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# PRODUCTION OF POULTRY MEAT AND EGGS AS FUNCTIONAL FOOD - CHALLENGES AND OPPORTUNITIES

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Invited paper

**Abstract:** In the last decades people became highly aware of the connection between food and health, especially in developed countries of Europe and USA. Food can only be considered functional if together with its basic nutritional impact it has beneficial effects on human health. It must improve general conditions and/or decrease the risk of the disease. Functional foods should be enhanced with added ingredients not normally found in the product, providing health benefits beyond their nutritional value. Functional foods are intended to be consumed as part of the normal diet but offer the potential of enhanced health or reduced risk of disease. Functional food could be rich in vitamins, omega-3 fatty acids or antioxidants. Poultry meat and eggs have a potential to be considered as a functional food because of the high level of conversion of beneficial nutrients from feed to poultry products. Enrichment of eggs is more pronounced than enrichment of meat because of the higher fat content. Current position and future opportunities of poultry products in production of functional food will be consider in this paper.

**Key words:** functional food, poultry, meat, eggs

## Introduction

In recent decades people have become aware of the strong connection and association between food and their health, especially in developed European countries and USA. They are now trying to contribute to the preservation of their health through adequate nutrition and in this way to diminish the risk of diseases. In this sense, they started to show more interest in the foodstuffs they consume, and also in the quality of poultry meat and eggs. Primarily, the main concern of consumers is that the food they consume is safe, healthy, i.e. free of substances which could directly endanger their health (micro organisms, mycotoxins, pesticides, antibiotics, etc.). Secondly, consumers have shown special interest in poultry products originating from alternative housing systems *(Rodić et al.,2006,*

*Rodić et al., 2010b)*, which are fresh, natural and have reduced content of substances which can pose risk to human health. Therefore, programs which developed production of poultry meat and eggs with reduced fat content *(Milošević et al., 2006; Nikolova et al., 2009)* and cholesterol content *(Stanaćev et al., 2005)* were especially interesting to consumers. In the third phase, consumers perceive food as possibility to realize certain benefit because they are additionally enriched with substances beneficial for their health *(Grashorn, 2005; Weberke, 2005)*, and poultry meat and eggs have huge potential in this aspect.

# Definition of functional food

Most authors define the functional food as food containing active components which exert positive effect on physiological processes in the organism and have beneficial effects on human health *(Singer, 2000; Jimenez Colmenero et al., 2001; Narahari, 2003; Siro et al., 2008)* because they reduce the risk of incidence of various diseases (Table 1).

**Table1. Relationship between n-6:n-3 fatty acids in food and cardiac infarction incidence in different human populations *(Singer, 2000)***

| Country | n-6:n-3 | Proportion of cardiac infarction (% of all deaths) |
|---|---|---|
| Europe/United States | 25:1 to 50:1 | 40 |
| Japan | 12:1 | 12 |
| Greenland | 1:1 | 7 |

Functional food, in addition to its basic nutritional value, must have higher content of certain substances (vitamins, fatty acids, antioxidants, probiotics, prebiotics, etc.) which have positive impact on consumers' health *(Surai et al., 1995 Grashorn, 2005)*. It must be in the shape and form in which it is usually consumed, in other words it cannot be in a form of pill, capsule or similar *(Siro et al., 2008)* and the need/requirement to consume greater quantities of the foodstuff than usual in order for the beneficial effect to be exerted is also not allowed. Poultry meat and eggs represent very good basis that can be enriched with useful and beneficial substances and become functional food, since certain beneficial substances which layers consume in their daily diets transfer relatively easily into their products *(Pritchard, 2003; Grashorn 2005, 2007)*. However, enrichment of poultry meat and eggs can have adverse consequences in regard to their quality *(Grau et al., 2001; Surai et al., 2002)*.

Functional food is interesting also from the economical aspect, because it opens for poultry producers the possibility to introduce new products into their product range. Of course, main assumption is that consumers of enriched products are willing to pay premium price for these products, which is by 15-20% higher

than average product price as stated by *Siro et al. (2008)*. This is a special challenge for our domestic market, since conducted studies have shown that most of the consumers are not willing to accept significant increase of price of poultry products *(Rodić et al., 2010a, Rodić et al, 2010c)*. In the analysis of the consumer attitude and desire to accept and include functional food into their nutrition, *Weberke (2005)* came to the information that this food was easier accepted by older people, as well as those who have family members who are ill, but only few were prepared to compromise if the flavour/taste of functional food was inferior to natural food.

# Poultry eggs

Eggs are very suitable for production of functional food because they can relatively easily be enriched with certain beneficial substances. Because of high fat content of egg yolk, by changing the fatty acid profile of the food lipids, the composition of lipids in eggs can also be altered. Also, all other substances that are soluble in fats may pass into egg, which sometimes is not desirable.

**Omega-3 fatty acids.** Omega-3 fatty acids belong to the group of polyunsaturated fatty acids that are proven to have positive effect on blood vessels and heart, reduce the risk of atherosclerosis, and reduce inflammatory processes and in some cases exhibit anti-carcinogenic effect *(Božić et al., 2000, 2002; Yannakopoulos et al., 2005)*. The fatty acid composition of food lipids has direct impact on fatty acid composition of egg yolk lipids. To date, it is determined that by adding oils rich in omega-3 fatty acids to diets used in nutrition of layer hens, their content in eggs can significantly be increased (Table 2). The main objective is to increase the level of these acids in the egg so that by consumption of one egg daily human requirements are met *(Grashorn, 2005)*. In that purpose, flaxseed oil, rapeseed oil, sunflower oil, fish oil and algae are added to poultry food *(Narahari, 2001; Tserveni-Goussi, 2001; Yannakopoulos et al., 2005).*

**Table 2. Fatty acid composition of some enhanced omega 3 eggs in Greek market (modified from *Yannakopoulos et al., 2005*)**

| | Village eggs | Omega-3 | Bio-omega-3 |
|---|---|---|---|
| Egg weight (white+yolk), g | 53.05 | 52.03 | 54.62 |
| Fatty acid, % | | | |
| C18:2n-6 | 11.24 | 14.44 | 17.57 |
| C18:3n-3 | 0.44 | 4.61 | 5.89 |
| C20:5n-3 | 0.23 | 0.75 | 1.15 |
| C22:6n-3 | 0.32 | 0.80 | 0.91 |
| Total n-3 | 1.90 | 6.15 | 7.96 |
| Total n-6 | 11.24 | 14.45 | 17.57 |
| Omega-6/Omega-3 | 5.9:1 | 2.2:1 | 2.2:1 |

Increase of the content of polyunsaturated fatty acids in eggs can also have negative effect, because eggs become more susceptible to oxidation and change of taste *(Tserveni Goussi, 2001; Surai et al., 2001)*. *Surai and Sparks (2001)* state that the solution is in the simultaneous addition of antioxidants - vitamin E, selenium and carotenoid which increases the stability of polyunsaturated fatty acids during storage period and cooking of eggs, the flavour is improved and egg is additionally enriched with antioxidants.

**Antioxidants.** Content of antioxidants in the egg can also relatively easily be increased since they can be transferred from the animal food into the egg. In this purpose, α-tocopherol (vitamin E), selenium and carotenoids are most often used. Vitamin E and carotenoids can be added in relatively wide range, since they hade no adverse effect on egg quality or consumers *(Grashorn, 2005)*. *Narahari (2001)* states that content of vitamin E in enriched eggs can be increased up to 4 times, and in case of carotenoids, the egg yolk colour must be considered. Adding of selenium must be carefully dosed because this element in higher concentrations is harmful to human health *(Surai, 2002)*. Recommendation is that eggs contain no more than half of recommended human daily requirements, i.e. 35μg Se *(Yaroshenko et al., 2004)*. Presence of organic selenium forms used as food additives in nutrition of layers makes the incorporation of Se into eggs considerably more efficient. It is proven that by providing of 0.3 to 0.5 ppm of organically bound selenium in diet for laying hens, the level of Se in eggs can be increased to 30-35 μg, which is approximately 50% of human daily requirements *(Fisinin et al., 2008)*. *Dvorska et al. (2007)* state that the content of Se in enriched eggs on Russian and Ukraine markets ranges from 20-35 μg, and that their price is by 10-50% higher compared to price of regular eggs. Authors state as an advantage for very developed market of designer eggs in Russia, is that the regulations relating to registration of new products are less complicated than in European Union, but as crucial disadvantage, the lack of knowledge of consumers about the beneficial effect of selenium and other antioxidants on human health is stated.

## Poultry meat

**Omega-3 fatty acids.** Meat, as well as eggs, represents foodstuff which can be used as functional food. Fatty acid profile of poultry meat can be altered depending on the fatty acid profile of food used in poultry nutrition *(Božić et al., 2002; Qi et al., 2010).* As sources of polyunsaturated fatty acids (PUFA) flaxseed oil, rapeseed oil and fish oil are used. *Taulescu et al. (2010)* established that the content of PUFA in broiler muscle tissue increased significantly when flax seed was introduced into broiler nutrition. Inclusion of 7% of flaxseed oil into diets for fattening chickens *Schneiderova et al. (2007)* changed the fatty acid profile of poultry meat lipids in the way that the share of α- linolenic acid in meat increased

significantly. The authors concluded that by adding flaxseed oil the desirable, which means reduced, ratio of n-6/n-3 poly unsaturated fatty acids in poultry meat can be achieved. *Božić et al. (2006)* state that by adding 6% of sunflower and flaxseed oil, the content of PUFA in meat of broiler chickens increased significantly, and atherogenic potential of this foodstuff decreased. Meat can be enriched with omega-3 fatty acids by adding of fish oil, but in this case the problem of change in the flavour/taste of meat occurs *(Grashorn, 2005)*. Similar to eggs, meat with high content of unsaturated fatty acids is more susceptible to oxidation *(Cortinas et al., 2004)*, therefore antioxidants such as vitamin E and selenium should be added to poultry feed.

**Antioxidants.** Along with the enrichment of meat with polyunsaturated fatty acids, the strategy of supplementing of food using antioxidants developed, in order to prevent oxidation of lipids in meat and subsequently improve the sensory quality of meat *(Bou et al., 2004; Grau et al., 2001)*. On the other hand, in addition to this effect, numerous antioxidants also have positive impact on human health, since it was established that α-tocopherol and Se reduce the risk of carcinoma incidence and cardio-vascular diseases *(Grashorn, 2007)*. For this reason, their content in poultry meat is increased, making it functional food. In case of α-tocopherol, its content can be increased by adding α-tocopherol acetate into food for fattening chickens *(Galvin et al., 1998; Surai and Sparks, 2000)*, whereas in case of selenium, this is accomplished by adding inorganic or organically bound selenium to food *(Yaroshenko et al., 2004; Bou et al., 2005)*. In addition to inorganic selenium, as selenium source in feed of broiler chickens also Se-enriched yeast is used, as well as algae, garlic and other herbs as sources *(Skrivan et al., 2010)*. *Surai (2002)* and *Perić et al., (2007a)* state that incorporation of selenium into chicken tissue is considerably more efficient when preparations based on enriched yeast are used. Also, organically bound selenium used in nutrition of chickens has positive impact on other meat quality properties *(Perić et al., 2007b, 2009; Tomović et al., 2006).*

**Table 3. Selected nutritive characteristic in raw brest muscle (BM) (modified from *Skrivan et al., 2010*)**

| Item | Basal diet (BD) (0.11mg Se/kg) | BD + sodium selenite (0.3 mg Se/kg) | BD + selenium enriched alga *Scenedesmus* (0.3 mg Se/kg) |
|---|---|---|---|
| Dry matter (g/kg BM) | $252.2^{b}$ | $257.7^{ab}$ | $260.1^{a}$ |
| Fat (g/kg BM) | 6.2 | 6.9 | 5.5 |
| Crude protein (g/kg BM) | $228.4^{b}$ | $234.2^{a}$ | $236.1^{a}$ |
| Selenium (μg/kg BM) | $57.6^{c}$ | $107.9^{b}$ | $165.1^{a}$ |

$^{a,b,c}$means with different superscript differ significantly

Antioxidants, and especially vitamin E and selenium, can be deposited in the poultry meat in relatively high percentage. *Yaroshenko et al. (2004)* state that

normal content of selenium in meat can be increased by 3 to 4 times. This is especially important in those regions where daily intake of selenium is below optimal requirements, which occurs even in developed European countries *(Bou et al., 2005*). Selenium deficit in nutrition is becoming a global issue *(Rayman et al. 2009)* which could be alleviated to some extent through consumption of poultry meat with higher selenium content.

# Conclusion

In conclusion, it can be stated that production of functional food has a future, in the World, in Europe, and even in Serbia. Share of this food on the market presently is below 1%, and it was estimated that the annual growth in the production of functional food is up to 10% in some developed world countries (USA, Australia, and Great Britain). Increase of production and consumption of functional food is constant and it occurs together with the increase of consumer awareness of the importance of healthy nutrition and its impact on health. Especially important is the impact of functional food in disease prevention (primarily carcinomas and heart disease), and recently, functional food is increasingly used in service of the beauty – to reduce weight, prevent obesity, improve the quality of skin, prevent aging, etc. The major obstacle in regard to consumption of this type of food is its flavour/taste which must not be violated because certain substance has been added, as well as the price of functional food which must be acceptable. Special challenge for this sector of the industry is registration and certification of new products, quality control and scientific verification of its positive effect on consumer health and welfare.

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# Proizvodnja živinskog mesa i jaja kao funkcionalne hrane – izazovi i mogućnosti

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## Rezime

Poslednjih decenija ljudi su postali svesni snažne veze koja postoji između hrane i njihovog zdravlja, posebno u razvijenim zemljama Evrope i SAD-u. Hrana se može smatrati funkcionalnom samo ukoliko pored sa svoje osnovne nutritivne funkcije ima povoljno dejstvo na ljudsko zdravlje. Ona mora da popravlja generalno zdravstveno stanje ljudi i da smanjuje rizik od pojave bolesti. Funkcionalna hrana mora biti obogaćena nekom dodatnom supstancom koja se normalno ne nalazi u toj namirnici (bar ne u toj količini) i mora da bude korisna po zdravlje pored svoje osnovne nutritivne funkcije. Funkcionalna hrana može biti bogata u vitaminima, omega-3-masnim kiselinama ili antioksidantima. Živinsko meso i jaja imaju potencijal da budu funkcionalna hrana zato što postoji visok stepen konverzije korisnih materija iz hrane u živinske proizvode. Obogaćivanja jaja je jednostavnije od obogaćivanja mesa zbog relativno visokog sadržaja masti u žumancetu. U ovom radu prikazano je trenutno stanje i buduća perspektiva proizvodnje živinskog mesa i jaja kao funkcionalne hrane.

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