et al.* [2009]. Fat content was higher (2.10 g/100 g, $P<0.001$) in ostrich muscle fed on L8 diet than in other groups (mean 1.23 g/100 g). Hoffman *et al.* [2005] reported that enrichment of ostrich diet with fish oil have no influence on chemical composition of muscles. However, diets used by authors mentioned contained two times protein more than these tested in the present experiment, what could reduce fat deposition in muscles.

Table 2. Proximate composition (g/100g edible meat) and physical quality traits of ostrich meat as related to differentiated level of linseed and rapeseed in the bird's diet (means ± SD)

Item	Group[1]				
	C	R5	R10	L4	L8
Moisture	76.15±0.770	76.59±1.145	76.27±1.121	75.96±0.527	74.75±1.160
Crude protein	21.56±0.736	21.14±1.182	21.35±1.048	21.6±0.606	22.03±1.101
Crude fat	1.18^{A}±0.254	1.15^{A}±0.344	1.27^{A}±0.427	1.33^{A}±0.110	2.10^{B}±0.262
Ash	1.11±0.01	1.12±0.01	1.11±0.01	1.11±0.01	1.11±0.01
pH 45	6.17±0.16	6.23±0.18	6.27±0.14	6.38±0.21	6.30±0.19
pH 24	6.12^{B}±0.19	6.13^{B}±0.17	6.13^{B}±0.23	6.41^{AB}±0.18	6.54^{A}±0.27
pH 72	6.26±0.19	6.22±0.13	6.21±0.17	6.23±0.26	6.38±0.29
L	28.64±2.39	30.47±1.79	30.44±0.83	29.74±2.96	28.83±2.61
A	17.18±2.02	16.21±1.35	16.77±1.38	16.12±0.96	15.82±1.29
B	10.42±1.58	10.61±0.95	11.03±0.90	11.05±0.98	10.75±0.93
WHC (%)	23.03±2.10	21.53±1.74	23.19±1.96	22.42±3.25	22.16±3.64
Drip loss (%)	1.08±0.26	1.31±0.40	1.00±0.38	0.89±0.43	1.19±0.40
Cooking loss (%)	37.43^{ab}±5.26	40.68^{a}±5.05	37.84^{ab}±4.85	34.99^{b}±4.79	38.77^{ab}±3.78
WB (N/cm^2)	33.46±8.82	33.96±5.22	33.82±4.62	33.21±7.28	33.88±11.03

[1]C – control; L4 – diet with 4% of linseed; L8 – diet with 8% of linseed; R5 – diet with 5% of rapeseed; R10 – diet with 10% of rapeseed.
[aA...]Within a rows means bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.001$.

Table 2 presents the muscle physical traits. The differences in feeding did not influence most of the investigated traits. However, the difference in pH 24 hours *post mortem* was found. Muscles from control and rapeseed groups had the lowest pH24 (mean 6.13 for C, R5 and R10 group, $P<0.001$), muscles from L4 group higher (6.41) and from L8 the highest pH24 (6.54). The pH of muscles from linseed-enriched groups (L4 and L8) had higher values than reported by other authors of pH for ostrich muscles (5.8-6.2) – Sales and Mellett [1996]. This was confirmed by correlations. Although a high final pH of ostrich meat may be favourable regarding meat colour and WHC, this beneficial effect may be lost because of the low intramuscular fat content of ostrich meat [Cooper and Horbańczuk 2002] and it could cause a problem in shelf-life, flavour and reddiness [Sales 1996].

Supplementation of diets also influenced the cooking loss. The muscles from L4 group had the lowest cooking loss (35%, $P<0.05$) while those from R5 the highest (40.7%). Despite feeding system the results of this study showed high cooking loss in all studied groups compared to results of other authors, what is caused by high internal temperature achieved during cooking. Sales [1996] confirmed that internal end temperatures affect the cooking loss.

Mean values for sensory traits including aroma, tenderness, juiciness and flavour are shown in Table 3. Mean scores for aroma were similar, did not differ ($P>0.05$) among all analysed groups and ranged from 4,48 to 4,62. Similar results were obtained for juiciness, although a slight tendency for a higher value (4.41) occurred in group L4. In turn, the scores for flavour differed among groups ($P<0.001$) with the highest value of 4.70 for group with 4% of linseed in the diet. Meat from different levels of

Table 3. Sensory properties of ostrich meat scored on a scale from 1 to 5 points as related to differentiated level of linseed and rapeseed in the diet

Item	Group[1]				
	C	R5	R10	L4	L8
Aroma (pts)	4.55±0.16	4.61±0.13	4.62±0.16	4.56±0.13	4.48±0.13
Juiciness (pts)	4.13±0.39	4.00±0.35	4.09±0.27	4.41±0.22	4.00±0.16
Tenderness (pts)	4.41±0.30	4.41±0.27	4.47±0.22	4.56±0.18	4.39±0.25
Flavour (pts)	4.37^{AB}±0.23	4.29^{B}±0.17	4.39^{AB}±0.22	4.70^{A}±0.15	4.45^{AB}±0.24

[1]C – control; L4 – diet with 4% of linseed; L8 – diet with 8% of linseed; R5 – diet with 5% of rapeseed; R10 – diet with 10% of rapeseed.
[AB]Within a rows means bearing different superscripts differ significantly at P<0.001.

linseed and rapeseed did not differ (P >0.005) in tenderness what was confirmed by the means of Warner-Bratzler values where also no differences were recorded among all investigated groups (Tab. 2). No effects on meat juiciness and tenderness were identified in chickens fed supplementary linseed by Lopez-Ferrer *et al.* [2001].

Analysing the sensory properties of ostrich meat it should be stressed that the mean scores reached the satisfactorily high value and juiciness was the only parameter with score around 4 except for group L4. Therefore, this leads us to conclude that introduction of oil seeds into the ostrich diet do not deteriorate the sensory quality of meat what is especially important from the consumer point of view. It should also be emphasised that Cooper and Horbańczuk [2002] concluded that the inclusion of low quality fish meal or vegetable oil in the diet can negatively affect the flavour or aroma of meat what occurred in Poland when ostrich growers were fed deteriorated fish meal mixed to the feed. On the other hand Hoffman *et al.* [2005] evaluating the effect of different levels of unrefined fish oil in the diet of the ostrich stated that the maximum amount of daily fish oil (43.5 g/day) consumed by the ostriches did not alter the flavour and aroma of meat significantly. They also claimed that the increased fishy flavour and aroma trend observed, could cause one to postulate that increased level of fish oil (above 43.5 g/day in the diet) could result in the development of a fishy aroma and flavour.

Summarizing, enrichment of the ostrich diet with rapeseed had no influence on selected physico-chemical parameters of the muscle. Introduction of 4% of linseed to ostrich diet positively affected flavour and led to the decrease in cooking loss, that is important from the consumer point of view. On the other hand, 8% linseed of the diet changed pH24 and increased fat content of meat.

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