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CHANGES IN FATTY ACID COMPOSITION OF POULTRY MEAT AFTER HEAT TREATMENT

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Abstract

The purpose of the paper is to determine the changes in the fatty acid composition of fat in poultry meat after the heat treatment, after frying in different types and combinations of fats. Lard, sunflower oil, palm oil and a combinations of three parts of lard and one part of sunflower oil, three parts of lard and one part of palm oil and three parts of palm oil and one part of sunflower oil were used for the examination. After frying with lard in the meat, there is a greater change in the fatty acid composition, where the fatty acid C18:1n9cof 45.84%, which it had it before frying, increased to 49.05%, C18:O decreased from 10.18% to 7.45% and decreased C16:O from 29.55 % to 27.45%. After frying in sunflower oil and palm oil, there has a formation of new fatty acids in insignificant amounts. In combination of three parts of lard and one part of sunflower oil, minimal changes in the fatty acid composition of less than 1% have been observed. In frying with three parts of lard and one part of palm oil fatty acid C14:O from 0.88% to 23.81%, fatty acids C16:O decreased from 27.24% to1.72%, C18:1n9c from 48.05 % to 15.16% and C18:2n6c from 12.44% to 0.20%. After the heat treatment of the meat in three parts of palm oil and one part of sunflower oil, there is an increase in the content of fatty acid from C18:2n6cfrom 8.42% to 11.62 %.

Key words: *quality, frying, lard, palm oil, sunflower oil*

INTRODUCTION

Thermal processing of meat is regular action in cuisine and in the meat industry. The objective of thermal processing of meat is to prepare the meat for consuming and to increase its sustainability. One of the most applied and fastest ways of thermal processing of meat for consuming in households is frying. Soft, boneless pieces of meat from the shoulder part, the thigh, the loin and the neck, and from which the visible fat tissue was removed, are usually used for frying. Sunflower oil and lard are used in the households to fry meat, and lately the palm oil became very popular. During frying with less or more oil, sensory characteristics which are very alike to those formed during grilling or roasting, are formed in the meat. During frying of the meat with less or more oil, attractive chestnut brown colour is being formed on its surface, while golden yellow to chestnut colour is formed on the surface of the fat tissue. The chestnut brown colour of the meat surface is consequence of Maillard reaction, which occurs during thermal processing.

During thermal processing – frying of meat, the temperature on the meat surface reaches 180-150°C (Rahelič et al., 1980) and numerous physical and chemical reaction happen within the meat. As a result of the heat, the water evaporates from the meat, the fats are extruded and they leak into the frying pan.

Changes which occur in the oils in which the meat is fried are primarily result of heat denaturation of fats, as well as a result of reaction between fats in the meat and soluble proteins.

MATERIAL AND METHODS

Material samples

The poultry that were used for examination are purchased from trade network usually from freshly slaughtered broilers (meat from the chest). The meat was cut down to size and shape as for frying, 80-100 g.

Fats used for the heat treatment of the meat (frying) and for examining their chemical changes after the heat treatment are lard, sunflower oil, palm oil and mixture, lard and sunflower oil in a ratio of 3:1, palm oil and sunflower oil in a ratio of 3:1, lard and palm oil in a ratio of 3:1. Lard used for the heat treatment of meat and for the examination of chemical changes in fat after the heat treatment of the meat is obtained from the trade network. The sunflower oil used to test the chemical changes in fats after the heat treatment of the meat is commercial oil produced in the oil factory ''Blagoj Gorev'' from Veles, R. Macedonia.

Thermal processing of the meat

Thermal processing – frying of the meat is performed in laboratory. The meat samples are frying after the melting and reaching the boiling point. The meat is fried in a large amount of fat, that is, the level of fat in the plate in which the meat was fried was enough to cover them. The determination of fried meat was subjective, that is, the conclusion that the meat was sufficiently thermally treated was the formation of the attractive colour on its surface. After the heat treatment, the meat is taken out of the plate in which it is thermally processed and it is transferred to another plate in which a kitchen paper for absorption of fat is placed on the bottom. The changes in meat weight were monitored by measuring meat before and after thermal processing with electronic weighing scale accurate to 0.1 g. Prior to the heat treatment of the meat, one sample of the fat in the amount of 25 cm^3 was taken or a total of 12 samples of fat were taken for testing the fatty acid composition before the treatment. Fat-sampling before heat treatment is done after fat fading. The fats are placed in glass bottles with a volume of 30 cm. After the heat treatment of the meat and the cooling of the fats, four more samples are taken to examine the changes that occur in the fatty acid composition of the fats.

Determination of fatty acids content

Examination of changes in fatty acid composition of the fats is conducted before and after thermal processing .The fats from the analyzed samples of the poultry meat were extracted by the Rose-Gottlieb, (AOAC, 1990) method (modified method of Secchiari and Coll. (2003). Butylated hydroxytoluene (BHT) (50 µg BHT/ml in methanol) was added in order to avoid oxidative degradation of the fatty acids. Methylation of the fatty acids was done by the AOAC Official Method 996.06 (2005).

The produced metal esters of the fatty acids (FAMES) were analyzed with gas chromatograph Hewlett Packard 5890 series II with flame ionization detector and capillary column HP 88 (60m x 0.250mm x 0.20 µm). Helium was the gas carrier, and the total duration of one cycle was 38.50 minutes. The FAMES produced from the analyzed samples of the fermented sausages were identified on the basis of the comparison of their retention time with the retention time of the standards of FAMES consisted in 37 component mixture (Supelco 37 component FAME mix). The content of each of the analyzed fatty acids is shown in percent (%).

Analyses of changes in fatty acid composition of the fats are examined in the laboratory of the Food Institute at the Faculty of Veterinary Medicine in Skopje.

Statistical analysis

All data were presented as mean value with their standard deviation indicated (mean ± SD).

RESULTS AND DISCUSSION

Significant physical changes, which contribute to change of basic characteristics of meat and forming new sensory characteristics important to its quality, occur during thermal processing of meat.

One of the basic changes which occur during thermal processing is weight loss – meat shrinkage. The weight loss of the meat which occurs after thermal processing could be seen best from data given in Table 1.

Table1. Weight Loss-meat shrinkage in poultry meat during thermal processing

Meat frying	Changes in meat weight	Parameters				
		x	s	Cv	min	max
Lard	Before thermal processing (g)	84.80	8.060	9.504	70.00	94.00
	After thermal processing (g)	46.80	5.741	12.267	42.00	56.00
	Shrinkage (%)	44.00	8.367	19.015	34.00	55.00
Sunflower oil	Before thermal processing (g)	85.60	5.426	6.334	82.00	94.00
	After thermal processing (g)	55.20	5.741	10.400	48.00	64.00
	Shrinkage (%)	35.66	2.494	6.994	32.00	39.00
Palm oil	Before thermal processing (g)	92.40	13.529	14.642	76.00	106.00
	After thermal processing (g)	57.40	10.151	17.684	44.00	66.00
	Shrinkage (%)	38.20	2.315	6.061	35.00	42.00
Lard and sunflower oil	Before thermal processing (g)	83.60	10.072	12.047	70.00	100.00
	After thermal processing (g)	51.60	8.139	15.773	40.00	64.00
	Shrinkage (%)	38.60	3.262	8.450	36.00	43.00
Lard and palm oil	Before thermal processing (g)	104.00	11.662	11.134	92.00	120.00
	After thermal processing (g)	65.60	4.630	7.058	60.00	72.00
	Shrinkage (%)	36.80	3.059	8.314	33.00	42.00
Palm oil and sunflower oil	Before thermal processing (g)	86.80	6.013	6.928	76.00	94.00
	After thermal processing (g)	59.60	9.830	16.494	44.00	68.00
	Shrinkage (%)	31.80	9.064	28.504	23.00	49.00

As seen from data presented in Table 2, the average weight loss during thermal processing of poultry by frying with sunflower oil is 35.66%, by frying with lard is 44.00 % and by frying with palm oil is 38.20%. The frying in a mixture of lard and sunflower oil, lard and palm oil, palm oil and sunflower oil in 3:1 the average weight loss is 35.53%.Shrinkage in poultry meat during thermal processing fried in palm oil and sunflower oil is the lowest and it is 31.80%, and the highest in meat that is fried in combination of lard and sunflower 38.60%. The obtained results in our examinations are in relation to the results stated by other authors. The meat shrinkage during thermal processing depends on the reached temperature in the centre of the product. The weight loss of meat will be as bigger as the temperature of oils in which the meat is thermally processed gets higher (Buchar and Frohlich, 1969; Rohman, A. and Che Man, Y. B. 2009a; Naz Shanina, et al., 2005; Gunston, F.D. 2004). Significant changes of fatty acid composition occur after thermal processing of meat, which is caused by the temperature during thermal processing, as well as the interaction of fats and soluble proteins and the interaction of other meat substances and oils used for thermal processing – frying of meat, (Rashood, et al.,1996; Marina, et al., 2010; Marikkar et al., 2011; Indrasti, et al., 2010).

The changes in the fatty acid content that occur during thermal processing of meat – frying with lard, sunflower oil and palm oil could be seen best from Table 2.

Table 2. Changes in the fatty acid content before and after heat treatment of poultry meat - fried with different types of fats

Fatty acid composition	Different types of fats					
	Lard		Sunflower oil		Palm oil	
	before frying	after frying	before frying	after frying	before frying	after frying
C14:0	1.22	1.43	-	-	0.65	0.75
C16:0	29.55	27.45	10.58	11.57	46.15	44.43
C16:1	2.36	2.79	-	-	-	0.36
C17:0	0.23	0.28	-	-	-	-
C17:1	0.15	0.23	-	-	-	-
C18:0	10.18	7.45	3.49	3.58	3.21	3.25
C18:1n9c	45.84	49.05	45.42	45.51	44.40	44.77
C18:2n6c	9.00	9.31	40.06	38.80	4.06	6.21
C18:3n6	0.39	0.45	-	0.20	-	0.23
C21:0	-	0.45	-	-	-	-
C18:3n3	0.45	0.86	-	0.18	-	0.21
C22:0	-	0.25	-	-	-	-
C20:5n3	-	-	-	0.15	-	-

It is acertained that two fatty acids are formed in poultry fried with lard, such as C21:0 in an amount of 0.45% and C22:0 in an amount of 0.25 %. During the thermal processing of the poultry, the content of C18:1n9c has increased from 45.84% to 49.05%, while C18:0 has decreased from 10.18% to 7.45%, C16:0 has also decreased from 29.55% to 27.45%. These changes are statistically significant at the level of ($p<0.5$).During frying of poultry with palm oil there is minimal decrease of the content of C16:0 from 46.15 % to 44.43 %,and at the expense of it new fatty acids appear, such as C18:3n3 andC18:3n6, which are either result of denaturation changes which occurred in the palm oil during thermal processing of the meat, or extracted from poultry. The changes which occur in fatty acid composition of fats after thermal processing of the meat are minimal and do not show statistical significance.

Most probably, the new fatty acids which appear in fats after thermal processing (most noticeable after frying with sunflower oil) of the meat are either extracted from the meat or newly created fat acids from the existing ones, under influence of high temperature during thermal processing of the meat

The changes in the fatty acid content that occur during thermal processing of meat – frying with combinations of fats could be seen best from Table 3.

Table 3. Changes in the fatty acid content before and after heat treatment of poultry meat - fried with different mixture of fats

Fatty acid composition	Different mixture of fats					
	Lard : sunflower oil (3:1)		Lard : palm oil (3:1)		Palm oil : sunflower oil (3:1)	
	before frying	after frying	before frying	after frying	before frying	after frying
C14:0	0.88	23.81	0.88	23.81	0.59	0.67
C16:0	27.24	1.72	27.24	1.72	42.31	41.99
C16:1	2.23	-	2.23	-	-	0.20
C17:0	0.12	-	0.12	-	-	-
C17:1	-	7.65	0.21	7.65	-	-
C18:0	8.15	51.25	8.15	51.25	3.23	3.48

C18:1n9c	48.05	15.16	48.05	15.16	45.24	41.71
C18:2n6c	12.44	0.20	12.44	0.20	8.42	11.62
C18:3n6	0.36	0.21	0.36	0.21	0.21	0.23
C18:3n3	0.53	-	-	-	-	0.10

Under the influence of high temperature during the frying of poultry in a mixture of lard and sunflower oil, one more significant change is that the content of C14: O increases from 0.88% to 23.81%, and decreases the content of C16:O from 27.24% to 1.72%, C18:O is increased from 8.16 to 51.25%, which is a consequence of the transformation of cis oleic fatty acid. After the heat treatment of poultry meat in the mixture of lard and sunflower oil, a new fatty acid C17:1 occurs in an amount of 7.65%, which we believe has been squeezed out of the meat. During the frying of poultry in a mixture of lard and palm oil,C16: O in the amount of 27.24% after frying decreased to 1.72%, while in oleic fatty acid (C18: O) before frying was represented by 8.15%, and after frying, its presence in fat was 51.25%. A similar situation exists with the fatty acid of C18: 2n6c where its quantity of 12.44% has decreased to 0.20%. After frying of the poultry in this combination of fats there is a new fatty acid C17: 1 which is represented by 7.65%. Other fatty acids have no significant changes, they are almost unchanged. In the third combination of fats pamitic fatty acid (C16: O), which in fats before frying was 42.31% after frying fell to 41.99%, then fatty acid C18: 1n9c which in fat before frying was present in quantity of 45.24% decreased to 41.71%, while fatty acid C18: 2n6c of 8.42% was increased to 11.62%. For other fatty acids in fat before and after frying of poultry meat there are no major changes.

CONCLUSIONS

Based on the investigations carried out on chemical changes that occur in fats after the heat treatment, the following conclusions can be made:

- The average shrinkage during heat treatment of poultry meat in sunflower oil is 35.66%, lard 44.00% and palm oil 38.20%;
- After frying of poultry in lard, there is an occurrence of C18:3n3 with a representation of 0.45% and C22:0 of 0.25% and after frying in palm fat there is a new fatty acid C16: 1 where its presence is 0.36%.

During frying the meat in the mixture of fats, changes that occur in the fatty acid composition of fat in which the meat is processed present the fact that some fatty acids have decreased, others have increased and there have been new fatty acids. The emergence of new fatty acids is considered to be primarily a consequence of the extraction of fatty acids from the meat, and others are a result of the denaturation of fatty acids and the transition into a cis or trans form of the corresponding fatty acid.

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ПРОМЕНИ ВО МАСНОКИСЕЛИНСКИОТ СОСТАВ КАЈ ЖИВИНСКОТО МЕСО ПО ТЕРМИЧКАТА ОБРАБОТКА

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Резиме

Целта на трудот е да се утврдат промените во маснокиселинскиот состав на мастите кај пилешко бело месо по термичката обработка и тоа по пржење во различни видови и комбинации на масти. За испитување се користеше свинска маст, сончогледово масло, палмина маст и комбинација на три дела свинска маст и еден дел на сончогледово масло, три дела на свинска маст и еден дел на палмина маст и три дела на палмина маст и еден дел на сончогледово масло. По пржењето со свинската маст кај месото има поголеми промени во маснокиселинскиот состав каде што масната киселина C18:1n9c од 45.84% која ја имаше пред пржење се зголеми на 49.05%, C18:O се намали од 10.18% на 7.45% и намалување на C16:O од 29.55% на 27.45%. По пржење во сончогледовото масло и палмина маст има формирање на нови масни киселини во незначително количество. Во комбинација од три дела свинска маст и еден дел на сончогледово масло констатирани се минимални промени во маснокиселинскиот состав кој изнесуваат под 1 %. При пржење со три дела свинска маст и еден дел на палмина маст масната киселина C14:O од 0.88% се зголеми на 23.81%, масните киселини C16:O се намалија од 27.24% на 1.72 %, C18:1n9c од 48.05% на 15.16% и C18:2n6c од 12.44% на 0.20%. По термичката обработка на месото во три дела на палмина маст и еден дел на сончогледово масло има зголемување на содржината на масната киселина C18:2n6c од 8.42% на 11.62%.

Клучни зборови: *квалитет, пржење, свинска маст, палмина маст, сончогледово масло*