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ORIGINAL PAPER

FATTY ACID COMPOSITION OF TURKEY BREAST MUSCLE AND THE SALUTOGENIC FEEDING REGIMEN FORMULATIONS (A PILOT STUDY)*

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Abstract

The objective of this study was to conduct a preliminary assessment of the impact of adding salutogenic formulations to turkey feeding diets on the fatty acid profile of intramuscular fat from breast and on their lipid profile indicators. The experiment was carried out on 60 BIG-6 breed turkeys. Turkey toms were fattened up to 20 weeks of age (140 days). From the rearing day of 42, the turkeys in the control group (BIOPOINT) were given Biopoint® supplements in drinking water (copper, selenium, flavonoid, lysine, vitamins C and E, garlic extract), while the experimental group was given Multicraft® fermented herbs extract (FHE) containing *Saccharomyces cerevisiae, L. casei*, *L. plantarum*. Twelve hours post mortem, *m. pectoralis superficialis* was excised and used for sampling (n=30 for each group), then stored for 18 months at the temp. of -20°C. 12 samples from or each group were taken for analysis in this pilot study. Once the samples were defrosted, the lipid profile was evaluated with the use of gas chromatography. The total antioxidant capacity of meat was determined by using the FRAP method. Based on FA contents, the following indexes were calculated: atherogenicity (AGI), thrombogenicity (TI), polyene peroxidisability (PI), nutri value (NVI) and h/H ratio. Regarding consumers' health, the lipids from FHE group of turkeys were characterized by a more expedient lipid acids profile and the following indicators: P/S (1.32), TI (0.63), h/H (1.41), PI (42.1), polygene index (0.06), compared with those from BIOPOINT group turkeys (vs. 1.17; 0.67; 1.26; 0.0; 38.3). Supplementation with FHE had a positive impact on the total antioxidant status of the turkey muscles. It may be concluded that owing to its positive influence on the metabolism of lipids and lipoproteins, the breast meat sourced from turkeys fattened with FHE supplementation with a confirmed salutogenic lipid profile may be beneficial for the health of consumers in the context of prevention of cardiovascular diseases.

Keywords: domestic turkeys, dietary supplementation, breast muscle oxidative stability, fatty acid profile.

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INTRODUCTION

As antibiotic growth promoters in livestock diets were banned in the European Union in 2006, in the search for alternatives many studies have been carried out in order to use feed formulations that include natural bioactive compounds, in an attempt to improve livestock's immunity (Van Der Ara et al. 2017). Widely used supplements for poultry feed are those with antimicrobial and antioxidant effects, pH controlling agents, enzymes, feed acidifiers, probiotics, prebiotics, phytobiotics, symbiotics and other specific active ingredients (Herkel et al. 2016). It has been indicated (Kwiecień et al. 2006, Van der Ara et al. 2017) that supplementing poultry feeds with antioxidant compounds (vitamins C and E, as well as selenium), probiotics, and herbal products with comprehensive biological and/or prebiotic propensities generally stimulates an increased immunity to pathogenic microorganisms of poultry. The prohibition of antibiotic growth promoters in the countries of the European Union (*Regulation Ec No* 1831/2003) created the need to constantly search for innovative solutions in poultry feeding, in order to decrease the incidence and severity of various diseases. This approach is also aligned with the expectations of consumers, who demand meat originating from rearing that is based on natural feed components (Wallace et al. 2010).

Contemporary consumers also pay attention to the overall nutritional value of meat and its products, including the fat content and fatty acid profile, as these components of human nutrition may also be crucial in the prevention of cardiovascular diseases and cancers (FAO/WHO 2008). Turkey meat is recommended to various groups of consumers as part of the widely understood health prophylaxis, as it is a very good source of nutritious proteins, B group vitamins (B_1, B_6, B_3, B_5) and minerals (K, Fe, Zn, Cu), and is characterized by a small content of saturated fatty acids and cholesterol (taking into account its low content in raw and skinless breast muscles: 49-57 mg 100 g^{-1}) (EFSA 2012, Kunachowicz et al. 2017, USDA 2018).

Dietary fat saturation plays a considerable role in modulating plasma cholesterol concentrations and determining the risk for human coronary heart disease (CHD). Because of that, the objective of this study was to conduct a preliminary assessment of the impact of adding salutogenic formulations to turkey feeding diets on fatty acid profile of intramuscular fat from breast and on their lipid profile indicators (AGI, TI, PI, NVI, h/H).

MATERIAL AND METHODS

Study material

The information concerning turkey feeding was previously provided in the publication by Rybarczyk and Morch (2018). To summarise: sixty BIG-6

turkey toms were fattened in the conditions of industrial rearing, in two separate turkey barns, in a free range system. During the entire period of fattening, the birds were fed *ad libitum* complete diets of identical composition. Subsequently, from 42th day of rearing until its end (140th day), the male turkeys in the control group (BIOPOINT) were given Biopoint® mineral and vitamin supplements to drink, in a standard portion (twice in 16 h); these were, respectively: Cardiox (chelate of copper, flanovoids, lysine: 0.5 l); Eselen (vitamin E and selenium: 0.3 l); Turboalistar (liquid extract of garlic: 0.5 l) and vitamin C (0.3 g). Male turkeys from the experimental group were given in their drinking water Multicraft® (Austria) Fermented Herbs Extract (FHE), which consists of caraway, yarrow, anise, fennel, birch leaf, goldenrod, rosemary, peppermint, marshmallow root, and raspberry leaf. The product also includes the 'Effective Microorganisms' complex, namely: *Saccharomyces cerevisiae* IFO 0203 (10^3 CFU ml^{-1}), *Lactobacillus casei* ATCC 7469 (10^5 CFU ml^{-1}) and *L. plantarum* ATCC 8014 (10^5 CFU ml^{-1}). Both groups of male turkeys were not given any antibiotic growth promoters nor were the birds treated with antibiotics. After the birds reached liveweight of approximately 20 kg, slaughter and post-slaughter processing of the birds were conducted according to the regulations which apply in the poultry industry.

Chemical analyses

Twelve hours post mortem, m. *pectoralis superficialis* was dissected from the chilled carcasses, out of which samples (n=30 per group), weighing c. 10 g, were excised and stored for 18 months in a refrigerator at the temp. of -20°C (± 1°C). After defrosting (24 h at +4°C), the samples (n=12 randomly chosen samples for each group of birds) were ground and the amount of fat in the dissected muscles was determined with the Soxhlet's method, according to AOAC (2016), on a Soxtec HT6 apparatus by Foss Tecator. Subsequently, extraction of lipids was conducted, using the Folch's method (FOLCH et al. 1957), after which the lipids which were transformed into derivatives of fatty acids methyl esters (FAME), according to AOCS Ce 2-66 (AOCS 1997). The fatty acid profiles were measured (in 3 repetitions for each sample) with the use of a gas chromatographer (Agilent Tech®. 7890 A, Agil. Tech. Inc., St. Clara), equipped with a flame ionization detector (FID) and a J&W HP-88 column (100 m×0,250 mm ID; 0,20 μm). The fatty acid files were identified by comparing their retention time with the retention times of the external standards of methyl esters (Supelco 37 F.A.M.E. Mix C 4 – C 24 Component).

Meat extract preparation for analysis of the antioxidant power of ferric reducing ability of parameter (FRAP)

All extracts were prepared by spreading about 3.0 g of ground meat on 15 cm^3 of phosphate buffer (pH 6.8). The extracts were sonicated for 15 min (Sonic 6D, Polsonic, Poland), left for 24 h at 4°C without light, and then son-

icated again for 15 min. The samples were centrifuged (MPW-380R; MPW Med. Instruments, Poland) for 10 min at 4°C and 10.000 *rpm,* and analyzed directly after preparation. The total antioxidant power of meat was determined using the ferric reducing ability of parameter (FRAP) assay by Benzie and Strain (1996). The FRAP reagent was prepared by mixing acetate buffer (300 μM, pH 3.6), a solution of 10 μM TPTZ in 40 mM HCl, and 20 μM $FeCl_3$ at 10:1:1 (v/v/v). The FRAP reagent (3.0 cm^3) and a sample (1.0 cm^3) were added to each well and mixed thoroughly. The absorbance was taken at 593 nm after 10 min. The standard curve was prepared using different concentrations of Trolox. All solutions were used on the day of preparation. All determinations were performed in triplicates using a UV/Vis Specord 210 spectrophotometer (Analytik Jena, Jena, Germany). The results were expressed in mM TE 100 g^{-1} of fresh mass.

Experimental calculation and statistical analysis

Based on the marked content of fatty acids, the indicators of the lipid profile of the muscle fat in the examined muscles were determined. The DFA indicator (Desirable Fatty Acids) was calculated according to Díaz et al. (2002). Atherogenic index (AGI) indicated a link between the sum of proatherogenic saturated fatty acids and antiatherogenic unsaturated acids. Thrombogenicity index (TI) was defined as the relationship between the pro-thrombogenic (saturated) and the anti-thrombogenic fatty acids. The AGI, TI and nutritive value indexes (NVI) were calculated according to Ulbricht and Southgate (1991) and Sari et al. (2015). The polyene index was used as a measure of PUFA (polyunsaturated fatty acids) damage and it was calculated according to Lubis and Buckle (1990). The peroxidisability index (PI) was calculated according to the equation proposed by Erickson (1992). The hypocholesterolemic fatty acids/hypercholesterolemic fatty acids ratio (h/H ratio) was calculated according to Santos-Silva et al. (2002).

The findings were logarithmized, and subsequently one-way analysis of variance (ANOVA) was used in the orthogonal system. Statistical significance of differences between the means of the groups was calculated using the Tukey's multiple comparisons test, at the level of significance $P \leq 0.05$ and $P \leq 0.01$, with the use of Statistica® 13.1 software (Statsoft, Tulsa, OK, USA).

RESULTS AND DISCUSSION

The content of fat in the breast muscle of male turkeys and its fatty acid composition depend on the bird's genetic traits and environmental factors, among which nutrition plays the most important role. In our study, we did not find any significant impact of feeding supplements used in fattening male turkeys on the fat content in their breast muscles (Table 1). However,

Table 1

Content of fatty acids (% of total fatty acid) in intramuscular fat from BIG-6 turkey breast muscles ($\bar{x}$ ± SD, n = 24)

Fatty acids	BIOPOINT (n=12)	FHE (n=12)	P value
Total lipids	0.65 ± 0.2	0.62 ± 0.1	0.850
SFA			
Butyric (C 4:0)	6.48 ± 1.68	7.56 ± 1.95	0.490
Caproic (C 6:0)	0.97 ± 0.53	0.75 ± 0.39	0.509
Caprylic (C 8:0)	0.53 ± 0.02	0.06 ± 0.12	0.226
Capric (C 10:0)	0.05^{b} ± 0.06	0.17^{a} ± 0.04	0.015
Undecanoic (C 11:0)	0.12 ± 0.02	0.11 ± 0.01	0.406
Lauric (C 12:0)	0.18 ± 0.02	0.17 ± 0.01	0.355
Myristic (C 14:0)	0.65^{b} ± 0.03	0.70^{a} ± 0.02	0.036
Palmitic (C 16:0)	20.8 ± 0.7	20.3 ± 0.5	0.263
Stearic (C 18:0)	9.93 ± 0.52	9.51 ± 0.51	0.289
MUFA			
Palmitoleic (C 16:1 *n-7*)	2.01 ± 0.05	1.63 ± 0.2	0.238
Elaidic (C 18:1 *n-9 trans*)	1.75^{a} ± 0.06	1.65^{b} ± 0.06	0.017
Oleic (C 18:1 *n-9 cis*)	22.4 ± 1.32	21.3 ± 0.35	0.159
Nervonic (C 24:1 *n-9*)	1.32 ± 0.16	1.22 ± 0.07	0.283
PUFA			
α-Linolenic (C 18:3 *n-3*)	1.54 ± 1.04	2.52 ± 0.38	0.106
Eicosatrienoic (C 20:3 *n-3*)	5.41 ± 0.78	4.83 ± 0.24	0.195
Eikozapentaenoic (C 20:5 *n-3*)	0	0.06 ± 0.11	0.356
Dokozahexaenoic (C 22:6 *n-3*)	0	0.12 ± 0.24	0.356
EPA (C20:5 *n-3*)+DHA (C 22:6 *n-3*)	0	0.178 ± 0.23	0.162
Total *n-3*	6.95 ± 0.4	7.52 ± 0.4	0.099
Linoleic (C 18:2 *n-6*)	23.8^{b} ± 0.90	25.3^{a} ± 0.63	0.035
Eikozadienic (C 20:2 *n-6*)	0	0.16 ± 0.33	0.356
Total *n-6*	23.8^{b} ± 0.9	25.5^{a} ± 0.9	0.043

^{ab} – means within rows bearing different superscripts differ significantly at: small letters – $P \leq 0.05$; BIOPOINT (control group); FHE – Fermented Herbs Extract (experimental group)

Herkel et al. (2010), in their study conducted on 18-week-old XL hybrid turkeys fed with a feed that was enriched with a blend of essential oils from oregano, anise and citrus fruits as well as fructooligosaccharides rich in prebiotics, found a significantly lower fat content in breast muscles (1.65%) than in the control group (3.62%).

When analyzing the composition of fatty acids in the breast muscle of male

turkey (Table 1), we established that the lipids of male turkeys fattened with feeds including FHE supplements contained significantly ($P \leq 0.05$) larger amounts of capric acid (C 10:0) and myristic acid (C 14:0) than from turkeys fattened with the feed supplemented with BIOPOINT. The higher content of capric acid may be beneficial for consumers, as according to the Nurse's Health Study (NHS), no significant increase in coronary heart disease (CHD) risk was associated with consumption of short to medium chain SFA (4:0 to 10:0) in a mixed diet (Hu et al. 1999). However, the increase of myristic acid content (C14:0) in the breast muscles observed in this study may also be disadvantageous for consumers' health due to an increase of total cholesterol (TC) synthesis in the liver, therefore increasing its concentration and atherogenic low-density lipoprotein LDL-C in blood by affecting LDL receptor activity (Fernandez, West 2005, Mensink et al. 2016).

It is generally acknowledged that in preventing human cardiovascular diseases (CVD), it is helpful to consume diets including Monounsaturated Fatty Acids (MUFA), which have a beneficial effect on blood lipid profile (Kien et al. 2014). In our study, we found that the breast muscles in the BIOPOINT group of the turkeys (Table 1) had the oleic acid content (C18:1 *n-9 cis*) that was significantly higher ($P \leq 0.05$) than in the FHE group, which results from the conversion of stearic acid (C18:0), including complex Δ_9-desaturase, which is present in the above group in larger amounts (Lee et al. 2016). Conversely, Marcinčáková et al. (2011) stated that the content of oleic acid (37.03%) is significantly lower ($P \leq 0.05$) in the breast muscles of broiler chicken given feed supplemented with lemon balm than in the control group (40.25%). In our study, and in contrast to the aforementioned authors, no significant impact of the applied FHE in male turkey fattening was established when the Σ MUFA content of their breast muscles is considered.

Mensink (2016) determined that an increase in the consumption of Saturated Fatty Acids (SFA) by humans is correlated with cardiovascular disease (CVD) risks, while high consumption of MUFA and PUFA *n-3* is beneficial to one's health. In our study, no significant differences in the SFA and MUFA content between the two groups of male turkeys were found (Table 1).

PUFA from *n-6* and *n-3* groups compete for desaturating enzymes that participate in the synthesis of their metabolites, whereby Δ_4 and Δ_6 desaturases more often utilize PUFA *n-3* than PUFA *n-6* acids. We established that using FHE in the fattening of male turkeys (Table 1) did not significantly change the profile of fatty acids from the *n-3* family of fatty acids, but it did increase the synthesis of the *n-6* family of fatty acids. The FHE diet supplementation significantly ($P \leq 0.05$) increased the content of linoleic acid (LA, C 18:2 *n-6*) and Σ PUFA *n-6* in the lipids of the fat of examined muscles. A higher LA intake reduces LDL-C (low-density lipoprotein-cholesterol), promotes insulin sensitivity and reduces risk of hypertension. However, it also has inflammatory and thrombogenic propensities due to the elongation to arachidonic acid (C 20:4 *n-6*), which is a precursor of pro-inflammatory eicosanoids, leukotrienes and lipoxins (Johnson et al. 2012).

Our study also showed that there was a significantly ($P \leq 0.05$) larger content of Σ PUFA in the muscles of turkeys fattened with FHE (33.0%) than in those fed BIOPOINT (30.8%) – Table 1. The results of Marcinčáková et al. (2011) confirmed a similar, significant ($P \leq 0.05$) impact of lemon balm fed to broiler chicken on the content of Σ PUFA in their breast muscles (23.80%) in comparison with the control group (21.37%). However, the increased content of PUFAs is not advantageous, as they are highly susceptible to oxidation because of their multiple double bonds.

The results of our study showed that the turkey breast muscle lipids from birds fed with FHE were characterized by a high level of Σ PUFA/Σ SFA, and that this value is beneficial (salutogenic). Based on the proposed healthy diet recommendations for patients suffering from ischaemic heart disease (IHD), it is recommended that Σ PUFA/Σ SFA of human diets should be higher than 0.45 to prevent IHD (WHO 2003, Hoenselaar 2012).

There are also scientific reports on the effect of various PUFA:SFA (P:S) ratios of dietary fatty acids on lipid metabolism, which is associated with the serum HDL-C concentration. The recommended value of PUFA:SFA was > 0.45 (HMSO 1994). From the results of our study, the breast muscles of male turkeys fed FHE, rather than those fed BIOPOINT, were characterized by a significantly higher ($P \leq 0.01$) ratio of PUFA:SFA, thus being more beneficial from the point of view of recommended human diets.

The value of proatherogenicity of the diet indicator (AGI) in our study was not significantly different between the muscle lipids of the groups of male turkeys. However, it has been established that the muscle lipids of the turkeys fed FHI were characterized by significantly ($P \leq 0.05$) lower and more beneficial value of thrombogenicity (TI) and hypocholesterolemicity (h/H) indicators than from turkeys fed BIOPOINT.

The refrigerated meat of turkeys is prone to oxidation due to its high content of PUFA and a high concentration of free iron (Mielnik et al. 2006, Marcinčák et al. 2008). Phytogenic feed additives, such as essential oils, have antioxidating propensities, retarding oxidation of lipids in meat during refrigerated cool storage (Šperňáková et al. 2007, Marcinčáková et al. 2011, Velasco, Williams 2011, Herkel et al. 2016).

Because of this oxidation propensity, a polygene index is often used to assess the stability of PUFA. Our results showed a high value of Σ PUFA (33.0) in the breast muscle of male turkeys fed FHE supplementation diets (Table 1). This is indicative of a potentially beneficial effects of such diets; i.e. a higher value of this indicator (0.06) vs. the control group (0.0) – Table 2.

The peroxidisability index (PI) is commonly used as an indicator of PUFA peroxidation (Erickson 1992, Kang et al. 2005). In our study, the PI value was significantly ($P \leq 0.05$) higher in the lipids of breast muscles of male turkeys fed FHE supplementation than those fed BIOPOINT. This points to higher oxidant stability of the meat of turkeys fed FHE than those fed BIOPOINT, even 18 months after refrigeration.

Table 2

Fatty acid profile (%), lipid profile indicators and FRAP of the intramuscular fat from BIG-6 turkey breast muscles ($\bar{x}$ ± SD, n=24)

Specification	BIOPOINT (*n*=12)	FHE (*n*=12)	*P value*
Σ SFA	39.3 ± 2.2	39.3 ± 1.1	0.968
Σ UFA	58.3 ± 2.2	58.8 ± 1.3	0.663
Σ MUFA	27.5 ± 1.7	25.8 ± 0.5	0.105
Σ PUFA	30.8^{b} ± 1.1	33.0^{a} ± 1.3	0.039
Σ DFA (Σ UFA + C 18:0)	68.2 ± 1.8	68.3 ± 1.6	0.941
Σ OFA (Σ SFA – C 18:0)	29.3 ± 2.0	29.8 ± 1.5	0.733
Σ DFA/Σ OFA	0.56 ± 0.04	0.57 ± 0.02	0.518
Σ UFA/Σ SFA	1.50 ± 0.1	1.5 ± 0.1	0.896
Σ PUFA/Σ SFA	0.79 ± 0.08	0.84 ± 0.06	0.282
P/S ratio	1.17^{B} ± 0.5	1.32^{A} ± 0.02	0.002
PUFA Σ *n-6*/Σ *n-3* ratio	3.43 ± 0.2	3.39 ± 0.1	0.464
AGI	0.57 ± 0.2	0.55 ± 0.01	0.168
TI	0.67^{a} ± 0.03	0.63^{b} ± 0.01	0.029
h/H ratio	1.26^{b} ± 0.05	1.41^{a} ± 0.02	0.002
Polyene index	0	0.06 ± 0.11	0.295
PI index	38.4^{b} ± 1.4	42.1^{a} ± 2.7	0.047
NVI	1.64^{A} ± 0.01	1.60^{B} ± 0.02	0.009
FRAP (mM kg^{-1})	0.770^{b} ± 0.004	0.774^{a} ± 0.004	0.039

^{aAbB} – means within rows bearing different superscripts differ significantly at: small letters – $P \leq 0.05$; capitals – $P \leq 0.01$

DFA – Hypocholesterolemic acids was calculated as: (Σ UFA+C 18:0 *n-6*);

OFA – Hypercholesterolemic acids was calculated as: (Σ SFA – C 18:0);

P/S – Poliunsaturated/saturated fatty acids ratio was calculated as:

[(C 18:2 *n-6* + C 18:3 *n-3*)/(C 12:0+C 14:0+C 16:0)];

AGI – Index of Atherogenicity was calculated as:

[(4×C14:0)+C16:0+C18:0]/ [Σ MUFA+Σ PUFA *n-6*+Σ PUFA *n-3*]

TI – Index of Thrombogenocity was calculated as:

(C 14:0+C 16:0+C 18:0)/ (0.5×MUFA)+(0.5×PUFA *n-6*)+(3×PUFA *n-3*)+(PUFA *n-3*/ PUFA *n-6*);

h/H – hypocholesterolaemic fatty acids/hypercholesterolaemic fatty acids ratio was calculated as:

[(Σ of C 18:1 *n-9*, C 18:2 *n-6*, C 18:3 *n-6*, C 18:3 *n-3*, C 20:3 *n-6*, C 20:4 *n-6*, C 20:5 *n-3*, C 22:4 *n-6*, C 22:5 *n-3*, C 22:6 *n-3*)/(Σ C14:0+C16:0)];

Polyene index was calculated as:[(C 20:5 *n-3*+C 22:6 *n-6*)/C 16:0]

PI – Peroxidisability index was calculated as:

(% monoenoic acid×0.025)+(% dienoic acid×1)+% trienoic acid×2)+(% tetraenoic acid×4) +(% pentaenoic acid×6)+(% hexaenoic acid×8);

NVI – Nutritive value index was calculated as: [(C 18:0+C 18:1 *n-9*)/ C 16:0].

When analyzing the nutritional value of the muscle lipids of examined breast muscles of male turkeys in both groups, our results showed that a significantly ($P \leq 0.01$) higher value of NVI was characteristic for the turkeys fed BIOPOINT supplementation than those fed FHE (Table 2). This results from a higher content of elaidic fatty acids (C 18:1 *n-9 trans*) in the muscles of turkeys fed BIOPOINT; being a natural food product, elaidic acid is probably not contributing to heart disease (Stillwell 2016).

When considering the total antioxidant potential (Table 2), we showed that the content of FRAP in the breast muscle of turkeys fed FHE was significantly ($P \leq 0.05$) higher than those fed BIOPOINT. This is an interesting finding as the group fed FHE was also characterized by a higher PUFA content in the muscle lipids. Our research shows how strong the total antioxidating effect of phytogenic substances, included in FHE, must be; stronger than the effect of C and E vitamins, selenium and garlic extract, included in Biopoint® formulation. Similarly, the study conducted by Papageorgiou et al. (2003) showed the impact of oregano extracts on the prevention of lipid oxidation of breast and thigh muscles of turkeys.

Summarizing, in spite of a significantly higher value of NVI (1.64) in the breast muscle of the control turkeys, it can be concluded that more beneficial values of the following indicators: P/S (1.32), TI (0.63), h/H (1.41), PI (42.1), and polygene index (0.06) were found in the breast muscle of turkeys from the experimental group, in comparison with the control group. Moreover, feeding turkeys with FHE led to a better antioxidating status of turkey muscles kept frozen for 18 months, which provides shelf-life and supply chain distribution benefits for both the turkey producers and the consumers.

CONCLUSIONS

1. Using dietary FHE in turkey fattening significantly impacted the fatty acid profile of the birds' breast muscles.

2. Turkeys fed diets containing FHE vs. the controls had a significantly higher value of the following indicators: P/S, TI, h/H, polygene index, and PI of fatty acids, and significantly higher total antioxidant potential; thus, potentially offering salutogenic propensities for a balanced human nutrition.

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