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Original scientific paper

CHEMICAL AND FATTY ACID COMPOSITION OF POULTRY MEAT AND PORK FATBACK AS A RAW MATERIAL FOR THE PRODUCTION OF FRANKFURTERS

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A b s t r a c t: The aim of the present research was to investigate the chemical composition and fatty acid profile of poultry meat and pork fatback, which were used as a raw material for the production of frankfurters. Skinless, boneless chicken meat (breast and drumstick) cleaned from adipose and connective tissue was used in the examinations, as well as pork fatback, which are the most common raw material for production of sausages. pH value, chemical composition (water, protein, fat and ash), cholesterol and fatty acid content were determined in chicken meat and pork fatback. Drumstick showed higher pH (6.48) than breast (5.92) and pork fatback (5.99) and contained more cholesterol (70.08 mg/100 g vs. 65.64 and 65.33 mg/100 g). Breast contained more protein (23.90%) than drumstick (19.86%) and less fat (1.88% vs. 7.24%). Pork fatback contained 13.79% water, 3.45% protein, 82.65% fat. The most common fatty acids in chicken meat were linoleic, oleic and palmitic. Drumstick contained more linoleic (30.40%) and oleic acid (28.38%) than breast (26.52% and 23.88%) and less palmitic acid (21.49% vs. 25.20%). Breast were richer in arachidonic, docosahexaenoic and docosapentaenoic acid. Drumstick contained more monounsaturated (MUFA) and polyunsaturated (PUFA) and less saturated (SFA) fatty acids. The ratio PUFA/SFA was higher in drumstick and n-6/n-3 ratio was very close to that of breast. The most common fatty acids in pork fatback were oleic (34.19%), palmitic (26.55%), stearic (14.84%) and linoleic (13.34%).

Key words: chicken meat; pork fatback; fatty acid

ХЕМИСКИ И МАСНОКИСЕЛИНСКИ СОСТАВ НА ПИЛЕШКОТО МЕСО И СВИНСКАТА ГРБНА СЛАНИНА КАКО СУРОВИНИ ЗА ПРОИЗВОДСТВО НА ВИРШЛИ

А п с т р а к т: Целта на ова истражување беше да се испита основниот хемиски состав и профилот на масните киселини во пилешкото месо и во свинската грбна сланина, кои се користат како суровини за производство на виршли. Во испитувањата е користено пилешко месо (гради и копани) без кожа, откоскено и исчистено од масно и сврзно ткиво, како и грбна свинска сланина, кои се најчеста суровина за изработка на колбаси. Во пилешкото месо и во сланината беа утврдувани: pH-вредност, основниот хемиски состав (вода, протеини, масти и пепел) и содржината на холестерол и на одделни масни киселини. Копаните покажаа повисок pH (6,48) од градите (5,92) и сланината (5,99) и содржеа повеќе холестерол (70,08 mg/100 g наспроти 65,64 и 65,33 mg/100 g). Градите содржеа повеќе протеини (23,90%) од копаните (19,86%), а помалку масти (1,88% наспроти 7,24%). Сланината содржеше 13,79% вода, 3,45% протеини, 82,65% масти. Најзастапени масни киселини во пилешкото месо беа линолната, олеинската и палматинската. Копанот содржеше повеќе линолна (30,40%) и олеинска киселина (28,38%) отколку градите (26,52% и 23,88%), а помалку палматинска (21,49% наспроти 25,20%). Градите беа побогати со арахидонска, докозахексаенска и докозапентаенска киселина. Копанот содржеше повеќе мононезаситени и полинезаситени, а помалку заситени масни киселини. Односот полинезаситени/заситени масни киселини беше поголем во копанот, а n-6/n-3 беше многу близок со тој кај градите. Во свинската грбна сланина најзастапени масни киселини беа олеинската (34,19%), палмитинската (26,55%), стеаринската (14,84%) и линолната (13,34%).

Клучни зборови: пилешко месо; свинска грбна сланина; масни киселини

INTRODUCTION

World chicken meat production amounted to 109 million tons in 2017. The leading world producer of chicken meat is United States of America (19,140,744.00 tons per year), the main producer in Europe is the Russian Federation (4,444,334.00 t), the largest producer of the Balkan countries is Romania (391,958.00 t). In Macedonia, chicken production has drastically decreased in recent years. Thus, in 1998 were produced 5,509.00 t, in 2010 3,236.00 t and in 2017 1,716.00 tons (Faostat, 2019).

Poultry meat has many desirable nutritional characteristics, such as high protein content, low lipid content and relatively high concentrations of essential fatty acids (Gallardo et al., 2012; Nkukwana et al., 2014). According to Morales-Barrera et al. (2013), fat in chicken breast meat contains 33.5% saturated, 30.5% unsaturated and 32% polyunsaturated fatty acids, which encouraging human consumption when these are compared with the low levels of polyunsaturated fatty acids (PUFA) and high levels of saturated (SFA) in red meats.

There has been interest in the role of poultry meat as a dietary source of long chain n-3 polyunsaturated fatty acids, mainly alpha-linolenic acid, eicosapentaenoic acid and docosahexaenoic acid (Dalziel et al., 2015).

The quality and quantity of lipids and their fatty acid composition in meat are influenced by endogenous (age, gender, genotype and castration) and exogenous (temperature, feeding) factors (Mašek et al., 2013). The lipid composition of meat is mostly affected by the nutrition of the birds, but other factors such as age and breed line also contribute to the changes in the fatty acid profile (Popova et al., 2016). Tougan et al. (2018) found that fatty acid composition in chicken meat is influenced by genotype, breeding system and type of muscle. Breast meat fatness, fatty acid composition and indices were largely related to genotype (Dal Bosco et al., 2012). The fatty acid profile of the different tissues reflected dietary fatty acid profile (Starčević et al., 2014).

In modern, intensive production systems, broilers reach market weight within 42 days and have high yields of breast meat for a variety of reasons including genetic selection, diets that target nutritional requirements, and proper management and animal husbandry. However, the rapid growth of fast-growing birds leads to concerns about welfare, especially metabolic and leg disorders (Owens et al., 2006). In several experiments carried out to compare fast-, medium- and slow-growing broiler chicken genotypes reared under organic conditions, important differences both in productivity and meat quality attributes were observed (Fanatico et al., 2005; Berri et al., 2005; Quentin et al., 2003; Castellini et al., 2002). Different sources of fat in food affect the fatty acids in the meat (Bostami et al., 2017). Poultry meat, however, has a very variable fat content depending on which part of the bird's body is meat and whether the skin is included (Givens et al., 2011). The review of Minihane et al. (2008) concluded that here were few truly comparative data on the fat and fatty acid content of retail chicken meat from organic versus conventional production systems. Canola oil increased the content of omega-9 and omega-3 fatty acids and decreased the content of omega-6 fatty acids in meat, fat and plasma in broiler chickens (Gallardo et al., 2012).

There are little data on the chemical composition and fatty acid profile in pork fatback. Feeding pigs with foods that contain microalgae or rapeseed products can increase the fatty acid composition in pig adipose tissue, especially DHA and omega-3, and, in particular, reduce the ratio between omega-6 and omega-3 fatty acids (Gjerlaug-Enger et al., 2015; Moran et al., 2018).

The purpose of this study was to examine chemical composition and fatty acid profile in chicken breast and drumstick, as well as pork fatback, used as a raw material for production of frankfurters.

MATERIAL AND METHODS

Chicken meat (skinless, boneless drumstick and breast), cleaned from fat and connective tissue was used in this tests, as well as pork fatback, which were used as a raw material for making chicken sausages. The material was taken before being used for production of frankfurters and it was obtained from a local market. In meat and pork fatback, the following parameters were determined: pH, basic chemical composition (water, protein, fat and ash), cholesterol and certain fatty acids content.

pH value was measured by pH meter Testo 230. Chemical composition was determined using AOAC (1997). The water content according to official method 950.46; protein according to 928.08; fat according to 991.36 and ash according to 920.153.

Fatty acids in the meat and pork fatback were detected based on their methyl ester content according to the method described by Park and Goins (1994). Separation of fatty acid methyl esters was performed on a gas chromatograph (Agilent Technologies 6890) with a flame-ionization detector and capillary column type HP-88 (100 m × 0.25 mm × 0.20 μm).

The cholesterol content of the meat and pork fatback was determined by the modified method according to Ubhayasekera et al. (2004). After saponification of cholesterol with the basic reagent, cleaning of the sample was carried out by the SPE procedure using Strata Si-1 columns (Phenomemex 8B-5 ∅12-HBJ). The cholesterol content was determined by high pressure liquid chromatography. The Atherogenic index was calculated by Ulbricht and Southgate (1991).

RESULTS AND DISCUSSION

The results obtained for pH, basic chemical composition and cholesterol content in skinless chicken drumstick and breast as well as in pork fatback are shown in Table 1.

Table 1

pH, basic chemical composition and cholesterol content of chicken meat and pork fatback

Parameters	Drumstick	Breast	Pork fatback
pH	6.48	5.92	5.99
Water (%)	73.12	74.43	13.79
Protein (%)	19.86	23.90	3.45
Fat (%)	7.24	1.88	82.65
Ash (%)	1.10	1.38	–
Cholesterol (mg/100 g)	70.08	65.64	65.33

It can be noted that drumstick had a higher pH than breast and pork fatback. The drumstick contained less protein and ash and more fat and cholesterol compared to the breast. Depending on the method of rearing the chicks and the carcass mass, Milićević et al. (2014) found that pH at 24 hours *post mortem* varied from 5.40 to 5.90 in breast and from 5.71 to 6.45 in drumstick. Slightly higher values were measured by Laudadio and Tufarelli (2011) in breast muscle (6.02–6.09) and drumstick muscle (5.89–6.03). Zaki et al. (2018), depending on the chicks diet, in the thigh muscles measured pH from 5.96 to 6.19.

Milićević et al. (2014) reported that breast contained more water (70.74–74.29%) than drumstick (69.50–72.29%), more protein (21.18–22.29% vs. 17.92–18.68%) and ash (0.99–1.29% vs. 0.91–1.02%), and less fat (2.61–5.53% vs. 5.19–9.85%). Meluzzi et al. (2009) found that broiler breast meat, depending on genotype and diet, contained more protein (23.7–24.4%) and ash (1.16–1.37%) and less fat (0.94–1.28%) compared to muscle from thigh (20.0–20.4% protein, 2.29–4.34% fat and 0.97–1.04% ash), while the water content was similar in both parts. According to Küçükyılmaz (2012) broiler breast meat grown under organic or conventional systems contained 72.7–74.1% water, 22.4–22.7% protein, 2.41–2.81% fat, 1.10–1.20% ash, while thigh meat contained 73.4–73.9% water, 17.3–18.6% protein, 6.54–8.29% fat, 0.89–0.94% ash. Bostami et al. (2017) in broiler meat, fed with different fat sources, determined the following chemical composition in breast muscle: water 74.87–75.70%, protein 26.20–27.43%, fat 0.49–0.91% and ash 1.42–1.51%, and in thigh muscle: 72.13–73.61%, 21.22–22.10%, 4.10–5.90% and 1.06–1.12%, respectively. Similar results were reported by Laudadio and Tufarelli (2011) in breast muscle: water 74.51–75.18%, protein 22.04–23.42%, fat 1.78–1.94% and ash 0.79–0.84%, and in drumstick muscle: 76.01–76.93%, 18.75–18.78%, 3.78–4.68% and 0.51–0.56%, respectively. According to Almeida et al. (2006) dark chicken meat (drumstick and thigh 40:60 proportion) contained 77.49% water, 18.83% protein, 4.08% fat. The broiler breast meat fed with canola oil contained 73.25–73.60% water and 1.87–1.91% fat (Gallardo et al., 2012).

Cholesterol content was higher in drumstick (70.08 mg/100 g) than in breast (65.64 mg/100 g) and pork fatback (65.33 mg). The cholesterol content in breast meat varied from 37.41 to 79.9 mg/100 g, while in drumstick varied from 48.35 to 99.5 mg/100 g in depend on treatments (Milićević et al., 2014). According to Almeida et al. (2006) dark chicken meat contained 80.30 mg/100 g of cholesterol.

It is noted that pork fatback contained quite a few proteins (3.45%). The high percentage of protein found in pork fatback indicates that it contained impurities of meat, which is a regular occurrence when it is used as a raw material for sausage production. Holland (1992) stated that the protein content of pork fatback is traceable.

The fatty acid composition of skinless chicken drumstick and breast and pork fatback is presented in Table 2.

Table 2

Fatty acid composition of chicken meat and pork fatback (%)

Fatty acids	Drumstick	Breast	Pork fatback
C10:0	0.02	0.30	0.10
C12:0	0.04	0.14	–
C14:0	0.51	0.66	1.55
C16:0	21.49	25.20	26.55
C16:1*n*-7	–	–	2.08
C16:1*n*-9c	3.11	3.06	–
C18:0	6.11	6.76	14.84
C18:1*n*-9c	28.38	23.88	34.19
C18:1*n*-11c	2.02	2.11	2.63
C18:2*n*-6	30.40	26.52	13.34
C18:3*n*-3	2.44	1.97	0.80
C20:4*n*-6	1.49	2.84	–
C20:5*n*-3	0.00	0.00	0.21
C22:5*n*-3	0.18	0.30	–
C22:6*n*-3	0.13	0.25	0.02
ΣSFA	28.78	34.29	44.07
ΣMUFA	35.56	32.73	40.32
ΣPUFA	35.66	32.99	15.62
n-6	32.40	30.04	13.90
n-3	2.81	2.52	1.13
n-6/*n*-3	11.53	11.91	12.93
PUFA/SFA	1.24	0.97	0.35
Atherogenic index	0.34	0.44	0.60
Trans FA	0.69	0.70	0.36

The results of the fatty acid composition of drumstick and breast were within the data reported in the literature. The content of saturated fatty acids (SFA) was higher in chicken breast (34.29%) compared to drumstick (28.78%) (Table 2). Chicken drumstick contained a higher percentage (35.56%) of monounsaturated fatty acids (MUFA) compared to breast (32.73%). Polyunsaturated fatty acids (PUFA) were presented with 32.99% in the breast and 35.66% in the drumstick. The most abundant fatty acids were linoleic acid (C18:2*n*-6) with 30.40% in drumstick and 26.52% in breast, *cis*-form of oleic acid (C18:1*n*-9c) with 28.38% and 23.88%, respectively, and palmitic acid (C16:0) with 21.49% and 25.20%, respectively. The content of eicosapentaenoic and docosahexaenoic acid was higher in chicken breast compared to drumstick.

Depending on the way the chicks were raised and the carcass mass, Milićević et al. (2014) found that breast contained slightly more SFA (29.53–40.87 mg/100 g) than drumstick (28.07–31.60 mg/100 g), and less MUFA (41.05–44.43 mg/100 g vs. 42.37–44.75 mg/100 g) and PUFA (15.86–28.69 mg/100 g vs. 24.07–29.17 mg/100 g). Dominant fatty acids were C18:1*n*-9c (37.12–39.56 mg/100 g in breast and 38.13–39.89 mg/100 g in drumstick), C16:0 (22.26–26.81 mg/100 g and 21.52–23.69 mg/100 g, respectively) and C18:2*n*6 (14.89–25.83 mg/100 g and 22.22–26.61 mg/100 g, respectively). Depending on the broilers diet, Trembecká et al. (2016) concluded that the most abundant fatty acid in the breast and thigh muscles was oleic with 40.18–40.99% and 41.12–41.85%, followed by palmitic with 26.60–26.84% and 26.42–27.05% and linoleic with 11.34–12.02% and 11.05–11.82%, respectively. Laudadio and Tufarelli (2011) found that the following fatty acids were presented in chicken muscle with the highest percentage: C18:1*n*-9 with 34.14–35.52% in breast and 34.68–36.50% in drumstick, C18:2*n*-6 with 28.02–29.01% and 26.20–26.65%, C16:0 with 19.38–19.92% and 20.20–20.98%, respectively. SFA content was 26.49–27.15% in breast and 27.94–29.26% in drumstick, MUFA 39.40–40.97% and 40.63–42.55%, PUFA 32.54–33.45% and 29.51–30.11%, respectively. The ratio of *n*-6 to *n*-3 fatty acids was 9.76–9.88% in the breast and 9.89–11.76% in the drumstick. Abdulla et al. (2015) in broiler breast muscles, fed on a variety of vegetable oils and calcium levels, found that the most common fatty acids were C18:1*n*-9 (23.0–39.2%), C16:0 (20.4–27.2%) and C18:2*n*-6 (16.2–33.0%). The ratio of *n*-6/*n*-3 was 0.8–10.3 and PUFA/SFA 0.5–

1.7. In the broilers meat fed a variety of foods, Zaki et al. (2018) found large variations in the content of fatty acids depending on the type of food. The most common fatty acids were oleic (C18:1*n*-9) with 31.81–37.30%, palmitic with 21.39–33.60% and linoleic with 16.62–25.19%. Depending on the age of chickens, in chicks aged 9 weeks Popova et al. (2016) concluded that the content of SFA (39.73%), MUFA (29.39%) and PUFA (30.88%) was higher in breast compared to thigh (34.65%, 37.02% and 28.33%, respectively). The PUFA/SFA ratio was 0.77 in the breast and 0.82 in the thigh. The n-6/n-3 ratio in the breast was 12.69 and in the thigh 19.50. Atherogenic index was 0.54 in breast and 0.41% in thigh. Depending on the type of fat source in the broiler diet, the total amount of SFA in breast muscle was 27.56–32.05% and in thigh 26.50–32.19%, content of MUFA 37.36–39.73% and 37.52–49.91%, PUFA 24.29–34.05% and 21.01–36.18%, respectively. The ratio of PUFA/SFA was 1.24–1.36 in the breast and 0.66–1.37 in the thigh (Bostami et al., 2017). The higher total MUFA content was recorded in thigh meat, while the proportion of PUFA was higher in thigh meat than breast. The ratio n-6/n-3 fatty acids of breast meat was highly lower than the one of thigh meat. The ratio PUFA/SFA was higher in breast than in thigh meat (Tougan et al. 2018).

Pork fatback contained more SFA (44.07%), less MUFA (40.32%) and at least PUFA (15.62%) (Table 2). The most common fatty acids were C18:1*n*-9c (34.19% of the total identified), C16:0 (26.55%), C18:0 (14.84%) and C18:2*n*-6 (13.34%). This order of fatty acids content was in accordance with the findings of Moran et al. (2018) and Gjerlaug-Enger et al. (2014). Orthofer (1996) and Hands (1996) pointed out that oleic (C18:1), palmitic (C16:0), linoleic (C18:2) and stearic acid (C18:0) were the most common fatty acids in pork fatback.

It can be concluded, that the fatty acids profile of chicken meat depends on several factors: genotype, food composition, production system, broiler slaughter age, muscle type, whether the meat is with or without skin, etc.

CONCLUSION

From the examination of chemical composition and fatty acid profile of skinless poultry meat and pork fatback, it can be concluded that the pH value was higher in drumstick, compared to breast and fatback. Drumstick contained more cholesterol. Breast were richer in protein and contained less fat compared with drumstick. The main identified fatty acids in chicken meat were linoleic, oleic and palmitic. Drumstick contained more linoleic and oleic and less palmitic acid compared to the breast. Breast were richer in arachidonic, docosahexaenoic and docosapentaenoic acid. Drumstick contained more MUFA and PUFA and less SFA. The most common fatty acids in pork fatback were oleic, palmatic, stearic and linoleic.

Generally, the raw materials tested provide a good basis for production of quality sausages.

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