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INTRODUCTION

In the past twelve 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 2nd International Meeting Agriscience & Practice (ASP 2019), giving an opportunity to the participants for presentation and discussion of original scientific and practical results in different fields of agriculture.

The 2nd International Meeting Agriscience & Practice (ASP 2019), held on 12 April 2019 at the 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 2019 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 North Macedonia and wider in the region.

Journal of Agriculture and Plant Sciences Vol. 17, No. 2 mostly contains the presented papers from the 2nd International Meeting Agriscience & Practice (ASP 2019).

Editorial Board,

December, 2019

Editor in chief,

Prof. Liljana Koleva Gudeva, PhD



IMPROVEMENT OF THE PRODUCTION TECHNOLOGY OF MEAT PRODUCTS WITH THE ADDITION OF FUNCTIONAL COMPONENTS

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Abstract

Functional food is a food where a new ingredient has been added to a food and the new product has a new function (often one related to health-promotion or disease prevention). Functional foods are one of the most important segments of the food industry. Many food products including fruits, vegetables, wine and cheese have been found to contain components with potential health benefits. In addition to these foods, new foods are being developed to enhance or incorporate these components.

The paper presents research related to the improvement / enrichment of meat products, produced in the meat industry in the Republic of N. Macedonia. The research relates to durable and semi-durable sausages and their production technologies in which various functional components are added: vegetable oils, antioxidants, probiotic. From the obtained research results, it can be concluded that the addition of functional components has contributed to improving the quality without changing the sensory properties of the products, the health benefits of consumers and the expansion of the assortment of meat products.

Key words: *functional food, quality, sausages, meat industry*

INTRODUCTION

Scientific progress in understanding the relationship between nutrition and health has an increasingly profound impact on consumer's approach to nutrition which has resulted in the development of the concept of functional foods. It is a practical and new approach to achieve optimal health status by promoting the state of well-being and possibly reducing the risk of disease. The term "functional foods" comprises some bacterial strains and products of plant and animal origin containing health-promoting physiologically active compounds in addition to the traditional nutrients which are beneficial for human health and reducing the risk of chronic diseases (Bhat & Bhat, 2011).

There are three basic requirements for a food to be regarded as functional: (i) it should be a food derived from naturally occurring ingredients; (ii) it should be consumed as a part

of the daily diet; and (iii) once ingested, it must regulate specific processes such as enhancing biological defence mechanisms, preventing and treating specific diseases, controlling physical and mental conditions, delaying the ageing process etc. (Goldberg, 1994; quoted by Verma & Banerjee, 2009).

Meat and meat products have many disease-preventing, health-promoting benefits, which according to a research makes them a viable option to be used as functional foods.

Meat contains many important nutrients, including bioactive compounds such as taurine, L-carnitine, creatine, conjugated linoleic acid (CLA) and endogenous antioxidants. Meat also contains unique endogenous antioxidants including carosine, anserine and others, along with iron and zinc, nutrients often lacking in the average diet and also contains a significant

source of vitamin B-12 (Leroy, 2006). Meat and meat products could be made more functional with some modifications. Modification of fatty acid and cholesterol levels in meat may be influenced by selection of breeds and genetic lines, changes in animal feeding practices and

additional ingredients added during meat processing (Leroy, 2006).

Adding probiotics to fermented meat products (i.e. sausage) may lead to health benefits, although this application is still marginal.

FUNCTIONAL COMPONENTS AND SUPPLEMENTS THAT FULFILL A HEALTH EFFECT INTO MEAT PRODUCTS

Numerous studies have sought to demonstrate the possibility of changing the image of meat and meat products from the traditionally accepted image to one of healthy living thanks to the addition (vegetables, extracts, fibers, and so forth), elimination (fats), and reduction (additives) of different ingredients (Fernàndes-Ginès et al., 2006).

When incorporating supplements and functional components into meat products, they may be declared as functional foods if they on one hand attain and fulfill the expected effect and it is also necessary to ensure that the products would ultimately preserve their specific properties, moreover the sensory properties, on the other hand. Functional components and supplements that fulfill a health effect can affect the flow of production and storage changes in different ways. Some of these supplements reduce and some increase the pH value of fermented sausages (Vasilev, 2009), while vegetable oils do not actually affect the pH changes. The physico-chemical and sensory characteristics of the meat products depend on the intensity of the change in pH. The pH value significantly affects the colour, firmness and aroma of fermented sausages. The presence of bioactive peptides, the application of functional starter cultures that produce antimicrobial compounds or probiotic strains, are significant potential during the production of fermented meat products, primarily fermented sausages. The above-said compounds and microorganisms can contribute to improving the quality of health and safety products. Most of these compounds contain substances that are not naturally active, but upon release from the rest of the complex protein molecule, these compounds become biologically highly active (presenting antihypertensive, antioxidant, immuno-stimulatory, antimicrobial and antimicrobial activity).

Grujić et al. (1988, 1989, 1990a/1990b) investigated the impact of soy protein and

brewer's yeast protein on the technological properties (rheological and color properties) and health effects of semi-durable sausages. Research has led them to conclude that the addition of these proteins to meat products has a significant effect on the increase of essential minerals and essential amino acids (tryptophan and arginine). The addition of fiber in meat products, affects the reduced energy value of the finished product, and thus the prevention of many chronic diseases (colon cancer, obesity, cardiovascular disease, etc.).

Sadri and Mahjub (2006) found a positive correlation between the addition of fiber and oils and colon cancer. Several studies have shown that dietary fiber has the ability to affect lowering LDL cholesterol in the blood, the risk of type 2 diabetes mellitus, the risk of coronary heart disease, the risk of blood pressure, the risk of obesity and the risk of colon cancer, (Willet et al., 2002; Liu et al., 2003; Schatzkin et al., 2007).

Jimenez-Colmenero et al. (2003) investigated the nut supplement in a restructured steak and found that the supplement affects changes in product properties during heat treatment, but also in color, texture, and sensory properties, making the product softer and providing better water binding.

Potential probiotic strains *Lb. rhamnosus* LG, *Lb. rhamnosus* L-705, *Lb. rhamnosus* E-97800 and *Lb. plantarum* E-98098 have been successfully used in the production of traditional fermented sausages (Erkilä, 2001).

Vukovich et al. (2009) in their research used a probiotic of the genus *Lb. chasseur* (LH 01) in functional fermented beef and pork sausages. The prebiotic used reached more than 8 log CFU/g, fermenting the sugars, creating favorable ripening conditions. The same authors conclude that functionally fermented sausages have a high biological value and a positive effect on human health.

Concerns about dietary sodium depletion are an important issue for the meat processing

industry (Lilić & Matekalo-Sverak, 2011). Decreasing the amount of sodium chloride affects the reduction of water retention and emulsifying properties of proteins in meat.

Procedures during meat processing that

lead to increased fat content, saturated fatty acids, salt and nitrite have attracted particular attention from researchers investigating the impact of human nutrition on health and the examination of functional foods.

CURRENT CONDITION OF THE MEAT PROCESSING INDUSTRY IN REPUBLIC OF NORTH MACEDONIA

According to the Food and Veterinary Agency data there are 50 meat and meat processing facilities registered in Macedonia. 12 of them are completely out of work, and some of them do not operate out of incompletely clarified reasons. 38 facilities still operating and 15 are registered to produce semi-durable and durable products with a capacity of 45,000 tonnes per year in one shift. As of the installed production facilities, 94% are owned by companies. With a total of 11,500 tons of processed meat last year, only 28% of the potential production capacity of 45,000 tons of semi-durable and durable meat is used, which is shocking. Out of the total processed meat, only 1,700 tons, or only 15%, are from domestic producers, i.e. meat from domestic producers. The rest comes from imports. In 2018, 2,936,495 kg of meat products were exported, and in 2017 2,070,904 kg, which is an increase of 41.7%, while imports last year amounted to 6,039,749, and in 2017 was 6,744,566 kg, which is decreased by

10.4% (Petrovski, 2017).

Macedonian meat processing companies offer mainly durable and semi-durable meat products. At the same time, the domestic meat industry is characterized by large investments, new facilities, machinery and processing technologies. It is in this context that, given the increasingly stringent requirements regarding the composition and nutritional value of food, meat industries need to set up and develop a new generation of meat preparations with the addition of functional components that will have high biological value and be accepted on the domestic market for its quality. From the range of processed meats mainly durable and semi-durable sausages can be modified to avoid the standard recipe for production of animal fat and spices. In order to meet the pre-set consumer demands and achieve greater competitiveness, the meat industry is facing a major challenge in finding new recipes with the addition of functional components.

Current condition of the meat products functional components produced in Macedonian meat factories

There are several studies on the addition of functional components into the meat products, produced in our meat factories. Various vegetable oils, antioxidants and probiotics were mainly added from the functional components.

Olive oil is a vegetable oil with the highest level of monounsaturated fatty acids (MUFA) and has attracted attention as a fat replacement in meat preparations. The oil has a high biological value due to the favorable blend of predominantly monounsaturated fatty acids (MUFAs) and naturally occurring antioxidants including vitamin E, vitamin K, carotenoids and polyphenols.

Kuzmanovski (2018) investigated the effects of different concentrations of added olive oil on the quality and sensory properties of semi-durable coarse-chopped sausages - from a range of Kranj sausages and National sausages, produced according to the Product Specification, in the domestic meat industry in

the country. Four groups of these two types of sausages have been produced. The first group was produced without addition of olive oil (control group), the second one with addition of 3g/kg, and the third one with addition of 4g/kg and the fourth group with addition of 5g/kg olive oil. After production, the groups of sausages were vacuumed and stored in refrigerator at temperature from 0 to +4°C. From the performed examinations and the obtained results, it could be concluded that the used concentrations of cold-pressed oil in the groups of sausages do not have impact on their chemical composition. Used concentrations of cold-pressed oil do not have impact on the oxidative changes of the examined groups of sausages, which means that olive oil fills antioxidant, antibacterial and functional properties. The ratio of PUFA / SFA in these sausage batches is 0.4%, which means that this group also satisfies the lipid content requirements of the product.

Sunflower (*Helianthus annuus* L.) besides soybeans, rapeseed and peanuts is one of the four most important oilseed crops worldwide. This oil has a high biological-nutritional value because of its beneficial effect on the functioning of the heart and cardiovascular system and on the maintenance and improvement of the general health of the body (Škorić et al., 2000; Lepšanović & Lepšanović, 2000) quoted by Premović et.al (2015). Pumpkin (*Cucurbita pepo* L.) is used for human and livestock nutrition. Pumpkin seeds are a source of protein, phytosterols, vitamins, glyceride oil, carotenoids, tocopherols microelements (K, Mg, Mn, Zn, Se, Co, Cr, Mo).

Malinov (2019) investigate the impact of cold-pressed sunflower and pumpkin oil on the chemical composition and microbiological quality of Bacon Folk sausages produced in local domestic meat industry. For this purpose, eight groups of Bacon Folk sausages have been produced. The first group was produced without addition of sunflower oil (control group), the second one with addition of 3g/kg, and the third one with addition of 4g/kg and the fourth group with addition of 5g/kg olive oil. According to the same order were produced the sausage groups with the addition of pumpkin oil. Sausage groups with cold pressed sunflower oil and pumpkin, have a slight decrease in the water content on the sixtieth day of production compared to the first day of production. The water content of the first day of production was (52.86% to 54.73% for sunflower sausages group; 52.24% to 54.61% for sausages with addition of pumpkin oil) and (52.71% up to 54.48%; 51.59% to 53.58%) on the sixtieth day of production. Protein content in cold pressed sunflower oil and pumpkin sausages group ranged from (10.85 to 11.54%; 11.65 to 11.95) on the first day and (11.52% to 12.01%; 11.52% to 12.01%) sixtieth day of production. The content of fats and minerals in both produced sausage groups were increasing to the end of production. Pathogenic bacteria were not detected. Used concentrations of cold-pressed sunflower and pumpkin oil in the groups of sausages do not have statistically significant impact on the chemical composition and microbiological quality of the sausages and full field the anti-oxidative effect.

Numerous microorganisms have been studied in the past sixty years, of which only a

few have commercial use in the meat industry. Today, several companies that produce starter culture provide pure cultures of *Lactobacillus* spp., *Pedococci acidilactic*, *P. Pentosaceus*, *Staphylococcus flusus* and *S. carnosus*.

When selecting starter cultures, their impact on the sensory properties of the product should be primarily determined. Incorrect selection of starter cultures and inappropriate technological processes often lead to the accumulation of undesirable metabolic products that can greatly impair the quality of the product and thus pose a health threat to consumers. In order for them to be used in the production of fermented sausages at all, it is necessary to select them. One possibility is to test existing strains that are part of starter cultures in terms of probiotic properties. Thus, for example, co-infected *L. sakei* Lb3 and *P. acidilactic* acid PA-2 have shown the ability to survive in conditions in which the intestinal tract is simulated, (Obradović & Vesković-Moračanin, 2007). In order to be a probiotic property, it is considered measurable that consuming one gram of fermented sausages should bring into the body at least one million probiotic bacteria (Vuković et al., 2009).

Joshevska (2013) evaluated the influence of probiotic and prebiotic on the quality of three production batches fermented sausages produced as functional food in the meat industry in Macedonia. As probiotic is used *Bifidobacterium longum* BB536 and inulin in powder form. The results of physico-chemical and functional parameters, microbiological quality and sensory evaluation can be used towards the introduction and implementation of functional components in the technology of production of this type of sausage in most meat industries in our country, in order to improve the quality and increase market competitiveness. From the investigation, it can be observed that the probiotic bacteria *Bifidobacterium longum* BB536, are intensively developed in the production batches until the 7th day of maturation. The added probiotic culture proved to be well reproduction during the fermentation of the fermented sausage, as it reached 6.63 / 6.03 log CFU/g. According to the adopted standards, the number of probiotic bacteria in functionally fermented products should be greater than 6 log CFU/g (Vukovic et al., 2009).

Goji berry fruits contain a wide spectrum of phyto compounds, vitamins B1, B2 and B6, minerals- Fe, Zn and Cu, amino acids (proteins), fatty acids and specific antioxidants so that many health experts call them "super food of berries".

Mitev (2018) 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 bacon folk sausage vacuumed and kept at a temperature of +4°C. The study was carried out on the 1, 10, 25, 35, and 50 day of the production of the sausage groups. 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. 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. This functional compound it can be used towards the introduction and implementation of functional components in the technology of production of this type of sausage in order to improve the quality of the product.

CONCLUSION

As of the aforementioned research regarding the usage of the functional components in meat products produced in meat processing factories in Macedonia, it can be stated that each addition proved to be successful because it affects the increase of the product's biological value thus to the health benefits

of the consumers, however not deteriorating the physico-chemical composition and the sensory features of the products themselves. Those researches can stimulate the producers to adjust their assortment and increase their market value.

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ПОДОБРУВАЊЕ НА ТЕХНОЛОГИЈАТА ЗА ПРОИЗВОДСТВО НА МЕСНИ ПРОИЗВОДИ СО ДОДАТОК НА ФУНКЦИОНАЛНИ КОМПОНЕНТИ

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Резиме

Функционална храна е храна во која е додадена нова состојка (функционална компонента) и новиот производ има нова функција (честопати поврзана со унапредување на здравјето или спречување на болести). Функционалната храна е еден од најважните сегменти на прехранбената индустрија. Откриено е дека многу прехранбени производи, вклучително овошје, зеленчук, вино и сирење содржат компоненти со потенцијални здравствени придобивки. Покрај овие намирници, се развива

нова храна за зајакнување или вклучување на овие компоненти. Во трудот се дадени истражувања поврзани со подобрување / збогатување на месни производи произведени во месната индустрија во Република Северна Македонија. Истражувањето се однесува на трајни и полутрајни колбаси и нивните технологии за производство, во кои се додаваат различни функционални компоненти: растителни масла, антиоксиданси, пробиотици, пребиотици. Од добиените резултати од истражувањето може да се заклучи дека додавањето на функционалните компоненти придонесува за подобрување на квалитетот без промена на сензорните својства на производите, здравствени придобивки на потрошувачите и проширување на асортиманот на месни производи.

Клучни зборови: функционална храна, квалитет, колбаси, месна индустрија.