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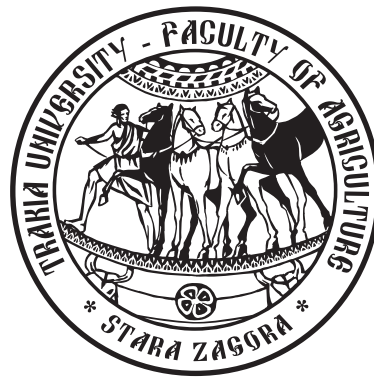
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Influence of Goji berries on oxidative changes, microbiological status and chemical properties of sausages

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Abstract. The objective of this study was to investigate the influence of dried and minced goji berries over the oxidative changes (acid level, peroxide value), microbiological status and chemical properties on semi-durable sausage vacuumed and kept at a temperature of +4°C. Therefore, four types of sausages were made. The study was carried out on the 1st, 10th, 25th, 35th, and 50th day of the production of the sausage groups. The acid level of all examined groups of sausages is increasing, and the highest increase is registered in the control group of sausages (2.08). During the storage of the sausages, the peroxide value increased from the first to the fiftieth day. The presence of *Listeria monocitogenes*, *Salmonella*, *Escherichia coli*, *Staphylococcus aureus* was examined as well as the number of aerobic bacteria. In all examined groups, none of the abovementioned bacteria were identified. During the storage of sausages, the number of aerobic bacteria ranged from 2.08 to 2.93 log/CFU/g, which was much lower than the permissible limit (7.00 log/CFU/g) according to the national legislation. The fruit of goji berry doesn't have a significant effect on the chemical composition of the studied sausage groups.

Keywords: goji berries, semi-durable sausages, chemical compositions, microorganisms

Introduction

The demands of consumers for meat products are directed towards quality and safety, along with flavor and taste characteristics of the product (Shaikh et al., 2006). The quality of meat products can be improved by applying a variety of powdered spice plants or their extracts which have an antioxidant, antimicrobial effect and favorably affect the sensory evaluation of the product (Antulovich et al., 2002; Sonza et al., 2005). Many studies have been carried out on the influence of different spice plants, including extracts (garlic, onions, basil, sage, green tea, pumpkin seeds) on the oxidative changes, microbial status and chemical composition of meat products (Zhanchez et al., 2010; Rohlik and Pipek, 2011, 2012; Kuzelov et al., 2015). Lately, there has been great interest in the goji berry plant, especially its fruits, which are examined mainly for medical purposes.

Goji Berry (*Lycium barbarum*) is a bush from the family *Solanaceae*. The use of leaves and seeds is mentioned in several medical books (Stuart and Smith, 1911). In addition to China, Goji is part of the medical tradition in other Asian countries, including Vietnam, Korea, Japan (Bich et al., 1999). Studies were carried out on the influence of the goji fruits on the resistance of the human organism and in general the improvement of the health of people. The fruits of goji berry as freshly squeezed fruit juices, concentrated drinks or in dry form have been used for thousands of years in the traditional Chinese medicine. Polysaccharides are the most important group of substances in the goji berry fruits. In some literature data these compounds in dry fruits can reach a value of 23% (Yin and Dang, 2008). These are carotenoids the content of which increases during the maturation process (Piao et al., 2005). Studies show that goji berry fruits contain a wide spectrum of phytochemicals, vitamins B1, B2 and B6, minerals - Fe, Zn and

Cu, aminoacids (proteins), fatty acids and specific antioxidants so that many health experts call them “super food of berries”. They increase the organism's resistance towards viruses and bacteria and influence better food digestion. There is a positive relation between the intake of fruits from this fruit and the health (hypoglycaemia, immunomodulation, anti-hypertension, liver function, anti-aging, antioxidant activity). Cold cooking oil from goji berry is a valuable product that can have a significant effect on human health. The high level of oleic and linolenic acid, as well as the high amount of α and γ -tocopherols makes this oil suitable for human consumption (Bone et al., 2003; Potterat et al., 2008; Bucheli et al., 2011; Kocugid and Sanlier, 2017).

Since there are very few publications in the available literature on the application of goji berry fruits in meat products and their impact on the oxidative properties, the microbiological status and the chemical composition of meat products, the aim of our research was to investigate the impact of different fruit concentrations from goji berry on these parameters in a semi-durable sausage.

Material and methods

For the purpose of the study, semi-durable bacon-folk sausages were used. According to the requests for the quality of minced meat, preparations of meat and meat products (Off. Gazette of RM No.63/2013) the bacon-folk sausage belongs to the group of semi-durable roughly minced sausages. The sausage was produced according to the Sanitary and Veterinary Regulations of R. Macedonia.

The sausage recipe included the following components: the samechicken moms - 3.00 kg, chicken over a duck - 12.00 kg, swine trimming - 35.00 kg, hard fat - 40.00 kg, nitrite salt - 1.7 kg, spice

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mixture - 0.400 kg, phosphate - 0.500 kg, emulsifier - 2.0 kg and hard water-frost - 5 kg. The goji berry dried fruits were minced with a mixer by adding nitrite salt as bearer before they were applied. The minced fruits of goji berries were applied during the preparation of the mixture.

The experiment was carried out with four groups of bacon-folk sausage as follows: Ist group – without adding of goji berry (control group); IInd, IIIrd and IVth group – by adding 0.1%, 0.3% and 0.5% goji berry, respectively.

After the filling and draining of the sausage, its heat treatment was started. Heat treatment was made according to the following formula: Drying 35 min, Smoking 20 min at 62°C, Boiling 35 min at 78°C or until the temperature inside the product reached 69-72°C. Following the heat processing the sausages were vacuumed with a vacuum measure - Vebomak. After the vacuuming, the sausages were kept in a chamber at a temperature of +4°C.

The acidity and peroxide value were examined on the 1st, 10th, 25th, 35th and the 50th day of production. Acid degree value was tested according to the MKC EN 1410 (2007) method. Peroxide value was tested according to the MKC method ISO 27107 (2011).

For microbiological analysis, from each sample 20g of material were taken which before the seeding was homogenized with 180ml of distilled water and the appropriate dilutions were made. The number of bacteria is represented as log/CFU/g.

The microbiological quality of sausage groups was examined on the 1st, 10th, 25th, 35th and 50th day of production. For the microbiological analysis the presence of *Listeria monocytogenes* was examined according to the MKC EN ISO 11290-1:2008 method; *Salmonella* species according to the MKC EN ISO 6579: 2008 method; *Escherichia coli* according to the MKC EN ISO 16649-2: 2008 method; *Staphylococcus aureus* according to the MKC method EN ISO 6888-2: 2008 and number of *Aerobic bacteria* according to the MKC EN ISO 4833-1: 2013 method.

Total nitrogen (TN) was determined according to the Kjeldahl method, moisture content by drying at 103±2°C to constant mass; the intramuscular fat content – the Soxhlet method, ash by burning and combustion (4-5h) at 525-550°C.

The results obtained were statistically processed by determining mean value, variation measures, variation analysis, factor of the variation and statistic importance, ANOVA single factor (Excel MS Office 2003).

Results and discussion

The results of the study for the acid level and the peroxide value in the tested groups of folk-bacon sausage are given in Figures 1 and 2. The acid level in all groups of the tested sausages is increased and the highest increase has been registered in the control group of sausages (2.08–2.65). The peroxide value of the control group at the beginning was 1.02±0.07 mmol/kg and 0.76±0.04 mmol/kg in group IVth with an addition of 0.5% minced goji berry fruit. The peroxide number from the 1st to the 50th day (during the storage of the sausages at temperature of +4°C) increases. The highest increase was in the control groups (1.02±0.07 mmol/kg; 0.40±0.09 mmol/kg; 1.04±0.08 mmol/kg; 0.71±0.05 mmol/kg; 0.90±0.02 mmol/kg) and the lowest in group IVth (0.76±0.04 mmol/kg; 0.47±0.002 mmol/kg; 1.09±0.07 mmol/kg; 0.74±0.08 mmol/kg; 0.82±0.04 mmol/kg).

According to Matiasević Biserka (1963) the sensory changes of the sausages are perceptible only when the value of peroxide is higher than 5 mmol/kg. It can be concluded that the process of

oxidation in the examined samples is not provided. The low values of the acid level and the peroxide value that we obtained in our research are probably result of the small oxidative activity of the applied minced fruits of goji berries and the vacuuming of the sausages.

Seirkaisai et al. (2014) investigated the influence of dried fruits of goji berries and powder of pumpkin seeds over smoked beef meat with decreased contents of nitrites and determined that with the application of 1.0% goji berry and 0.5 % pumpkin seeds the sensory characteristics (colour) of the smoked beef meat is improving. Bulambaeva et al. (2014) reported that the usage of goji berries and pumpkin seeds in the sausage production influences the improvement of the sensory characteristics of the sausage. Kulczynski and Gramza-Michalowska (2016) state that goji berry can be an effective supplement in the prophylaxis of diseases.

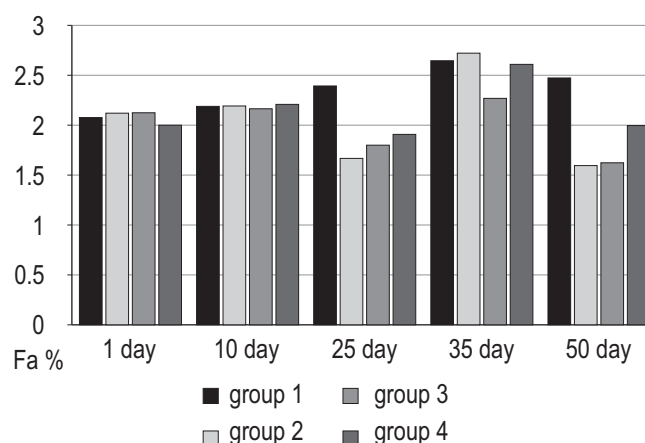


Figure 1. Change in the degree of acidity in the four groups of bacon-folk sausages tested during vacuum storage at +4°C

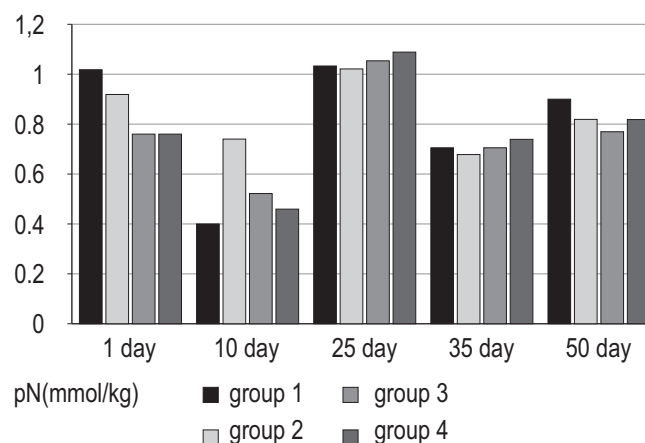


Figure 2. Changes of peroxide values in the four groups of bacon-folk sausage tested during vacuum storage at +4°C

The results of the microbiological status of the sausages are given in Table 1. The results show that during all of the research stages none of the examined sausages registered the presence of *Listeria monocytogenes*, *Salmonella species*, *Escherichia coli* and *Staphylococcus aureus*. Only the number of aerobic bacteria is determined. Regarding the sausage quality based on the microbiological status there is no significant difference between the examined groups of sausages.

Table 1. Microbiological status of the bacon-folk sausage (log CFU/g) (Mean±SD)

Days	Group I Control	Group II	Group III	Group IV	Significance
1	2.93±0.22	2.53±0.12	2.18±0.18	2.76±0.28	NS
10	2.86±0.18	2.08±0.42	2.82±0.22	2.50±0.20	NS
25	2.52±0.52	2.11±0.42	2.68±0.18	2.72±0.48	NS
35	2.76±0.10	2.70±0.28	2.76±0.12	2.85±0.22	NS
50	2.51±0.18	2.75±0.58	2.69±0.48	2.77±0.42	NS

*NS – not significant

Table 2. Chemical composition of bacon-folk sausage (Mean±SD)

Parameters (%)	Group I Control	Group II	Group III	Group IV
		1 st day of production		
Water	42.60±0.22	42.66±0.28	42.48±0.52	42.66±0.20
Fats	42.00±0.72	42.00±0.48	42.00±0.28	42.00±0.22
Proteins	10.57±0.08	10.30±0.18	10.20±0.28	10.70±0.40
Ash	3.008±0.12	2.96±0.20	2.92±0.28	3.18±0.18
		50 th day of production		
Water	40.42±0.18	42.06±0.28	41.76±0.42	42.77±0.40
Fats	45.00±0.20	45.00±0.52	45.00±0.40	43.00±0.70
Proteins	10.79±0.28	10.81±0.52	10.57±0.48	10.73±0.20
Ash	2.86±0.58	3.00±0.40	3.07±0.72	2.00±0.48

In any of the analyzed sausage groups, the total number of bacteria did not exceed the referent level of 7log/CFU/g. From the 1st to the 50th day, the total number of aerobic bacteria ranged from 2.08±0.42 to 2.93±0.22 logCFU/g, which is probably the result of vacuuming and good hygiene practice in the production area where the sausage groups were produced.

From the results in Table 2 it can be seen that the water content from the 1st to the 50th day of production in all investigated groups decreases, and the content of proteins increases. The differences in chemical composition among sausage groups are small and statistically insignificant. From this it can be concluded that the fruits of goji berry have no effect on the chemical composition of the sausage during storage at +4°C.

Conclusion

The obtained results indicate that the low levels of the acid and the peroxide values are probably a result of the anti-oxidative activity of the applied minced goji berry fruits and vacuuming of the sausages. The fact that in none of the tested sausage groups bacteria (*Listeria monocitogenes*, *Salmonella species*, *Escherichia coli* and *Staphylococcus aureus*) were not determined is due to the good hygiene practice where they are produced, and not to the antimicrobial effect of the goji berry fruits. The fruits of goji berry have no statistical proven effect on the chemical composition (water, fats, proteins, ash) of the sausage during storage at +4°C.

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Mauff G, Pulverer G, Operkuch W, Hummel K and Hidden C, 1995. C3-variants and diverse phenotypes of unconverted and converted C3. In: Provides of the Biological Fluids (ed. H. Peters), vol. 22, 143-165, Pergamon Press. Oxford, UK.

Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows, IXth International Conference on Production Diseases in Farm Animals, September 11-14, Berlin, Germany.

Thesis:

Hristova D, 2013. Investigation on genetic diversity in local sheep breeds using DNA markers. Thesis for PhD, Trakia University, Stara Zagora, Bulgaria, (Bg).

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Animal welfare

Studies performed on experimental animals should be carried out according to internationally recognized guidelines for animal welfare. That should be clearly described in the respective section "Material and methods".

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