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ANIMAL PRODUCTS AS COVENTIONAL AND FUNCTIONAL FOOD – AN OVERWIEV

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ABSTRACT

In the present paper, the details about the consumption of animal products worldwide, in Europe and Croatia are given. The consumers' perception about animal products is discussed in the light of raising concern about food-borne diseases, intoxications, GMO products, animal welfare and other issues related to animal production. On the other hand, signs of the consumers demand for more healthy and nutritious foods are stressed. At the food market of the industrialised countries, within past decade as the major trend, functional foods can be detected. Some information is given about different meats, eggs and milk that qualify as functional food. In meats and eggs the emphasize was given on the enrichment of these products with polyunsaturated fatty acids, vitamin E, selenium; the potential of carnosine and conjugated linolenic acid (CLA) are briefly mentioned as their functional properties as ingredients of meats are currently investigated. Dairy products were also discussed in this light. Milk was described as protein vitamin and mineral rich product which has always been considered as a healthy animal product. Beside these beneficial traits, milk and milk products are also rich with CLA and they represent a great proportion of total functional foods produced today globally. As future prospects it is foreseen that functional foods will increase their presence on market in industrialised countries. This should be seen as a great opportunity for the animal products industry but also as a technological and social challenge. The producers of livestock should also be aware of these possibilities.

Key words: food / functional food / animal products / consumption / consumers

1 INTRODUCTION

Animal products have always played an important role in human nutrition. Modern man is a descendant of a hunter/gatherer from the Palaeolithic, yet genetic investigations have proved that genomes of the Palaeolithic and today's man are identical (Hedges *et al.*, 1992; Hammer, 1995). This is of great importance for the nutritional habits of modern man which are still adapted to simple diets from the past; 40 000 years are not long when physiological evolution is in question. However, this diet was substantially altered due to the cultural and civilisation development of mankind. The emerging of the stationary agriculture some 9000 years ago (Neolithic revolution) was certainly of the most significant influence for that. The invention of plough enabled more efficient and faster production of plants and consequently animals, which led to surplus of not only food but also time and resulted in the dawning of first civilisations with their cities, trade and social organisation.

Such developments in assuring of food supplies allowed rapid population growth. From population size of 3 million estimated for the times 10 thousand years B.C. to 50 million by the year about 1000 B.C. during the period in which the majority of the known civilisations emerged. It is believed that at the beginning of the first century A.D. human population counted between 200 and 300 million and that it doubled until 1650. The next doubling happened around 1850 to approximately 1 billion, while by 1930 the world population reached

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2 billion. The last doubling happened at the end of past millennium, 1999, when human population reached the size of 6 billion. According to Sarre (2002), the current growth rate is 2% which means that next doubling could be expected in only 35 years. Probable world population of 10 billion can be anticipated very soon. This puts the mankind in front of new and growing challenges not only in the domain of food production but also of the preservation of environment. The answers to these issues are given through three main standpoints. Pessimistic view is represented by neo-Malthusians, who argue that the population growth is a major threat to our environment and world economy, so according to them food production is not expected to be sufficient in near future. The second standpoint belongs to the group called Cornucopians; it is an optimistic view assuming that population growth is not connected to environmental and economic problems. In this point of view population growth is considered as a stimulus to enhance our ability in problem solving through improved innovative approaches. The third view is neither pessimistic nor optimistic; it has a neutral perspective of the problem.

Nevertheless, food related problems are nowadays notsolely oriented to quantity but also to its quality. This is very well illustrated on the example of changing n-6/n-3 ratio in the human diet during the history. In the Palaeolithic, this ratio was 0.79 (Eaton *et al.*, 1996), but today, in developed countries this ratio has enormously grown to 15 (Sanders, 2000). Because of their importance in the human diet and a complexity of production, animal products such as meat and milk are constantly under particular interest of scientists, animal breeders, food technologists, politicians, activists and others concerned in food issues.

2 CONSUMPTION OF THE MAIN ANIMAL PRODUCTS (MEAT AND MILK)

In the past 50 years, the global food consumption patterns went through significant changes. The main reason for this is the growth of income and urbanisation which occurred in large fraction of developing world where milk consumption almost doubled, meat consumption tripled and more, while egg consumption increased 5 fold as shown on Fig. 1 (Gerosa and Skoet, 2012).

Still, this is well below the level of consumption in the developed countries despite the fact that the proportion of animal products in energy intake and consumption level in these countries declined, which led to the narrowed gap between the two country groups. The trend of gradual converging of developing toward developed countries in terms of food consumption levels and dietary patterns resulted in the increase of the share of animal products in human diets in general with exception of milk. The milk consumption in developing countries is still markedly smaller, which can be partially

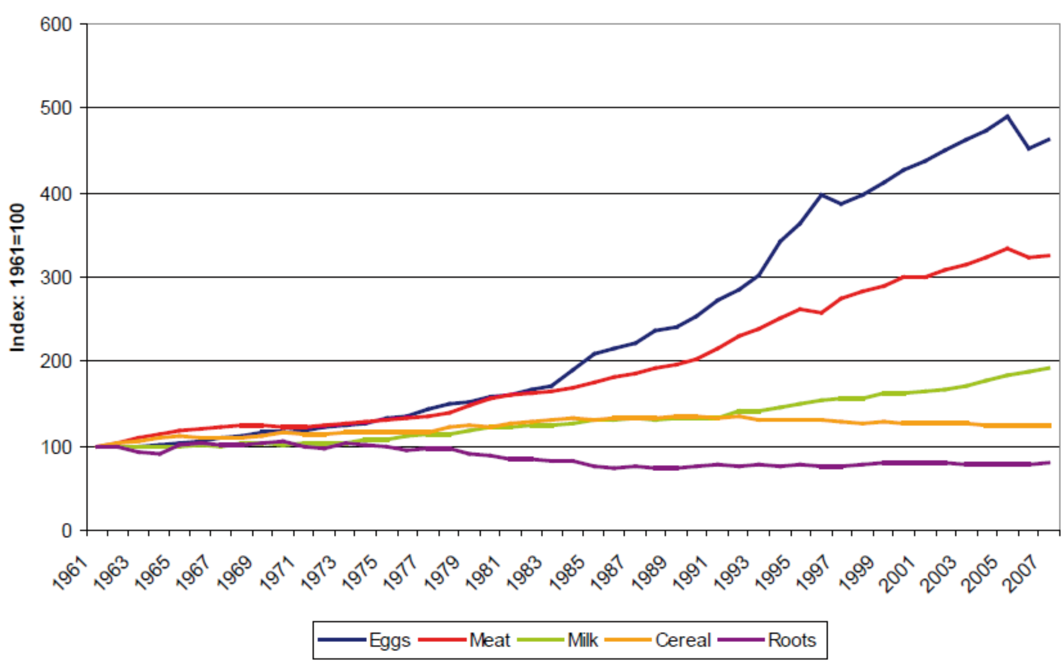

Figure 1: *Per caput consumption of major animal products in developing world*

Table 1: *Milk and dairy products consumption (modified according to Kashtanova, 2010)*

Per caput consumption	1981	1990	2000	2007
World (kg/year)	86	80	104	113
Developed (kg/year)	222	180	235	248
Developing (kg/year)	35	40	56	68

explained by the higher proportion of lactose intolerant population in Africa and parts of Asia (table 1).

Traditionally, in the Western world meat is considered as desirable source of proteins and energy with outstanding gourmet value, which makes it an expansive food. Its importance is constantly increasing also in other parts of the world. As a consequence, the meat consumption is globally growing (table 2).

Table 2: *Trends in meat consumption (modified according to Givens, 2005; WHO/FAO, 2009)*

Per caput consumption	1964-66	1995	2009	2010
World (kg/year)	24.2	35.7	41.3	41.9
Developing (kg/year)	10.2	24.0	31.1	31.8
Developed (kg/year)	61.5	77.3	78.0	78.4

This trend is also followed by positive projections in both meat production and consumption. For instance, Fiala (2008) forecasted that worldwide consumption of meat will rise by 72% between 2000 and 2030, while global production of meat will more than double between 2000 and 2050 as predicted by Steinfeld *et al.* (2006).

The European Union as a world region which certainly belongs to the group of developed countries has substantially high meat consumption as shown in table 3. The table shows the data on *per capita* meat consumption till 2007 and the projections from 2008 to 2013. As it can be noted from the table, dominant role in meat consumption belongs to pork.

Similarly, high and very stable consumption of dairy products in the EU countries can be observed from the data presented in table 4. The dairy is considered as the most prominent sector in the number of EU countries; milk being the main product is produced in every one of them without exception. In terms of value it is the number one single product at approximately 14% of agricultural output (Office for Official Publications of the European Communities, 2006).

In Croatia however, the consumption of animal products is not stable, with the exception of beef and milk, as can be seen from table 5.

For example, from the presented data on pork consumption it can be seen that the highest consumption was recorded in 2010 (19.80 kg) and the lowest in 2000 (14.5 kg); while average consumption of pork in monitored period was 16.35 kg. The average consumption of poultry meat in the period from 2000 to 2006 was 19.36 kg; in the following years it decreased to 16.96 kg in 2008, while in 2010 the increase to 19.10 kg was recorded. The egg consumption varied from 216 eggs in 2001 to 144 in 2008; the average consumption in monitored period was 170 eggs per household member. Interestingly, the consumption of poultry meat and eggs has not declined even in the time of avian influenza burst in the continental part of Croatia in 2005. Gajčević *et al.* (2006) found that only 10.5% of the questioned consumers reduced the consumption of poultry meat and 14% of them reduced the consumption of eggs after they learned about the presence of virus.

3 CONSUMER'S PERCEPTION OF ANIMAL PRODUCTS

The literature sources point out that perception of product quality is influenced by social, economic and cultural factors that affect eating habits. In recent past, this has become a hot topic due to scandals related to food-borne illnesses, intoxications, GMO products, animal welfare and other issues related to animal production. Moreover, there is a growing interest among the consumers related to health considerations where animal products are often associated with negative image such as promoters of cardio-vascular diseases, obesity and cancer. As a result these products are sometimes avoided in

Table 3: *Per capita meat consumption in EU-27 for the period of 2004 to 2013 in kg/year (European Commission, 2007)*

Meat (kg/year/capita)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Beef and veal	17.5	17.3	17.6	17.5	17.4	17.3	17.2	17.1	17.1	17.1
Pork	42.2	42.1	42.1	42.3	42.5	42.5	42.5	42.7	42.9	43.1
Poultry	22.7	23.0	22.5	22.6	22.9	23.1	23.4	23.6	23.7	23.9
Lamb	2.8	2.9	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7
Total EU-27	85.2	85.3	85.0	85.2	85.5	85.6	85.8	86.1	86.4	86.8

Table 4: *EU-25 dairy consumption forecasts (2005–2013) ('000 tonnes)*

Dairy product	2005	2006	2007	2008	2009	2010	2011	2012	2013
Fluid milk	187.6	187.4	187.8	186.8	187.1	187.3	187.6	187.7	188.0
Butter	4.1	4.1	4.0	4.0	3.9	3.9	3.8	n.a.	n.a.
Cheese	17.8	18.1	18.2	18.5	18.5	18.6	18.7	n.a.	n.a.

*n.a. – not available; Source: DG Agriculture, Eurostat, FAPRI, Agra CEAS consulting (2004)

order to reduce these risks which could lead to reduced profitability of subjects involved in the production of food originated from meat and dairy animals. For example, meats and processed meats are often associated with high levels of saturated fatty acids, cholesterol, sodium and high fat (Whitney and Rolfes, 2002); red meat is regarded as cancer promoting food (Ovesen, 2004; Valsta *et al.*, 2005). Similarly, consumption of dairy products, especially with high milk fat content, has been criticized due to the high levels of C-12 to C-18 fatty acids with supposedly negative effect on human health (Molkentin, 2000).

On the other hand, there are obvious signs of the consumers demand for more healthy and nutritious foods. Moreover, regarding the food market changes in the industrialised countries within past decade there is one major trend reflected in consumer interest in food products that can contribute to their health (Mollet and Rowland, 2002) or alleviate the symptoms of ageing and illness (Gray *et al.*, 2003). The products with benefits exceeding their nutritional value are often called functional foods.

4 ANIMAL PRODUCTS AS FUNCTIONAL FOODS

Kralik *et al.* (2010) stated that according to FUFOSE program of the European Commission there is no exact definition of functional foods, but the so called working definition defines that food can be considered as functional if "together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases. The amount of intake and form of the functional food should be as it is normally expected for dietary purposes. Therefore, it could not be in the form of pill or capsule just as normal food form"(Dipplock *et al.*, 1999). The term functional food was first used in Japan, in the1980s, for food products fortified with special constituents that possess advantageous physiological effects (Siro *et al.,* 2008). However, the European Commission supports the development of two types of health claims essential for functional food which must always hold in the contest of full nourishment and should be related to usually consumed amounts (Functional Foods, The European Food Information Council, 06/2006). These claims emphasized by the European Commission are:

A) The claims about "enhanced function", which apply certain physiological, psychological and biological functions apart from their established roles in growth, development and other normal functions of the body. This kind of claim does not mention illness or pathological conditions, e.g. "certain indigestible oligosaccharides improve the growth of specific bacterial flora in guts".

B) The claims about "the decreased risk of development of illnesses", which are connected with the consumption of food or nutrients which can help decreasing the risk of certain illness or condition due to specific nutrient or nutrients contained by this food, e.g. "adequate intake of Calcium can help decreasing the risk of osteoporosis in later life".

Functional food can be formed in almost all food categories. Animal products such as meats, eggs and milk have great potential for delivering important nutrients such as fatty acids, minerals, antioxidants and bioactive peptides into the diet.

4.1 MEAT AND EGGS

Meat and poultry products are a food category with both positive and negative nutritional attributes. Meat and meat based foods are major sources for many bioactive compounds including iron, zinc, conjugated linoleic acid (mainly ruminants) and B vitamins. Meat and eggs are an excellent source of proteins, essential amino and fatty acids. They represent a good supply of vitamin D, A and B12, folate and phosphorus, selenium etc. In the recent years the consumers in developed countries have been well aware of the fact that today's lifestyle, stress, smoking habits, obesity or slenderness and unbalanced diet are the main cause of health problems. A good example of the severe irregularities in the nourishment is the

Table 5: *Consumption of animal products in Croatia per household member/year (Statistical yearbook of Republic of Croatia, 2000–2010)*

Year	Beef (kg)	Pork (kg)	Poultry meat (kg)	Milk (L)	Eggs
2000	9.89	14.50	19.70	87.71	186
2001	9.00	17.61	19.31	88.92	216
2002	8.86	14.66	19.26	91.95	214
2003	8.55	18.14	19.30	83.34	162
2004	9.34	16.44	19.03	84.60	163
2005	9.41	18.09	19.61	85.10	166
2006	9.23	14.83	19.32	81.02	158
2007	10.02	14.52	18.69	79.34	152
2008	9.05	15.51	16.96	74.80	144
2009	9.20	15.80	18.20	76.90	148
2010	8.70	19.80	19.10	77.40	158

undesirable n-6/n-3 PUFA ratio in everyday diets. Many researchers report that favourable narrow n-6/n-3 PUFA ratio of 1 – 4: 1 have changed to very high ratio of 15 – 20 : 1 due to the altered eating habits (Simopoulos, 1998; Sanders, 2000). The main source of n-3 fatty acids are vegetable and fish oils. By insufficient intake of fish and by feeding the meat animals cereals rich with n-6 PUFA, which in turn produce meats with wide n-6/n-3 ratio, the basis of unbalanced diet is formed. In this fact lays the importance of designing the meats enriched with n-3 PUFA, which have specific role in function of the kidney and neural membranes. Moreover, the immunity and neurological disorders as well as allergy reactions can be reduced by intake of food rich with n-3 PUFA (Simopoulos, 1998).

The meat from ruminants is generally more saturated due to the biohydrogenation in the rumen. This means that fatty acid profile of meat from animals such as pigs and poultry is more susceptible for alteration by diets. Nevertheless, there are numerous investigations showing that intervention into diets, the profile of fatty acids can be altered in the meat of various animals, including beef, by short term feeding strategies (Moloney, 2001). Manipulation of the n-6/n-3 ratio in pork and increasing the long-chain PUFA (EPA and DHA) by use of linseed and fish oils has been very successful (Enser *et al.*, 2000; Riley *et al.*, 2000). Sensory analyses of the fresh meat from these investigations showed no effects on organoleptic quality or on technological traits. Leskanich *et al.* (1997) increased the content of n-3 PUFA in the *longissimus* muscle, backfat and sausage by feeding pigs diet which contained 2% rapeseed oil plus 1% fish oil.

Similarly, there were some successful attempts in case of poultry meat and eggs by inclusion of vegetable and animal fats in the diet for broilers and laying hens (Grobas *et al.* 2001; Kralik *et al.*, 2004; Ezhil Valavan *et al.*, 2006; Kralik *et al.*, 2008). Linseed oil is a good source of α-linolenic fatty acid, while fish oil provides the best source of long chain fatty acids such as EPA (C20:5) and DHA (C22:6). Lopez-Ferrer *et al.* (2001a) showed that feeding broiler chickens with fish oil significantly increased all forms of n-3 PUFA content. Namely, EPA, DPA and DHA were increased by 5.65, 6.75 and 23.2 times, respectively, in broiler thigh muscle by feeding diet containing 4% fish oil. The authors obtained the same effect by use of linseed and rapeseed oil (Lopez-Ferrer *et al.*, 2001b).

In order to avoid the occurrence of deteriorated sensory traits, the antioxidants are often added to the diet for animals. The most effective in the inhibition of lipid oxidation *in vivo* is α-tocoferol (vitamin E). Many investigations proved its antioxidative properties in different meats. The content of PUFA significantly affects the deposition of vitamin E in the poultry meat; the increased PUFA content reduces content of vitamin E. This is explained by the activity of vitamin E in the inhibition of oxidative processes in tissues of the living bird (Grashorn, 2007). Vitamin E also has positive effect on functional properties of broiler meat. Olivo *et al.* (2001) reported that addition of vitamin E in the feed for animals influenced the level of protein denaturation, lowered the water loss and enhanced the emulgation properties. The research of Surai (2006) on chicken showed that addition of increased concentration of vitamin E and selenium resulted in the increase of both in the animal tissues which influenced the decrease of lipid peroxidation in the meat stored at 4 and −20 °C.

Selenium has been also used in the enrichment of various meats and eggs in an attempt to increase functional traits of the diet because of its significant role in metabolism maintenance. It also takes part in antioxidative protection of cells and plays an important role in the functioning of male reproductive system (Oldereid *et al.*, 1998). The exceptionally high concentration of selenium in the diet has positive influence on the decreased incidence of cancer, while some investigations showed that presence of selenium in the diet can be connected to a better protection of organism from HIV virus (Rayman, 2000). Department of health in Great Britain (1991) defined optimal daily allowance for selenium as 75 μg/L for men and 60 μg/L for women. Rayman (2000) reported that intake of mentioned recommended daily allowances results in optimal concentration of GSH-Px in the blood plasma (95 μg/L). Salonen *et al.* (1982) stressed that deficiency of selenium linearly affects the decrease of selenium in the blood serum. In patients with less than 45 μg selenium /L of blood serum the cardiovascular diseases (CVD) are more frequent, the mortality being tripled compared to the patients with CDV connected with other causes. Ge and Yang (1993) reported that long term deficit of selenium in human diet causes the occurrence of degenerative illness of locomotor system (Kaschin-disease). Through the addition of organic selenium in the animal feed, the significant increase in the Se levels can be achieved in the muscles of pigs (Simek *et al.*, 2002), chicken (Yaroshenko *et al.*, 2004), lamb (Steen *et al*,. 2008) and other animals. Surai and Sparks (2001) reported that addition of Se in the amounts of 0.4 mg/kg of feed for laying hens in the form of selenised yeast results in the egg that contains about 30 μg Se.

In recent years there is an increased interest for some other potentially functional food compounds such as carnosine for which is believed to have the anti-aging effect (Hipkiss, 1998) and conjugated linoleic acid or CLA (Whigham *et al.*, 2000) in meat. CLA showed the anticancerogenic and antiteratogenic effect on laboratory animals; also it was proved that CLA has an effect on metabolism of fats and energy by accelerating the fat decomposition and lowering of its accumulation and also increasing the muscle mass (Hasler, 1998). Interestingly, it was found that thermal processing of meat (cooking, frying) increase the CLA content in meat (Ha *et al.*, 1987; Shantha *et al.*, 1994). From various meats, lamb is a good source of CLA. However, CLA is more represented in dairy products.

4.2 DAIRY PRODUCTS

Because it is reach in proteins (contains all nine essential amino acids required by human), vitamins (thiamine, riboflavin, B_{12}) and minerals (Ca, Mg, P, K, Se and Zn), milk has always been considered a healthy animal product. It is a complex mixture of bioactive proteins, lipids and saccharides and contains numerous biologically active substances such as immunoglobulins, enzymes, antimicrobial peptides, oligosaccharides, hormones, cytokines and growth factors (Bhat Z.F. and Bhat H., 2011). There are three major proteins in milk and these include caseins, ß-lactoglobulin and α-lactalbumin, which, during degrade fermentation or digestion into bioactive peptides by proteolytic enzymes. Some of these peptides exert biological activities such as antihypertensive, mineral-binding, antioxidative antimicrobial, immuno- and cytomodulating activity (Walther and Sieber, 2011).

Typical cow milk fat is composed of 5% polyunsaturated fatty acids (MUFA), 70% saturated fatty acids (SFA) and 25% monounsaturated fatty acids (SFA) (Tyagi *et al.*, 2012). Conjugated linoleic acid (CLA) is a term used for a one or more of positional and geometric isomers of linoleic acid with conjugated double bonds. The most important source of CLA are dairy products, which contain over 20 isomers of CLA, out of which cis-9, trans-11 is being the predominant one. Research on this FA has shown that it has a wide range of beneficial effects on health, i.e. protection against carcinogenesis, arteriosclerosis and tumorogenesis. Furthermore, it has an antioxidative effect and has been shown to reduce LDL cholesterol and heart disease and to modulate lipid metabolism (Beppu *et al.*, 2006; Choi *et al.*, 2007; Smit *et al.*, 2010; Smedman and Vessby, 2001). CLA content is depended on individual (Kelsey *et al.*, 2003), breed (Lawless *et al.*, 1999; Yassir *et al.*, 2012), production system (Jahreis *et al.*, 1997), dietary oils (Abu-Ghazaleh *et al.*, 2002; Chilliard *et al.*, 2000; Loor and Herbein, 2003; Murphy *et al.*, 2008) and is process related (Avramis *et al.*, 2003; Baer *et al.*, 2001; Prandini *et al.*, 2011; Serafeimidou *et al.*, 2012).

Recently, the market of functional food has been dominated by gut health products, in particular probiotics with 379 product launches worldwide in 2005 (Ouwehand, 2007). Probiotics are defined as „live microorganisms, as they are consumed in adequate numbers confer a health benefit on the host"(Charalampopoulos *et al.*, 2003). Dairy products are the key product sector accounted for about 56% of functional foods' total global sales in 2004 (Benkouider, 2005). The main markets of dairy probiotics are Scandinavia, Holland, Switzerland, Croatia and Estonia; among developing markets Greece, France and Spain are considered (Makinen-Aakula, 2006).

5 FUTURE PROSPECTS

The forecasts of animal product consumption are mainly based on the presumption that they will rise proportionally with income levels. According to estimates by UN/FAO, the trend toward the increased consumption of animal products will continue to rise in the following decades in developed countries; for example the prediction is that by the year 2030 meat consumption will be 100 kg per person in industrialised countries (Bruinsma, 2003). The World Bank report estimates that the global meat demand is expected to grow by 56% in the period between 1997 and 2020. Together with the economy development a trend has been observed that animal products are not used only in providing of necessary nutrients but also in providing some other, beneficial traits characterised by the ability to improve health status and prevent diseases (Roberfroid, 2000). It can be predicted that functional foods will increase their presence on market in industrialised countries due to the desire of consumers to extend life by acceptance of the link between their diet and health. Indeed, in these countries the increase of functional food consumption is observed stimulated by availability and potential wellbeing of those who consume them. This should be seen as a great opportunity for the animal products industry but also as technological and social challenge. The producers of livestock should also be aware of these possibilities since strategies of enrichment of animal products with functional compounds include their dietary supplementation at the animal production level. Agriculture aimed at such objectives must be incorporated in the improvement of both nutrition and health. This can be efficient only if the information flow is enabled between agricultural and health sectors. However, the fact that everyone should have in mind is that even the expert in nutrition cannot always clearly differ the conventional from functional foods (Niva, 2007). For that reason the accurate and unambiguous evaluation methods should be introduced in order to provide clear information for the producers. Having in mind that the similar system already exists and functions, this should not be considered as a significant obstacle but a way of building the trust between the consumers and producers of functional foods.

6 REFERENCES

Abu-Ghazaleh A.A., Schingoethe D.J., Hippen A.R., Whitlock L.A. 2002. Feeding Fish Meal and Extruded Soybeans Enhances the Conjugated Linoleic Acid (CLA) Content of Milk. Journal of Dairy Science, 85**:** 624–631

Agra CEAS Consulting. 2004. Desktop study into demand for dairy products. Final report for Dairy supply chain forum. http://archive.defra.gov.uk/foodfarm/food/industry/sectors/milk/pdf/agraceasreport.pdf

Avramis C.A., Wang H., McBride B.W., Wright T.C., Hill A.R. 2003. Physical and processing properties of milk, butter, and cheddar cheese from cows fed supplemental fish meal. Journal of Dairy Science, 86**:** 2568–2576

Baer R.J., Ryali J., Schingoethe D.J., Kasperson K.M., Donovan D.C., Hippen A.R., Franklin S.T. 2001. Composition and properties of milk and butter from cows fed fish oil. Journal of Dairy Science, 84**:** 345–353

Benkouider C. 2005. The world's emerging markets. Functional Foods and Nutraceuticals. http://www.ffnmag.com/NH/ASP/strArticleID/770/strSite/FFNSite/articleDisplay.asp

Beppu F., Hosokawa M., Tanaka L., Kohno H., Tanaka T., Miyashita K. 2006. Potent inhibitory effect of trans9, trans11 isomer of conjugated linoleic acid on the growth of human colon cancer cells. The Journal of Nutritional Biochemistry, 17**:** 830–836

Bhat Z.F., Bhat H. 2011. Milk and Dairy Products as Functional Foods: A Review. International Journal of Dairy Science, 6: 1–12

Charalampopoulos D., Pandiella S.S., Webb C. 2003. Evaluation of the effect of malt, wheat and barley extracts on the viability of potentially probiotic lactic acid bacteria under acidic conditions. International Journal of Food Microbiology, 82: 133–141

Chilliard Y., Ferlay A., Mansbridge R.M., Doreau M. 2000. Ruminant milk fat plasticity: Nutritional control of saturated, polyunsaturated, trans and conjugated fatty acids. Animal Research, 49**:** 181–205

Choi J.S., Koh I.U., Jung M.H., Song J. 2007. Effects of three different conjugated linoleic acid preparations on insulin signalling, fat oxidation and mitochondrial function in rats fed a high-fat diet. British Journal of Nutrition, 98: 264–275

Dipplock A.T., Agget P.J., Ashwell M., Bornet F., Fern E.B., Robertfroid, M.B. 1999. Scientific Concepts of Functional Foods in Europe: Consensus Document. British Journal of Nutrition, 81: 1–27

Eaton S. B., Eaton S. B. III, Konner M. J., Shostak M. 1996. An evolutionary perspective enhances understanding of human nutritional requirements. The Journal of Nutrition, 126: 1732–1740

Enser M., Richardson R.I., Wood J.D., Gill B.P., Sheard P.R. 2000. Feeding linseed to increase the n-3 PUFA of pork: Fatty acid composition of muscle, adipose tissue, liver and sausages. Meat Science, 55: 201–212

European Commission. 2007. The European pig meat market situation and outlook. http://www.pigproducer.net/uploads/media/prevost.pdf

Ezhil Valavan S., Mohan B., Chandrasekaran D., Mani K., Mohan B., Edwin S.C. 2006. Effects of various n-3 lipid sources on the quality characteristics and fatty acids composition of chicken egg. http://www.cabi.org/animalscience/Uploads/File/AnimalScience/additionalFiles/WPSAVerona/10233.pdf

FAO – Food and agriculture organization .2011. Food outlook, June 2011. Global market analysis. Report. http://www.fao.org/docrep/014/al978e/al978e00.pdf

Fiala N. 2008. Meeting the demand: An estimation of potential future greenhouse gas emissions from meat production. Ecological Economics, 67: 412–419

Functional Foods. The European Food Information Council, 06/2006. www.eufic.org
Gajčević Z., Škrtić Z., Kralik G. 2006. Impact of bird influenza occurrence on consumption of poultry products. Feedstuffs, 48, 3: 143–148
Ge K., Yang G. 1993. The epidemiology of selenium deficiency in the etiological study of endemic diseases in China. American Journal of Clinical Nutrition, 57, 2: 259–263
Gerosa S., Skoet J. 2012. Milk availability: trends in production and demand and medium-term outlook. ESA Working paper No. 12-01, February 2012, Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations.
www.fao.org/economic/esa
Givens D.I. 2005. The role of animal nutrition in improving the nutritive value of animal derived foods in relation to chronic disease. Proceedings of the Nutrition Society, 64: 395–402
Grashorn M.A. 2007. Functionality of PoultryMeat. The Journal of Applied PoultryResearch, 16: 99–106
Gray J., Armstrong G., Farley H. 2003. Opportunities and constraints in the functional food market. Nutrition & Food Science, 33, 5: 213–218
Grobas S., Mendez J., Lazaro R., de Blas C., Mateos G.G. 2001. Influence of Source and Percentage of Fat Added to Diet on Performance and Fatty Acid Composition of Egg Yolks of Two Strains of Laying Hens. Poultry Science, 80:1171–1179
Ha Y.L., Grimm N.K., Pariza M.W. 1987. Anticarcinogens from fried ground beef: heat altered derivatives of linoleic acid. Carcinogenesis, 8: 1881–1887
Hammer M.F. 1995. A common ancestry for human Y cromosoms. Nature, 378: 376–378
Hasler C.M. 1998. Functional foods: their role in disease prevention and health promotion. Food Technology, 52, 11: 63–70
Hedges B., Kumar S., Tamura K., Stoneking M. 1992. Human origins and analysis of mitochondrial DNA sequences. Science, 255: 737–739
Hipkiss A.R. 1998. Carnosine, a protective, anti-ageing peptide? The International Journal of Biochemistry & Cell Biology, 30, 8: 863–868
Jahreis G., Fritsche J., Steinhart H. 1997. Conjugated linoleic acid in milk fat: High variation depending on production system. Nutrition Research, 17**:** 1479–1484
Kashtanova E. 2010. Global trends in milk production and trade: the impact on the European milk market. Biotechnology in Animal Husbandry, 26, 1–2: 129–134
Kelsey J.A., Corl B.A., Collier R.J., Bauman D.E. 2003. The effect of breed, parity, and stage of lactation on conjugated linoleic acid (CLA) in milk fat from dairy cows. Journal of Dairy Science, 86**:** 2588–2597
Kralik G., Grčević M., Gajčević-Kralik Z. 2010. Animal products as functional foods. Feedstuffs, 52, 1: 3–13
Kralik G., Ivankovic S, Bogut I., Csapo J. 2004. Effect of dietary supplementation with PUFA n-3 on the lipids composition of chicken meat. Acta Alimentaria, 33:129–139
Kralik G., Škrtić Z., Suchý P., Straková E., Gajčević Z. 2008. Feeding Fish Oil and Linseed Oil to Laying Hens to Increase the n-3 PUFA of Egg Yolk. Acta Veterinaria Brno, 77: 561–568
Lawless F., Stanton C., L'escop P., Devery R., Dillon P., Murphy J.J. 1999. Influence of breed on bovine milk cis-9, trans-11-conjugated linoleic acid content. Livestock Production Science, 62, 43–49
Leskanich C.O., Matthews K.R., Warkup C.C., Noble R.C., Hazzledine M. 1997. The effect of dietary oil containing (n−3) fatty acids on the fatty acid, physicochemical, and organoleptic characteristics of pig meat and fat. Journal of Animal Science, 75: 673–683
Loor J.J., Herbein J.H. 2003. Dietary canola or soybean oil with two levels of conjugated linoleic acids (CLA) alter profiles of 18:1 and 18:2 isomers in blood plasma and milk fat from dairy cows. Animal Feed Science and Technology, 103: 63–83
Lopez-Ferrer S., Baucells M.D., Barroeta A.C., Grashorn M.A. 2001a. n−3 Enrichment of chicken meat. 1. Use of very long-chain fatty acids in chicken diets and their influence on meat quality: Fish oil. Poultry Science, 80: 741–752
Lopez-Ferrer S., Baucells M.D., Barroeta A.C., Galobert J., Grashorn M.A. 2001b. n−3 Enrichment of chickenmeat. 2. Use of precursors of long-chain polyunsaturated fatty acids: Linseed oil. Poultry Science, 80: 753–761
Makinen-Aakula M. 2006.Trends in functional foods dairy market. In: Proceedings of the third functional food net meeting, Liverpool
Molkentin J. 2000. Occurrence and biochemical characteristics of natural bioactive substances in bovine milk lipids. British Journal of Nutrition, 84, 1: 47– 53
Mollet B., Rowland I. 2002. Functional foods: At the frontier between food and pharma. Current Opinion in Biotechnology, 13: 483–485
Moloney A. 2001. Meat fatty acid composition as affected by feeding. In: Proceedings of the conference "Healthier Meat in Future", Ghent, Belgium, 23 Nov. 2001: 34–43
Murphy J.J., Coakley M., Stanton C. 2008. Supplementation of dairy cows with a fish oil containing supplement and sunflower oil to increase the CLA content of milk produced at pasture. Livestock Science, 116: 332–337
Office for Official Publications of the European Communities. 2006. Milk and milk products in European Union. Luxemburg, European Communities.
http://ec.europa.eu/agriculture/publi/fact/milk/2007_en.pdf
Oldereid N.B., Thomassen Y., Purvis K. 1998. Selenium in human male reproductive organs. Human Reproduction, 13, 8: 2172–2176
Olivo R., Soares A.L., Ida E.I., Shimokomaki M. 2001. Dietary vitamin E inhibits poultry PSE and improves meat functional properties. Journal of Food Biochemistry, 25, 4: 271–283
Ouwehand A. 2007. Success in applying pro- and prebiotics in dairy products. In: Proceedings of the fourth international FF Net meeting on functional foods.
Ovesen L. 2004. Cancer health concerns. In: Encyclopedia of meat sciences W. K. Jensen, C. Devine, Dikeman M. (eds.). Oxford, Elsevier: 623–628
Prandini A., Sigolo S., Piva G. 2011. A comparative study of

fatty acid composition and CLA concentration in commercial cheeses. Journal of Food Composition and Analysis, 24**:** 55–61

Rayman P.M. 2000. The importance of selenium to human health. The Lancet, 356, 9225: 233–241

Riley P.A., Enser M., Nute G.R., Wood J.D. 2000. Effects of dietary linseed on nutritional value and other quality aspects of pig muscle and adipose tissue. Animal Science, 71: 483–500

Salonen J.T., Alfthan G., Pikkarainen J., Huttunen J.K., Puska P. 1982. Association between cardiovascular death and myocardial infarction and serum selenium in a matched pair longitudinal study. The Lancet, 320, 8291: 175–179

Sanders T.A.B. 2000. Polyunsaturated fatty acids in the food chain in Europe1. American Journal of Clinical Nutrition, 71, 1: 176–178

Sarre P. 2002. Paradise lost, or the conquest for the wilderness. In: An Overcrowded world? Sarre P., Blunden J. (eds.). Oxford, Oxford University Press

Serafeimidou A., Zlatanos S., Laskaridis K., Sagredos A. 2012. Chemical characteristics, fatty acid composition and conjugated linoleic acid (CLA) content of traditional Greek yogurts. Food Chemistry, 134, 4: 1839–1846

Shantha N.C., Crum A.D., Decker E.A. 1994. Evaluation of conjugated linoleic acid concentrations in cookedbeef. Journal of Agricultural and Food Chemistry, 42, 8: 1757–1760

Simek J., Chladek G., Koutnik V., Steinhauser L. 2002. Selenium content of beef and its effect on dripand fluid losses. Animal Science Papers and Reports, 20: 49–53

Simopoulos A.P. 1998. Overview of evolutionary aspects of omega-3 fatty acids in the diet.World Review of Nutrition and Dietetics, 83: 1–11

Siro I., Kapolna E., Kapolna B., Lugasi A. 2008. Functional food. Product development, marketing and consumer acceptance – A review. Appetite, 51: 456–467

Smedman A., Vessby B. 2001. Conjugated linoleic acid supplementation in humans-metabolic effects. Lipids, 36**:** 773–781

Smit L.A., Baylin A., Campos H. 2010. Conjugated linoleic acid in adipose tissue and risk of myocardial infarction. American Journal of Clinical Nutrition, 92: 34–40

Statistical yearbook of Republic of Croatia, 2000–2010.

Steen A., Strøm T., Bernhoft A. 2008. Organic selenium supplementation increased selenium concentrations in ewe and newborn lamb blood and in slaughter lamb meat compared to inorganic selenium supplementation. Acta Veterinaria Scandinavica, 50, 7

Steinfeld H., Gerber P., Wassenaar T., Castel V., Rosales M., de Haan C. 2006. Livestock's long shadow. Environmental issues and options. Rome: Food and Agriculture Organization of the United Nations.
ftp://ftp.fao.org/docrep/-fao/010/a0701e/A0701E00.pdf (24 June 2009)

Surai P. F. 2006. Selenium in Nutrition and Health. Nottingham University Press.

Surai P.F., Sparks N.H.C. 2001. Designer eggs: from improvement of egg composition to functional food. Trends in Food Science & Technology, 12: 7–16

Tyagi A.K., Hossain S.A., Tyagi A. 2012. Feeding strategies for enhancing the nutritional and therapeutic potential of milk. In: Regional Training on Quality Control of Milk during Production, Processing and Marketing and Introduction to Novel Technologies for Dairy Products Diversification, India, 9–18 April 2012**:** 145–149

Valsta L.M., Tapanainen H., Mannisto S. 2005. Meat fats in nutrition. Meat Science, 70: 525–530

Walther B., Sieber R. 2011. Bioactive proteins and peptides in foods. International Journal for Vitamin and Nutrition Research, 81**:** 181–192

Whigham L.D., Cook M.E., Atkinson R.L. 2000. Conjugated Linoleic Acid: Implications for Human Health. Pharmacological Research, 42, 6: 503–510

Whitney E.N., Rolfes S.R. 2002. Understanding nutrition. 9th ed. Belmont, CA, Wadsworth

WHO/FAO. 2009. The state of food and agriculture. Rome, Food and agriculture organization of the United Nations

Yaroshenko F.O., Surai P.F., Yaroshenko Y.F., Karadas F., Sparks N.H.C. 2004. Theoretical background and commercial application of production of Se enriched chicken. In: Proceedings of the XXII World's Poultry Congress, Turkey: 410

Yassir M. A., Arifah A. K., Yaakub H., Zuraini A., Zakaria Z.A., Somchit M.N. 2012. Effect of Breed on cis-9, trans-11 and trans-10, cis-12 Conjugated Linoleic Acids (CLA) Concentrations in Milk Fat of Dairy Cattle and the Relationship of These CLA with other Unsaturated C18 Fatty Acids. Pertanika Journal of Tropical Agricultural Science, 35: 165–172