

GOCE DELCEV UNIVERSITY - STIP
FACULTY OF AGRICULTURE



JOURNAL OF AGRICULTURE AND PLANT SCIENCES

YEAR 2018

VOLUME 16, Number 2

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Journal of Agriculture and Plant Sciences, JAPS, Vol 16, No. 2
Successor of the Yearbook of Faculty of Agriculture of GDU, Vol 14

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ISSN 2545-4447 print
ISSN 2545-4455 on line
Vol. 16, No. 2, Year 2018

**GOCE DELCEV UNIVERSITY - STIP, REPUBLIC OF MACEDONIA
FACULTY OF AGRICULTURE**

UDC 63(058)
ISSN 2545-4447 print
ISSN 2545-4455 on line



Journal of Agriculture and Plant Sciences, JAPS, Vol 16, No. 2

Successor of the Yearbook of Faculty of Agriculture of GDU, Vol 14

YEAR 2018

VOLUME XVI, Number 2

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CONTENT

Adrijana Burovska, Dragica Spasova, Biljana Atanasova, Dusan Spasov, Mite Ilievski EXAMINATION OF SOME QUALITY FEATURES OF OATS GROWN IN CONDITIONS OF ORGANIC PRODUCTION	9
Mite Ilievski, Biljana Atanasova, Dusan Spasov, Dragica Spasova, Verica Ilieva, Natalija Markova Ruzdic, Pavle Vuckov PROTEIN PROFILE OF SOME GENOTYPES OF FLAX (<i>Linum usitatissimum</i> L.) IN THE STRUMICA REGION, REPUBLIC OF MACEDONIA	17
Radivoje Jevtić, Vesna Župunski, Mirjana Lalošević, Novica Mladenov, Bojan Jocković EFFECT OF ABIOTIC AND BIOTIC STRESS AND CROP MANAGEMENT ON HEALTH CONDITION AND YIELD OF CEREALS	25
Ana Korubin – Aleksoska, Milan Mitreski, Jane Aleksoski, Mohammad Ayaz Ahmad, Sime Dojcinov, Zarko Bebic STUDY OF QUANTITATIVE CHARACTERISTICS IN ORIENTAL TOBACCO GENOTYPES	33
Vladimir Kuzmanovski, Aco Kuzelov, Elena Joshevska INFLUENCE OF OLIVE OIL ON THE FATTY ACIDS COMPOSITION OF COARSE CHOPPED BOILED SAUSAGES	43
Ivo Mitrushev, Verica Ilieva, Natalija Markova Ruzdik INFLUENCE OF THE SEED SIZE AND VARIETY ON THE SEEDLING VIGOUR AND GERMINABILITY IN THREE VARIETIES OF SOFT WHEAT SEED	51
Dimitar Nakov, Metodija Trajchev MONITORING UDDER HEALTH AND MILK HYGIENE ON-FARM USING QUICK SCREENING METHODS	57
Ilco Ristov, Ilija Karov CULTIVATION AND PROTECTION OF SEASONAL FLOWERS IN GREENHOUSES IN STRUMICA	65
Venelin Roychev, Angel Ivanov, Neli Keranova, Nikolay Tsaykin AGROBIOLOGICAL EVALUATION OF GRAPEVINE VARIETIES FOR WHITE AND RED WINES	73

INTRODUCTION

In the past ten years the educational, research and applicative activities of the Faculty of Agriculture – Stip, Goce Delcev University – Stip, contributed to the development of agriculture sector in the country and broader region.

The Faculty of Agriculture organized the 1st International Meeting Agriscience & Practice (ASP 2018), giving an opportunity to the participants for presentation and discussion of original scientific and practical results in different fields of agriculture.

The 1st International Meeting Agriscience & Practice (ASP 2018), held on 10-11 May at Faculty of Agriculture - Stip, was organized with intention to bring together all agricultural stakeholders for sharing their knowledge, experience and obstacles. One of the main aims was to link research and field work in agricultural sector in the country and broader, giving it an international dimension. All oral presentations as well as poster presentations at ASP 2018 were organized in several scientific sessions:

- Agricultural economics,
- Plant biotechnology,
- Plant production,
- Plant protection,
- Quality control and food safety,
- Soil science and hydrology,
- Viticulture, enology and fruit production.

The main goal of the Meeting was linking and promoting scientific achievements and practical knowledge, presented in different thematic areas, which were achieved in the Republic of Macedonia and wider in the region.

Journal of Agriculture and Plant Sciences Vol. 16, No. 2 contains the presented papers from the 1st International Meeting Agriscience & Practice (ASP 2018).

Editorial Board,

December, 2018

Editor in chief,

Prof. Liljana Koleva Gudeva, PhD



INFLUENCE OF OLIVE OIL ON THE FATTY ACIDS COMPOSITION OF COARSE CHOPPED BOILED SAUSAGES

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Abstract

The paper examines the influence of ordinary and cold pressed olive oil on the fatty acid composition of coarse chopped boiled sausages. For this purpose, cold pressed olive oil was added in the production of the Folk sausages and in the production of Kranj sausages was added ordinary olive oil. In both production batches, olive oil is added in the amount of 3, 4 and 5 g/kg. In the examined production batches of Folk sausage, the content of palmitic and stearic fatty acids (C16: 0 and C18: 0) is within the limits of other meat products. A smaller percentage representation is observed in the content of C16: 0, and greater in the content of (C18: 0) in the production batches of Kranj sausages. The ratio of PUFA / SFA in bought production batches of sausages is up to 0.4%, which means that the sausages full field the quality requirements of the product according to the lipid content that means that the addition of olive oil in this type of batches is appropriate.

Key words: Folk sausage, Kranj sausage, monounsaturated fatty acids, polyunsaturated fatty acids, saturated fatty acids, quality

INTRODUCTION

Meat and meat products are considered essential in the diet of the population. The main ingredients of the meat, among the water are: proteins, fats, vitamins and minerals, which give the meat a high degree of biological and nutritional value. In the context of the above-mentioned, particularly important sources, types of meat are fatty acids (especially fish meat), B-vitamins and iron content.

Besides the nutritional value, meat and meat products have an important social role in modern society. The increase in population, urbanization, economic growth and the development of markets have led to an increase in demand for meat and products of animal origin (Costales et al., 2006; Steinfeld et al., 2006 a, b).

Food from animal origin, including meat, is required to act favourably for the preservation of human health. To achieve this goal, different additives of plant origin and vegetable oils are added to the meat and meat products. Some

of them have an influence on the oxidative processes, some effect on the microbiological quality of products and some of them can be used as a partial replacement of the fatty tissue that is added to the production of meat products.

Lately, more research has been carried out on the use of different types of vegetable oils in the production of meat products. Muguerza et al. (2001) and Jimenez-Colmenero, (2007) investigated the use of olive oil, Carvalho et al. (2006) and Rubio et al. (2007) investigated the used of sunflower oil in the production process of sausages, Muguerza et al., (2003; 2004) and Rubio et al. (2007) investigated the used soybean oil, Valencia et al. (2006; 2007) fish oil and algae oil, Vasilev et al. (2011) investigated the use of palm oil in the production of different types of meat products.

Hyun-Jen Lee et. al., (2015) investigated the effect of lard substitution with vegetable oils on

the quality properties of sausages. The authors concluded that with the replacement of lard with mixed vegetable oils there were no adverse effects on the quality of sausages. The reduced composition of saturated fatty acids, authors said that made the quality product.

Luruena-Martinez et al. (2004) and Muguerza et al., (2002) state that the addition of olive oil does not cause significant differences in the shrinkage of heat treatment but gives them

more yellow colour.

Bloukas et al. (1997) found that greater olive oil content causes greater weight loss, probably due to higher amounts of added water.

The aim of our research was to investigate the influence of different quantities of cold pressed and ordinary olive oil on the fatty acid composition of semi-permanent, coarse chopped boiled sausages.

MATERIAL AND METHODS

Production of Coarse Chopped Boiled sausages

The Kranj and Folk sausage served as a material for examination. According to the Rulebook for demands regarding quality of minced meat, meat preparations and meat products (Official Gazette of Republic of Macedonia No. 63 from 29.04.2013), these sausages belongs to the group of semi-permanent, coarse chopped boiled sausages. The production of the sausages was in compliance with all sanitary and veterinary regulations applicable in Macedonia.

The cold press olive oil (Santorina extra virgin, Nutria C.A, Greece), was added during preparation of the mix for Folk sausages and ordinary olive oil (Olio Di Sansa Di Oliva) was added during preparation of the mix for Kranj sausages. The mix is stuffed in pork small intestines. Four groups of bacon – Folk and Kranj sausages were prepared for the experiment:

- I group – without addition of cold press olive oil (control group)
- II group – with addition of 3gr/kg cold press olive oil
- III group – with addition of 4gr/kg cold press olive oil
- IV group – with addition of 5gr/kg cold press olive oil

Examination of fatty acid composition

Fatty acid composition of groups of sausages was determined by gas chromatography. Method of work with the sample is AOAC 996.06 GC-FID-7890 A with the device Gas chromatograph with flame ionization detector. The fats from analysed samples of sausages have been extracted by hydrolysis (acid hydrolysis).

The Folk sausages were manufactured according to the following technological recipe: chicken MOM 3 kg; chicken mess 12 kg; pork trimming 35 kg; hard fatty tissue 40 kg; leek 3 kg; nitrite salt 1.7 kg; spice "Koleks" 0.400 kg; polyphosphate 0.500 kg; emulsifier 2.0 kg; hard water 20.0 kg; cold pressed olive oil Santorina (extra virgin).

The recipe used for production of the sausage is as follows: 0.7 kg emulsifier, 2.0 kg polyphosphate, 1.8 kg nitrite salt, 0.4 kg spice for Kranj sausage, ordinary olive oil Olio Di Sansa Di Oliva 3g/kg; 4g/kg; 5g/ kg.

Olive oil in both groups of sausages was added during the cure of the mixture. After preparation and mixing, the mix is stuffed in natural pork intestines with diameter 32-34mm. After stuffing and pressing, the sausages were thermally processed, according to the following formula: 35 minutes drying at 62°C, 20 minutes smoking at 62 °C, 35 minutes boiling at 78 °C. After thermal processing, the sausages were vacuumed with vacuum machine Vebomak. After vacuuming, the sausages were stored at refrigerator at temperature of +4 °C.

Pyrogalllic acid is added in order to avoid fatty acids release. Methylation of fatty acids was conducted according to AOAC GC - FID - 7890. The obtained fatty acid methyl esters (FAMES) were analysed with a gas chromatograph with flame ionization detector and capillary column (SP 2560 100 mx 0.25 mm to 0, 25 µm).

Working conditions: injection temperature

225°C, detector 285°C. The initial temperature at 100°C is maintained 4 minutes, increased by 3°C each minute, up to final temperature of 240°C, leave 15 minutes. The carrier gas had helium flow of 0.75 ml/min. Certain FAMES from the analysed groups of sausages are identified partially, on the basis of comparison between their retention times (characteristic for their molecular mass as identification parameter) and FAMES retention standards (which include cis and trans isomers

of fatty acids). Analysed content of each fatty acid is expressed in percent (%).

Statistical processing

Each parameter was determined after three repetitions, and the results are presented as mean value \pm Sd. The obtained results are mathematically and statistically processed in Microsoft Excel 2003.

RESULTS AND DISCUSSION

Fatty acid composition of production batches of Fok sausages

The results of the studies on the fatty acid composition of the investigated samples of Folk and Kranj sausages are given in Tables 1,2,3,4.

Table 1. Fatty acid composition of Folk sausages (%)

Fatty acids (%)	I batch	II batch	III batch	IV batch
C14:0	1.23	1.25	1.20	1.19
C16:0	23.87	23.64	24.05	23.89
C16:1	2.37	2.41	2.14	2.49
C17:0	0.59	0.54	0.61	0.56
C17:1	0.32	0.28	0.32	0.30
C18:0	13.10	12.88	13.81	13.06
C18:1n9c	44.09	43.62	44.35	43.35
C18:2n6c	12.60	13.48	11.85	13.59
C183n6	0.42	0.44	0.26	0.33
C183n3	1.11	1.15	1.10	0.95
C20:2	0.30	0.31	0.30	0.29

Table 2. Saturated, polyunsaturated, monounsaturated and unsaturated fatty acids in the production series of Folk Sausage (%)

Fatty acids (%)	I batch	II batch	III batch	IV batch
Saturated	38.79	38.31	39.67	38.70
Polyunsaturated	14.13	15.07	13.21	14.87
Monounsaturated	47.09	46.62	47.12	46.43
Unsaturated	61.22	61.69	60.33	61.30

According to Table 1 and 2, it is seen that the content of C16:0 ranges from an average of 23.64% to 24.05% in batches with added olive oil compared to 23.87% in the control. The content of C18: 0 ranges from 12.88% to 13.81% for batches with added olive oil in relation to 13.10% in the control group sausages. The content of these saturated fatty acids is within the limits of other meat products. During production of Folk sausages the content of C16:0 has decreased, while C18:0 is increased compared to the results for Kranj sausages, which is consequence of the different types of meat for sausage production and fat content.

Pork meat normally contains a greater amount of palmitic and oleic acid due to the type of meat and its structure of lipids and poultry meat is significantly comes with lower content of stearic acid. Although in the recipe of the Folk sausage, MOM chicken is involved and digested, yet the percentage of pork trimming content and fatty tissue provide most of the content of steric acid.

The ratio of PUFA /SFA to these series of sausages is 0.4%, which indicates that this group satisfies the quality requirements of the product according to the lipid content. The greater difference in the ratio of PUFA / SFA between

this type of sausages and the previous (Kranj) is due to the higher percentage of fatty tissue (40%: 20%).

From 7-13 g olive oil can be added to 100 g sausages as a substitute for animal fats. However, the purpose of replacing animal fat with olive oil is to produce products with low fat content (Jiménez-Colmenero et al., 2007). One of the basic strategies for developing a healthy lipid formula is to concentrate active ingredients in food products to allow consumption at the recommended levels of intake with normal sizes of portions. Recommendations for the diet by the World Health Organization (2003) were that, MUFA should be the main dietary fatty acids. If MUFAs are the predominant fatty acids in the products, the total fat intake will not be significant (Pérez-Jiménez et al., 2007).

Ansorena and Astiasaran, (2004), in their research studied Dry fermented sausages produced by a partial substitution of pork back fat with pre-emulsified olive oil. The authors established that After 5 months of storage at 4 °C, the combination of the increase in oleic acid and the preservation of PUFA by the antioxidant activity of the olive oil emulsion and antioxidants (when added), lead to better MUFA+PUFA/SFA ratios in olive oil containing sausages (1.90-1.98 g/100 g fatty acids) and particularly in antioxidants containing sausages (2.02-2.16 g/100 g) than in control ones (1.72 g/100 g). Vacuum packaging of the piece was the best method to minimize formation of lipid oxidation volatile compounds.

Six treatments of Chorizo de Pamplona, traditional Spanish fermented sausage, were manufactured under usual commercial conditions by replacing 0, 10, 15, 20, 25 and 30% of pork back fat by pre-emulsified olive oil with soy protein isolate. Sausages with 20-30% replacing level had higher ($p<0.05$) protein

content than control as a result of the addition of soy protein isolate. The oleic acid increased ($p<0.05$) in sausages with 15-30% replacing level, and linoleic acid increased in sausages with 10-25%. Sausages with 10-25% of substitution had lower total SFA-stearic and higher ($p<0.05$) total MUFA, total PUFA, (MUFA+PUFA)/ (SFA-stearic), and PUFA/(SFA-stearic), reported (Muguerza et al., 2001).

Backes et al., (2017) in Italian type of sausages with addition of vegetable oils, found lower levels of saturated fatty acids (SAFAs), higher levels of monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). The results showed that the replacement of pork with emulsified vegetable oil improved the nutritional values of salami of the Italian type.

Kaayardi et al. (2003) examined the effect of olive oil on the chemical and sensory characteristics of the Cabanosi sausage made from soy sauce, cottonseed oil, in which three samples were made 0.1%, 1.0% and 2 %. They found that as the percentage of olive oil increased, the total saturated fatty acids increased as the total polyunsaturated fatty acids decreased.

The content of fatty acids, the structural and percentage distribution of sausages in both types (Kranj and Folk), using olive oil, showed that olive oil has an influence on the PUFA / SFA ratio, and so on the quality of the produced sausages in the ratio of the lipid content. The produced sausages have a quality fatty acid profile, primarily because of the lower percentage of saturated fatty acids compared to non-saturated fatty acids.

Comparatively, our results with the literary results showed similarity and appropriate correlation with regard to the structure of the fatty acid composition and the manner of storage.

Table 3. Fatty acid composition of Kranj sausages (%)

Fatty acids (%)	I batch	II batch	III batch	IV batch
C14:0	1.43	1.41	1.40	1.39
C16:0	25.72	25.26	25.97	25.19
C16:1	3.03	3.10	2.91	3.00
C17:0	0.49	0.52	0.47	0.51
C17:1	0.52	0.55	0.47	0.53
C18:0	12.57	12.47	13.30	13.17
C18:1n9c	44.57	44.27	43.02	43.70
C18:2n6c	10.54	10.87	11.02	11.17
C18:3n6	0.40	0.68	0.69	0.56
C:183n3	0.73	0.85	0.75	0.78

Table 4. Saturated, polyunsaturated, monounsaturated and unsaturated fatty acids in the production series of Kranj Sausage (%)

Fatty acids (%)	I batch	II batch	III batch	IV batch
Saturated	40.21	36.66	41.14	40.26
Polyunsaturated	11.67	12.40	12.46	12.51
Monounsaturated	48.12	46.40	47.92	47.27
Unsaturated	59.79	60.32	58.86	59.74

From the table of contents for the fatty acid composition of the Kranj sausage, it can be determined that the content of palmitic acid (C16: 0) ranges from 25.19% to 25.26% in the batches with added olive oil in relation to 25.72% in the control, respectively 12.47% to 13.30% stearic (C18: 0) for the batches with added olive oil in relation to 12.57% in the control. The content of these saturated fatty acids is within the limits of other meat products. Oleic acid accounts for 92% of MUFA in food, and 60-80% of oleic acid comes from olive oil (Pérez-Jiménez et al., 2007), as confirmed by our research.

Olive oil is a vegetable oil with the highest level of monounsaturated fatty acids (MUFA) and has attracted attention as a replacer for animal fat in processed meat products. Olive oil has a high biological value due to a favourable mix of predominantly MUFA and naturally occurring antioxidants including vitamin E, vitamin K, carotenoids and polyphenols such as hydroxytyrosol, tyrosol and oleuropein, (Moon et al., 2009).

Since 3, 4 and 5 gr / kg of olive oil were added in the produced sausages, the content of monounsaturated fatty acids increased adequately with the addition: 46.40% for added 3 gr/kg olive oil, 47.92% for added 4 gr / kg olive oil and 47.27% for added 5 gr / kg olive oil.

Therefore, the replacement of animal fat with olive oil or its addition to a greater quantity of 4 or 5 gr / kg (as in our research) can produce the products with a healthier composition of lipids (higher MUFAs, predominantly oleic acid) without greater deterioration of the diet quality.

According to Ansorena and Astiasaran (2004), the PUFA / SFA ratio is one of the parameters currently used to assess the quality of foods in terms of lipid content. According to the same authors, this ratio should not exceed 0.4%, in order to reduce the negative effects of saturated fatty acids. In our research in all three groups, the ratio of polysaturated to saturated fatty acids is 0.3%, and in the control is 0.2%, which means that the addition of olive oil in this type of batches is appropriate.

CONCLUSIONS

Adding of olive oil more than 4 or 5g/ kg (according to our research), allows greater production of products containing healthy amount of lipids (higher MUFA, mainly oleic acid) without any significant deterioration of food quality.

The content of fatty acids, the structural and percentage distribution of sausages in both types (Kranj and Folk), using olive oil, showed that olive oil has an influence on the

PUFA / SFA ratio, and so on the quality of the produced sausages in the ratio of the lipid content. The produced sausages have a quality fatty acid profile, primarily because of the lower percentage of saturated fatty acids compared to non-saturated fatty acids. Comparatively, our results with the literary results showed similarity and appropriate correlation with regard to the structure of the fatty acid composition and the manner of storage.

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**ВЛИЈАНИЕ НА МАСЛИНОВОТО МАСЛО ВРЗ МАСНО КИСЕЛИНСКИОТ СОСТАВ НА
ГРУБО ИСИТНЕТИ БАРЕНИ КОЛБАСИ**

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Резиме

Во трудот е испитувано влијанието на обично и ладно цедено маслиново масло врз маснокиселинскиот состав на грубо иситнети барени колбаси. За таа цел во производството на Народен колбас е додадено ладно цедено маслиново масло, а во производството на Крањски колбас е додадено обично маслиново масло. И во двете производни серии додадено е маслиново масло во количина од 3, 4 и 5 g/kg. Кај испитуваните серии на Народен колбас содржината на палмитинската и стеаринската масна киселина (C16:0 и C18:0) е во границите како и кај останатите месни преработки. Помала процентуална застапеност е забележан во содржината на C16:0, а поголема во содржината на (C18:0), кај крањските серии колбаси. Односот на PUFA / SFA, кај двете производни серии колбаси изнесува до 0.4%, што значи дека колбасите ги задоволуваат условите за квалитет на производот според содржината на липиди, односно дека потполно е оправдано додавањето на маслиновото масло кај овој тип на барени колбаси.

Клучни зборови: народен колбас, крањски колбас, мононезаситени масни киселини, полинезаситени масни киселини, заситени масни киселини, квалитет