FATTY ACID PROFILE OF THREE FAT DEPOTS FROM SLAUGHTER OSTRICHES *(STRUTHIO CAMELUS)*

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Abstract. The aim of this study was to compare the content of fatty acids in ostrich back, breast and abdominal depot fat. Experimental material consisted of 20 Blue Neck ostriches coming from a private farm in Poland. Ostriches were slaughtered at the age of 12 months and abdominal, breast and back fat depot samples (from each bird) were evaluated for fatty acids composition. Fat from the back and the breast regions had a higher content of saturated fatty acids and these differences were statistically significant ($P \leq 0.01$) in relation to abdominal fat. Among saturated fatty acids, palmitic and stearic acids were found in the greatest amount, constituting 40.1 and 5.2% of total fatty acids, respectively. In the group of monounsaturated acids, oleic and palmitooleic acids were predominant, with the average content of 28.8 and 7.9% of total fatty acid content, respectively. The total PUFA content was on average 16.5% of total fatty acids, with linoleic acid being found in the greatest amount.

Keywords: abdominal fat, back fat, breast fat, fatty acids, ostrich

Introduction. In many countries worldwide, a growing interest in the farming of large exotic birds is being observed, of which ostriches (Struthio camelus) and emus (Dromaius novaehollandiae) are of greatest economic importance. The products being acquired from these birds – mainly meat, fat and oil obtained from it have been recently enjoying an ever growing interest of scientists, technologists and consumers (Grompone et al., 2005; Horbańczuk et al., 1998, 2004; Liu et al., 2011; Méndez-Lagunas et al., 2011; Sales, 1996; Sales and Franken, 1996; Palanisamy et al., 2011; Poławska et al., 2012).

Emu and ostrich oil is particularly valued in the market. This oil is extracted from fat which in Ratite is situated in the abdominal, breast and back regions. According to Birkbec (1995), it is possible to obtain from 4 to 15 kg of fat from one emus, depending on age, sex and condition. In turn, about 4-5 kg of fat is being obtained from ostriches after slaughter (Morris et al., 1995), whereas about 2 kg from South American rhea (Grompone et al., 2005). Culled breeding ostriches with the body weight of 130–160 kg can deliver even 25 kg of adipose tissue after slaughter (Horbańczuk et al., 2003). Ostrich oil has been used for centuries by the Egyptian, Roman and African cultures for topical relief of dry skin, burns, lesions, contact dermatitis, eczema, psoriasis, sunburn, muscular pain, bed sores, and for minor cuts and scratches (Palanisamy et al., 2011). In many countries worldwide, cosmetic and pharmaceutical products being prepared based on the oil from Ratities have been patented.

In recent years, studies on the use of ostrich oil in food industry have been also conducted. Ostrich fat depots are used in the meat processing trade as a fat source in processed products or sold locally where they are used in cooking as a source of lard (Hoffman et al., 2012). The stearine fraction obtained from ostrich oil can be used in production of shortenings. Basuny et al. (2011) showed that a cake prepared with addition of ostrich stearine had better sensory properties. On the other hand, the oleine fraction in a mixture with other vegetable fats improved oxidation stability.

An important factor determining the quality of animal products is fatty acid profile. Consumer demands in the market have been continually growing as their awareness rises, while the information on product properties more and more frequently affect their purchase decision. Taking the above into consideration, a research study was carried out which aimed at determining the content of fatty acids in ostrich depot fat taking into account its location in the bird organism.

Materials and methods

Animals and sampling

Experimental material consisted of Blue Neck ostriches coming from a private farm in Poland. Bird feeding was based on granulated complete feed mixtures and bulk feeds. Starter feed mixture (16% total protein, 9.6% fibre, 9.7 MJ/kg) was fed until the 3rd month of life, whereas the Grower one (14.5% total protein, 10.7% fibre, 9.5MJ/kg) from the 4th month on.

Twenty ostriches were slaughtered at the age of 12 months in a commercial cattle and swine abattoir in Poland, with the slaughtering process adapted for ostriches. Abdominal, breast and back fat samples (from each bird) were evaluated for fatty acids composition.

Fat tissue samples were stored in polypropylene containers filled with inert gas (N_2 5.0) at -18°C until the

chemical analyses were performed. Prior to them, the containers with their content were thawed, the top fat layer (approximately 0.5 cm) was removed and fat was drawn from deeper layers, being better protected against potentially possible oxidation of unsaturated fatty acids.

Fatty acid analyses

Extraction

Fat tissue samples, approximately 100 mg each, collected in a few points were placed in screw top amber glass vials (7.5 ml) with a PTFE seal. To each vial, 5 ml chloroform was added, nitrogen was introduced and they were closed under its continuous stream, thereafter being subject to vigorous shaking for 3 hours. To separate the chloroform phase from non-lipid residues, the vials were centrifuged for 20 minutes (at 2000 rpm).

Hydrolysis

The chloroform phase was drawn into an amber glass vial (4 ml) in the amount corresponding to 5 mg extracted lipids, chloroform was evaporated under a stream of nitrogen and next the vial was closed using a screw cap being equipped with a valve enabling introduction of inert gas and reagents with no need to unscrew it and enter the air. The vials were immediately filled with nitrogen, 400 µl 0.5 M KOH solution in methanol was added and incubated in a heating block at 80°C for 20 minutes.

Esterification

After cooling, 500 µl 14% boron trifluoride (BF_3) solution in methanol was introduced into each vial and they were incubated at 80°C for 35 minutes. To extract fatty acid methyl esters (FAME), 1 ml saturated NaCl solution and 2 ml isooctane, as an extractant, were added to each cooled vial, they were vigorously shaken for 1 hour and left for 0.5 hour until the phases were separated. The upper isooctane layer was collected to separate vials containing approximately 0.5 g anhydrous sodium sulphate (VI) (Na_2SO_4) and, after filling the vials with nitrogen, left for 2 hours. Dried FAME extracts were placed in GC autosampler vials.

GC Analysis

Determination of the content of fatty acid methyl esters in adipose tissue lipids was performed by the method of gas chromatography-mass spectrometry (GCMS) with a Perkin Elmer CLARUS GC-MS apparatus, using a Perkin Elmer COL-ELITE-5MS capillary column (60 m x 0.25 mm ID, 0.25 µl film). The standard was a mixture of 37 fatty acid methyl esters manufactured by SUPLECO: F.A.M.E. mix C4-C24.

GC parameters

- Carrier gas: helium (He) 6.0; gas flow: 5 ml/min.; injection volume: 1µl; sample split in injector 50:1; injector temperature: 200°C; column temperature programme: 110°C for 5 minutes, gradient 5°C/min. to 180°C, 180°C for 15 minutes, gradient 5°C/min. to 290°C, 290°C for 5 minutes; transfer line temperature: 290 °C.

MS parameters

- SIR (Selected Ion Recording) analysis according to selected m/z abundances; ionisation energy: 70eV; ion source temperature: 200 °C.

The obtained results were analysed statistically using STATICTICA 7.1 computer software package. The significance of differences between groups was determined with one-factor analysis of variance by means of the Duncan's test.

Results

Table 1 presents the profile of saturated fatty acids in ostrich depot fat taking into account its location in the bird organism. The lowest SFA content was found in abdominal fat (41.28%), whereas the highest one in the back and breast ones: 49.1 and 48.3%, respectively. These differences were statistically significant ($P \leq 0.01$). Among saturated fatty acids, palmitic and stearic acids (C16: 0 and C18: 0) were found in the greatest amount, constituting 40.1 and 5.2% of total fatty acid composition, respectively (Table 1). Other saturated fatty acids constituted less than 1% of total fatty acid composition.

In terms of quantity, monounsaturated fatty acids constituted an essential group among unsaturated fatty acids (37.2%)(Table 2) . The prevailing monounsaturated fatty acids were oleic acid (C18:1n9c) and palmitooleic acid (C16:1n7), with an average content of 28.8 and 7.9% of total composition, respectively. The content of these acids in the back and the breast regions was similar, being however higher in the abdominal one by 4.2 and 0.8%, respectively, and these differences were statistically significant ($P \leq 0.01$). Other monounsaturated fatty acids were found in minute quantities (Table 2).

The total PUFA content constituted on average about 16.5% of total fatty acids, with linoleic acid (C18: 2n6c) being found in the greatest amount (15.6%). The content of that acid in abdominal fat was significantly higher ($P \leq 0.01$) than in subcutaneous fat from the back and the breast regions (Table 2). Long-chain fatty acids, such as arachidonic acid (C20:4n-6), eicosapentaenoic acid (EPA, C20:5n-3) and docosahexaenoic acid (DHA, C22:6n-3), constituted only 0.1% of total fatty acid composition (Table 2).

Discussion and conclusions

The profile of fatty acids being found in the depot fat of ostriches depended on fat tissue location in the bird organism. Fat from the back and the breast regions had a higher content of saturated fatty acids in relation to the abdominal one. Similar trends were observed in the study by Frontczak et al. (2008) who analysed ostrich abdominal and subcutaneous back fat. However, the above-mentioned authors did not give any information on the sex and age of birds, the fat tissue of which had been analysed. It was found in the own study that fat tissue from the back and the breast regions had a similar fatty acid profile, which had been also observed in the earlier study by Horbańczuk et al. (2004) who evaluated subcutaneous fat of 14-month-old slaughter ostrich males.

In the own study, saturated fatty acids constituted on average 46.2% of total fatty acid content. These results were most similar to those being obtained by Liu et al. (2011) (total SFA – 40.9%). In the studies by other authors, i.e. by Horbańczuk et al. (2004), Hoffman et al. (2012) and Shahrayar and Lotfi (2012), ΣSFA was smaller than that being observed in this study by 15.0, 8.0

and 16.9%, respectively. Hoffman et al. (2012), mentioned above, observed that the fatty acid profile of ostrich fat depended on the bird genotype. The breast and abdominal fat of South African Black ostriches contained significantly less SFA than of Zimbabwean Blue Neck ones.

Table 1. **Saturated fatty acid content*** [%] **of ostrich fat depots from the back, abdominal and breast regions** (mean ± SD)

Item	Fat depot			Average value
	Back	Abdominal	Breast	
C8:0	0.00053a±0.0001	0.00049A±0.0001	0.00065Bb±0.0001	0.00055±0.0001
C10:0	0.0021±0.0004	0.0018A±0.0005	0.0025B±0.0007	0.0021±0.0006
C11:0	0.00019±0.00005	0.00017a±0.00006	0.00021b±0.00007	0.000196±0.00006
C12:0	0.029a±0.007	0.024b±0.005	0.031a±0.006	0.028±0.007
C13:0	0.0019±0.0006	0.0018±0.0005	0.002±0.004	0.0019±0.0005
C14:0	0.72a±0.17	0.60b±0.11	0.72a±0.12	0.68±0.14
C15:0	0.12±0.03	0.11±0.03	0.11±0.02	0.11±0.03
C16:0	42.5A±4.0	36.3B±3.8	41.6A±2.2	40.12±4.38
C17:0	0.10A±0.02	0.08B±0.02	0.10A±0.02	0.09±0.02
C18:0	5.60A±0.81	4.20B±0.66	5.72A±0.76	5.17±1.01
C20:0	0.009±0.003	0.007±0.003	0.009±0.003	0.008±0.003
C21:0	0.0006±0.0002	0.0005±0.0001	0.0005±0.0002	0.0005±0.0002
C22:0	0.0008±0.0002	0.0009±0.0003	0.0008±0.0003	0.0008±0.0003
C23:0	0.0007±0.0003	0.0007±0.0003	0.0006±0.0003	0.0007±0.0004
C24:0	0.001±0.0009	0.001±0.0001	0.001±0.0001	0.001±0.0008
SFA	49.12A±4.69	41.28B±4.23	48.26A±2.54	46.22±5.24
* based on the sum of fatty acids; Mean values in rows marked with different letters differ significantly (A, B, C at P≤0.01; a, b, c at P≤0.05)				

Table 2. **Unsaturated fatty acid content*** [%] **of ostrich fat depots from the back, abdominal and breast regions** (mean ± SD)

Item	Fat depot			Average value
	Back	Abdominal	Breast	
C14:1n5	0.03A±0.008	0.04B±0.009	0.04B±0.008	0.04±0.008
C16:1n7	7.74A±1.54	8.66B±1.55	7.87A±0.99	7.95±1.46
C17:1	0.001±0.0001	0.001±0.0004	0.001±0.0003	0.001±0.0003
C18:1n9t	0.24±0.05	0.26±0.09	0.25±0.09	0.25±0.09
C18:1n9c	27.40A±2.8	31.70B±2.80	27.50A±1.90	28.83±3.21
C20:1	0.09±0.02	0.09±0.02	0.08±0.01	0.09±0.02
C22:1n9	0.0007±0.00007	0.0007±0.00006	0.0008±0.00007	0.0007±0.00007
C24:1n9	0.001±0.0005	0.001±0.0006	0.001±0.0008	0.001±0.0006
C18:2n6c	14.00a±2.80	16.90b±2.40	15.10a±2.0	15.66±2.56
C18:3n3	0.61A±0.07	0.81B±0.05	0.61A±0.07	0.68±0.11
C20:2n6	0.09±0.02	0.09±0.02	0.08±0.01	0.09±0.02
C20:3n6	0.023±0.004	0.025±0.001	0.023±0.008	0.024±0.007
C20:3n3	0.01±0.0009	0.01±0.005	0.01±0.004	0.01±0.004
C20:4n6	0.05A±0.01	0.06B±0.02	0.06B±0.01	0.06±0.02
C22:2n6	0.001±0.0008	0.001±0.0006	0.001±0.0007	0.001±0.0007
C20:5n3	0.02±0.008	0.03±0.01	0.03±0.01	0.03±0.01
C22:6n3	0.011A±0.005	0.017±0.007	0.021B±0.01	0.016±0.01
MUFA	35.07A±2.92	40.72B±2.93	35.76A±1.83	37.18±3.61
PUFA	15.80A±2.86	17.98 B ±2.38	15.96A±2.08	16.58±2.62
* based on the sum of fatty acids; Mean values in rows marked with different letters differ significantly (A, B, C at P≤0.01; a, b, c at P≤0.05)				

Monounsaturated fatty acids play a positive role in the prevention of civilisation-related diseases. It is recommended to increase their percentage in diet and replace polyenic fatty acids of the n-6 family, which oxidise easily, with them. The MUFA percentage in total unsaturated fatty acid content amounted on average to

69.1% per 53.7% of unsaturated fatty acids in total fat composition. The content of oleic acid (C18:1n9c) in the fat depots under analysis was similar to that determined by Shahrayar and Lotfi (2012) in the breast fat of 11-month-old ostriches (28.0%). A considerably higher C18:1n9c content (36.4%) was a characteristic of the fat tissue of 5-year-old culled breeding ostriches (Horbańczuk et al., 2003). It should be stressed that high oleic acid content was also found in ostrich intramuscular fat, i.e. 25.1 to 29.3% (Hoffman et al., 2012) and 28.3 to 31.5% (Girolami et al., 2003).

In unsaturated fatty acid composition, an important group is polyunsaturated fatty acids, mainly due to their physiological functions. Polyunsaturated fatty acids, as well as their esters (triglycerides), are a component of many effective care formulas as well as those for treatment of some skin diseases with excessively dry epidermis (Bojarowicz and Woźniak, 2008). In this group of fatty acids, linoleic acid (C18:2n6c) was found in the highest quantity (15.6%) in the fat depots under analysis. It is apparent from reports of other authors that the C18:2n6c content in ostrich fat may range from 7.4% (Liu et al., 2011) to 21.2% (Shahrayar and Lotfi, 2012).

A measure of fat quality is the ratio of unsaturated fatty acids to saturated fatty acids. In human diet, it should reach a value close to 2. The ΣUFA / ΣSFA proportion in the fat depots under analysis amounted on average to 1.17:1, with the most favourable one in abdominal fat, i.e. 1.42:1. Liu et al. (2011), when analysing all subcutaneous, tripe and intestinal fat tissue, obtained similar results – 1.44:1. In the studies by other authors, a reciprocal proportion of unsaturated fatty acids to saturated ones was more favourable than in the present study: 1.78:1 (Basuny et al., 2011) and 2.1:1 (Horbańczuk et al., 2004). These differences result most likely from the fact that the fatty acid profile of fats depends on many factors, among other not only on bird age (Shahrayar and Lotfi, 2012), bird genotype (Hoffman et al., 2012; Okruszek, 2012), bird sex or fat location in the bird organism (Wang et al., 2000) but also on the composition of fatty acids in their feed ration (Bartos et al., 2004, Crespo and Esteve-Garcia, 2001, Kralik et al., 2003). The effect of diet on the composition of fatty acids in emu fat was demonstrated by Backerbauer et al. (2001). Feeding of soybean oil resulted in a greater concentration of linoleic acid and less palmitic acid in the rendered emu oil from the subcutaneous and retroperitoneal adipose tissues. In addition, soybean oil feeding increased the linolenic acid content of the retroperitoneal adipose tissue. Other fatty acids were not affected by the source of dietary fat.

Summing up the foregoing considerations, it may be concluded that abdominal fat seems to be most recommended to be used in food and cosmetic industries because of higher content of unsaturated fatty acids in it. Due to a growing interest in this raw material, research works referring to its quality should be continued.

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