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APPLICATION OF GROUND GOJI BERRY FRUITS IN MACEDONIAN BACON-FOLK SAUSAGE

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Abstract

The effect of addition of ground goji berry fruits (GGBF) in different concentrations on the heat treatment weight loss, proximate composition, fatty acid profile and sensory characteristics of semi-durable bacon-folk sausage was determined.

Four sample groups of sausage were examined: control group – without addition of goji berry and three experimental groups with addition of 0.1%, 0.3% and 0.5% of GGBF. The addition of GGBF to the filling mass does not influence the heat treatment, weight loss and proximate composition of the sausages, but changed in degree the fatty acids composition of the examined sausages.

On the first day of production, the statistically significant differences ($p < 0.05$) of sensory scores for cross-sectional view and colour between the control group and groups III and IV were determined.

Key words: antioxidant effect, sausages, technological properties, quality

Introduction. Various additives, such as plant proteins, omega-3 fatty acids, plant fibres, inulin, probiotics, oligofructose, soy proteins, brewer's yeast proteins, parts of plants, or extracts, such as muscat flower, garlic, cardamom, black pepper, coriander, onion, basil, sage, green tea, pumpkin seed, etc. are added in meat, especially in meat products. Some of them are used because of their antioxidant and antibacterial effect, and some of them in order to enhance the quality of meat and meat products [1–6].

In the last few years, the interest for goji berry application is getting bigger. Examinations on the impact of goji berry fruits to human health have been conducted. Those examinations indicate that goji berry fruits have impact on the

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increase of organism's resistance and improvement of food digestion [7–10]. There are no sufficient data for usage of goji berry in meat products worldwide. In our country there are no data at all. That is why the objective of this study was to determine the influence of GGBF addition on: heat treatment weight loss, chemical composition, acid degree and peroxide number, microbiological status, fatty acid composition and sensory characteristics of semi-durable bacon-folk sausage.

Material and methods. Semi-durable bacon-folk sausage was used as an object of examination. According to the Regulation on requirements in terms of quality of minced meat, meat preparations and meat products [11], the bacon-folk sausage belongs to the group of semi-durable meat products. The sausage was produced in accordance with all sanitary and veterinary rules applicable in the Republic of North Macedonia. The sausage formulation was: 3 kg/100 kg chicken mechanically separated meat (MOM), chicken over duck 12 kg/100 kg, 35 kg/100 kg swine trimmings, 40 kg/100 kg backfat, 3 kg/100 kg leek, four different concentrations of ground goji berry fruits depending of the production batch, 1.7 kg/100 kg sodium chloride, 0.400 kg/100 kg spicy mix Koleks, 0.500 kg/100 kg polyphosphate, emulsifier 2.0 kg/100 kg and 5.0 kg/100 kg flaky ice.

The dried goji berry fruits were ground with mixer, and sodium chloride was put as an additive. Ground goji berry fruits (GGBF) were put during preparation of the sausages' filling mass. It was stuffed in porcine small intestines. Four groups of bacon-folk sausage were prepared in this experiment:

Group I: without addition of GGBF (control samples)

Group II: with addition of 0.1% GGBF

Group III: with addition of 0.3 % GGBF

Group IV: with addition of 0.5% GGBF

After stuffing and draining the sausages were dried for 35 min at 50–55 °C, smoked for 20 min at 60–62 °C and cooked for 35 min at 76–78 °C, i.e. until the temperature in the product centre reached 69–72 °C. After heat treatment, the sausages were chilled and after that vacuumed with Vebomak vacuum machine. After vacuuming, the sausages were stored in refrigerator at 0–4 °C.

Heat treatment weight loss. After stuffing and thermal processing, the sausages were weighed on electronic weight scale. The difference in sausages weight provides the heat treatment weight loss.

Proximate composition. The content of proteins was determined as total nitrogen (TN) according to the Kjeldahl method. For the moisture content determination standard method was used by drying at 103 ± 2 °C to constant mass, total intramuscular fat content was determined by extraction method using Soxhlet apparatus, and the ash content was determined by burning and combustion for 4–5 h at 525–550 °C.

Fatty acid composition of the sausages was determined with a gas chromatography according to AOAC 996.06 method. The GC-FID-7890 A with appliance of the tool gas chromatograph with Flame Ionizated Detector was used. The total

intramuscular fat from the analyzed samples of sausages was extracted by acid hydrolysis. The pyrogallic acid was added so as to avoid liberation of the fatty acids. The methylation of fatty acids was performed according to AOAC GC-FID-7890 procedure. The obtained methyl esters of fatty acid (FAMES) were analysed using the appliance of gas chromatograph with Flame Ionization Detector and a capillary column (SP®-2560 100 m × 0.25 mm to 0.25 µm). Operating conditions were: injector temperature 225 °C and detector temperature 285 °C. Initial temperature of 100 °C was kept for 4 min increased by 3 °C every minute to a final temperature of 240 °C, hold 15 min. The holder gas was helium with a flow rate of 0.75 ml/min. Certain FAMES from the analyzed groups of sausages were identified separately on the basis of comparison with the retention time standards FAMES (which include *cis* and *trans* isomers of fatty acids) standard mix. The analyzed content of each fatty acid was expressed in percentage (%) after data normalization.

Sensory analysis. Sensory analyses were performed by five trained experts who have over 20 years working experience. The external appearance, cross-sectional view, colour, odour, taste and consistency were examined.

Statistical analysis. The means ± SD of the obtained data were made. The ANOVA analysis using factor of variation and statistic importance by Excel MS Office 2003 software was used for statistical analysis of data. The calculations were done after five repetitions ($n = 5$).

Results and discussion. ***Heat treatment weight loss.*** Results about weight losses of sausages after heat treatment are presented in Table 1. The control group demonstrated the biggest weight loss, in comparison with group III where the smallest weight loss was found. The differences between heat treatment weight losses of four samples are small and statistically insignificant ($p \geq 0.05$).

Proximate composition. A comparison between the first and the 50th day of experiment showed significant ($p < 0.05$) decrease of water content and increase of protein content of all studied samples (Table 2). The differences of proximate composition among four sausage groups were small and statistically insignificant ($p \geq 0.05$). It can be concluded that the addition of GGBF did not influence the proximate composition of the sausages during their storage at 4 °C. Similarly to

Table 1

Heat treatment weight loss of four groups of bacon-folk sausage

Bacon-folk sausage	Mass of sausages after filling (kg)	Mass of sausages after heat treatment (kg)	Heat treatment weight loss (%)
Group I	40.00	34.00	15.00
Group II	40.00	34.20	14.50
Group III	40.00	34.30	14.25
Group IV	40.00	34.20	14.50

T a b l e 2

Proximate composition of four groups of bacon-folk sausage

Parameters (%)	Group I (Control)	Group II	Group III	Group IV
1st day of production				
Water	42.60 ± 0.22^{b}	42.66 ± 0.28^{b}	42.48 ± 0.52^{a}	42.66 ± 0.20^{b}
Fats	42.00 ± 0.72	42.00 ± 0.48	42.00 ± 0.28	42.00 ± 0.22
Proteins	10.57 ± 0.08^{c}	10.30 ± 0.18^{b}	10.20 ± 0.28^{a}	10.70 ± 0.40^{d}
Ash	3.08 ± 0.12^{b}	2.96 ± 0.20^{a}	2.92 ± 0.28^{a}	3.18 ± 0.18^{c}
50th day of production				
Water	40.42 ± 0.18^{a}	42.06 ± 0.28^{c}	41.76 ± 0.42^{b}	42.77 ± 0.40^{d}
Fats	45.00 ± 0.20^{b}	45.00 ± 0.52^{b}	45.00 ± 0.40^{b}	43.00 ± 0.70^{a}
Proteins	10.79 ± 0.28^{b}	10.81 ± 0.52^{c}	10.57 ± 0.48^{a}	10.73 ± 0.20^{b}
Ash	2.86 ± 0.58^{b}	3.00 ± 0.40^{c}	3.07 ± 0.72^{d}	2.00 ± 0.48^{a}

Means $\pm$ SD. The different superscripts ^{a,b,c,d,e} after the standard deviations denote statistical differences amongst samples in each column ($p < 0.05$)

T a b l e 3

Fatty acid composition of four groups of bacon-folk sausage

Fatty acid %	Group I	Group II	Group III	Group IV
C12:0	0.10^{a}	0.11^{a}	0.12^{b}	0.10^{a}
C14:0	1.14^{a}	1.22^{b}	1.18^{a}	1.13^{a}
C16:0	22.31^{c}	22.26^{b}	21.83^{a}	21.90^{a}
C16:1	2.26^{b}	2.41^{d}	2.16^{a}	2.35^{c}
C17:0	0.44	0.42	0.41	0.42
C17:1	0.20	0.21	0.19	0.21
C18:0	12.01^{b}	11.66^{a}	12.30^{c}	11.69^{a}
C18:1n9c	38.92^{a}	39.70^{c}	39.46^{b}	39.93^{d}
C18:2n6c	20.63^{c}	20.03^{a}	20.29^{b}	20.24^{b}
C20:0	0.39	0.41	0.41	0.40
C18:3n6	0.72^{b}	0.65^{a}	0.75^{b}	0.72^{b}
C18:3n3	0.80^{a}	0.85^{b}	0.82^{a}	0.86^{b}
Saturated fatty acids	36.39^{d}	36.08^{c}	35.26^{a}	35.64^{b}
Monounsaturated fatty acids	41.38^{a}	42.32^{c}	41.81^{b}	42.38^{c}
Polyunsaturated fatty acids	22.15^{c}	21.53^{a}	21.86^{b}	1.82^{b}
	100	100	100	100

Means $\pm$ SD. The different superscripts ^{a,b,c,d,e} after the standard deviations denote statistical differences amongst samples in each column ($p < 0.05$)

our results, Bulambaeva et al. [12] demonstrated that in cooked sausages with a reduced amount of nitrites the addition of GGBF can guarantee their good quality and chemical safety.

Fatty acid composition. A little bit higher concentration of saturated fatty acids (SFA) of samples from Group I (36.39%) and Group II (36.08%) were found

Table 4

Sensory evaluation of four groups of bacon-folk sausage

Sensory evaluation	Group I	Group II	Group III	Group IV
1st day of production				
External appearance	7.20 ± 0.10^{a}	7.70 ± 0.20^{b}	$8.40 \pm 0.0.40^{c}$	$8.60 \pm 0.0.48^{d}$
Cross-sectional view	7.42 ± 014^{a}	8.10 ± 0.28^{b}	8.80 ± 0.18^{c}	9.20 ± 0.20^{d}
Colour	7.20 ± 0.28^{a}	8.20 ± 0.48^{b}	8.90 ± 0.18^{c}	9.40 ± 0.24^{d}
Smell	8.00 ± 0.42^{a}	8.20 ± 0.22^{b}	8.20 ± 0.18^{b}	8.40 ± 0.20^{c}
Taste	8.00 ± 0.28^{a}	8.30 ± 0.18^{c}	8.20 ± 0.48^{b}	8.40 ± 0.52^{d}
Consistence	7.80 ± 0.12^{b}	7.90 ± 0.28^{c}	8.60 ± 0.42^{a}	8.60 ± 0.14^{a}
Average value	7.43	7.93	8.45	8.61
50th day of production				
External appearance	7.10 ± 0.20^{a}	7.50 ± 0.18^{b}	8.00 ± 0.28^{c}	8.20 ± 0.22^{d}
Cross-sectional view	7.40 ± 0.10^{a}	7.50 ± 0.14^{b}	8.20 ± 0.22^{c}	8.20 ± 0.12^{c}
Colour	7.00 ± 0.24^{a}	7.50 ± 0.44^{b}	7.70 ± 0.50^{c}	7.80 ± 0.28^{d}
Smell	7.50 ± 0.18^{a}	8.20 ± 0.24^{d}	7.80 ± 0.42^{b}	8.00 ± 0.22^{c}
Taste	8.00 ± 0.28^{d}	7.70 ± 0.18^{c}	7.20 ± 0.42^{b}	6.80 ± 0.24^{a}
Consistence	8.10 ± 0.14^{c}	7.80 ± 0.24^{b}	7.40 ± 0.44^{a}	8.40 ± 0.20^{d}
Average value	7.5	7.63	7.71	7.90

Means ± SD. The different superscripts ^{a,b,c,d,e} after the standard deviations denote statistical differences amongst samples in each column ($p < 0.05$)

in comparison with their content in Groups III and IV (Table 3). The deviations of percentage of polyunsaturated fatty acids (PUFA) were just 0.62% – between 21.53% and 22.15% (Table 3). The highest content for monounsaturated fatty acids (MUFA) was found in samples from Group IV (42.38%), and the smallest in Group I (41.38%).

With the remaining fatty acids, the percentage ratio varies between the groups (Table 3). According to Valsta et al. [13] in bovine muscle tissue, saturated fatty acids are the most common. Wettsell et al. [14] stated that saturated fatty acids in beef account for 80% of the total fatty acids. Ševic et al. [15] examined the fatty acid composition of meat from the Mangulica and Landras breeds and established that saturated fatty acids in the meat of these two breeds of pigs are 33.31 and 38.74%, polyunsaturated fatty acids 11.15 and 12.33%, and monounsaturated fatty acids 41.83 and 50.25%.

It can be noted that the different concentration of GGBF used in the sausages does not affect the fatty acid composition of sausages from three experimental groups, with the exception of the C16 (palmitic acid) concentration.

If we compare our results with those obtained by the authors mentioned above, certain differences are established because they examined the fatty acid composition of different breeds and meat (beef, pork).

Sensory evaluation. Both on the first and on the 50th day of the production, the control group obtained lower sensory scores compared to the other

three groups (Table 4). On the first and the 50th day, none of the investigated sausages groups showed statistically significant differences in sensory characteristics: appearance, odour, taste and consistency. On the first day of production, there are statistically significant differences ($p < 0.05$) in the sensory characteristics of cross-sectional view and colour between the control group I and groups III and IV. Most likely, this is a result of the influence of sodium nitrite and the use of GGBF, which are red, and most likely influence the colour formation of examined sausages. SERIKKAISAI et al. [16] have determined that the addition of 1.0% goji berries and 0.5% pumpkin seeds enhances the sensory characteristics (colour) of smoked beef. In addition O'KEEFE and WANG [17] have determined that the peanuts extract has good impact on quality and durability of beef products, too.

Conclusions. From the performed examinations, it could be concluded that ground goji berry fruits do not have impact on heat treatment weight loss, proximate composition, fatty acid composition of examined groups of sausages. On the first day of production, there are statistically significant differences ($p < 0.05$) in the sensory characteristics, cross-sectional view, and colour between sausages without GGBF and those with 0.3 and 0.5% GGBF addition which indicates impact of ground goji berry fruits on the colour of examined sausages.

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