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FUNCTIONAL FOOD OF ANIMAL ORIGIN. MEAT AND MEAT PRODUCTS

Summary. The functional food is nowadays the leading trend in food industry, especially in the sector of diary products, soft drink and confectionery. Among the functional foods of animal origin the crucial role is played by milk products fermented with probiotic bacteria. Meat industry follows the functional trends slowly, despite the fact that the development in this area could stop the declining tendency of meat consumption caused by socio-economic and health related reasons. The strategies for achieving healthier meat and meat products involve modification at the farm level and manipulation of meat raw materials. Modification at farm level includes genetic selection, diets and feeding levels and animal diet supplementation. These procedures provide changes in such meat constituents as protein, fat content, fatty acid composition and antioxidants content, e.g. vitamin E and selenium level. Most desirable modification of meat composition includes a higher percentage of unsaturated fatty acids, especially n-3 fatty acids, including improvement of n-6 : n-3 ratio, PUFA : SFA ratio and reduction in fattiness. The very recent trend is also promoting the health benefits of vitamins, minerals, and bioactive chemicals already present in meat, such as L-carnitine, taurine, creatine, choline or antioxidants, such as ubiquinone and histidyl dipeptides.

Key words: meat, functional products, fatty acids profile, vitamins, minerals, probiotics, fiber

Functional food concept and strategies for functional products development

The growing, among consumers, consciousness of the impact of everyday diet on health, life expectancy and well being, leads to increased demand for food products with added value. These products are described as functional or designer foods – foods that may provide proven health benefits beyond basic nutrition. These products include foods with reduced fat, sugar or salt, fortified with minerals, vitamins, phytochemicals, probiotic bacteria or polyunsaturated fatty acids. The term "functional food" has already been defined several times (ROBERFROID 2002), but so far there is no legislative and internationally accepted definition for this group (ALZAMORA et AL. 2005).

The European Commission's Concerted Action on Functional Food Science in Europe (FuFoSE), coordinated by International Life Science Institute (ILSI) Europe defined functional food as food products which, together with the basic nutritional impact, have 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, consumed in the diet. Therefore, it could not be in the form of pill or capsule, but just as normal food form (DIPLOCK et AL. 1999).

There are several strategies for development of functional foods. The most common is incorporation of nutraceuticals – bioactive chemicals found as natural components of food of animal or vegetable origin – into existing traditional food products to gain health benefit. Examples of such functional ingredients are: dietary fiber; oligosaccharides; sugar alcohols; amino acids, peptides and proteins; glycosides; isoprenes and vitamins; choline; lactic acid bacteria; minerals; unsaturated fatty acids and others not included in the former categories, e.g. antioxidants, plant sterols (GOLDBERG 1994). The other way of designing functional food is reduction of undesirable food components such as fat, sugar, cholesterol, sodium, nitrites or enhancement of the beneficial substances naturally present in the food at the animal/plant production stage. The very recent trend is promoting the health benefits of bioactive chemicals already present in foodstuffs, for example the polyphenols in tea, long chain polyunsaturated fatty acids in fish or L-carnitine in meat.

The functional food is nowadays the leading trend in food industry, especially in the sector of a diary products, soft drink, confectionary, bakery and baby food products (SIRÓ et AL. 2008). Among the functional foods of animal origin the crucial role play milk products fermented with probiotic bacteria and/or with added probiotic, prebiotic and bioactive substances such as vitamins, minerals and plant extracts; and lactose-reduced milk. Designer eggs with enhanced level of antioxidants: vitamin E, carotenoids, selenium and n-3 fatty acids, such as docosahexaenoic acid, are also a developing group of functional food (SURAI and SPARKS 2001). At the same time the meat industry follows the functional trends, however slowly despite the fact that the development in this area could stop the declining tendency of meat consumption caused by combination of socio-economic and health related reasons (JIMÉNEZ-COLMENERO 2007).

Meat and meat products

Meat and meat products are associated with negative health image mainly due to high content of cholesterol and fat rich in saturated fatty acids (SFA up to 50% in beef, around 40% in pork), as well as sodium chloride presence in processed meat. The relationship between these components and increased risk of lifestyle diseases such as obesity, cardiovascular disease (CDV), coronary heart disease (CHD), several types of cancer and hypertension is well established and makes consumers skeptical about meat (ARIHARA 2006). But common opinions about the fat or cholesterol content in meat are not always entirely accurate. Since the early 1980s the red meat industry began to shift production systems to favor less fat (HIGGS 2000). Due to this trend, nowadays, the fat content of lean meat in the muscles and animal species most utilized for consumption is frequently lower than 5%. Unfortunately the same cannot be said about many widely--consumed meat products in which fat content reaches values of 25% or even more (CHIZZOLINI et AL. 1999, JIMÉNEZ-COLMENERO 2000). Similarly sodium content in meat is relatively low, approximately 50-90 mg per 100 g, but in meat products is much higher: salt content can reach 6% in uncooked cure derivatives. The contribution of meats to cholesterol intake in diet is relatively higher, ranging from one third to one half of the total daily intake. Meat in general contains about 75 mg per 100 g, but the role of dietary cholesterol on serum cholesterol concentrations appears not to be significantly correlated, excluding people genetically predisposed to hypercholesterolemia (CHIZZOLINI et AL. 1999, MCNAMARA 2000).

Concluding, meat and meat products, like many other foods, contain constituents which consumed in inappropriate proportions have a negative effect on human health. But it has to be remembered that meat is also an important nutrient for human health and development. It is a major source of high biological value proteins satisfying requirements regarding tissue growth and reconstruction. Moreover, it was recognized that specific amino acids present in meat have favourable effect on nervous and immune system, while peptides, released during digestion or during food processing, may reduce the cardiovascular disease or hypertension (JIMÉNEZ-COLMENERO 2007). Meat is also high in essential nutrients (Table 1) such as niacin, folic acid, vitamins B1, B2, B6, B12, iron, zinc and selenium (VERBKE et AL. 1999, BIESALSKI 2005). These micronutrients are either not present in plant derived food or have a poor bioavailability. Meat is also one of the richest natural sources of glutathione which is an antioxidant providing defense against toxicological and pathological processes (HIGGS 2000). Ruminant meat is additionally a source of conjugated linoleic acid (CLA) (Table 2) having anticarcinogenic and antiatherogenic properties. Meat contains also bioactive substances importance of

Table 1. Selected vitamins and minerals in 100 g of red meats (KUNACHOWICZ et AL. 2005, WILLIAMS 2007)
Tabela 1. Wybrane witaminy i składniki mineralne w 100 g mięsa czerwonego (KUNACHOWICZ i IN. 2005, WILLIAMS 2007)

Vitamin, mineral	Beef	Pork	Lamb	RDA
Vitamin B1 (mg)	0.04-0.08	0.80	0.10-0.12	1.1 mg
Vitamin B2 (mg)	0.18-0.24	0.27	0.20-0.23	1.4 mg
Niacin (mg)	4.60-5.00	5.60	4.10-5.2	16 mg
Vitamin B6 (mg)	0.33-0.52	0.35	0.10	1.4 mg
Vitamin B12 (µg)	2.50-4.00	0.6	0.96	2.5 ug
Fe (mg)	1.60-2.50	0.7-1.3	2.0-2.6	14 mg
Zn (mg)	3.20-5.50	1.5-3.3	2.3-4.5	10 mg
Se (µg)	9-44	16-36.1	11-23.4	55 ug

Table 2. CLA content in meat (RAES et AL. 2003, RAINER and HEISS 2004)
Tabela 2. Zawartość CLA w mięsie (RAES i IN. 2003, RAINER i HEISS 2004)

Meat	CLA content (mg/g of fat)
Beef	1.2-14
Veal	2.7
Lamb	5.8
Pork	0.6
Chicken	0.9
Turkey	2.6

which in human physiology is only just beginning to be recognized, such as L-carnitine, taurine, creatine, choline and such antioxidants as ubiquinone and histidyl dipeptides: carnosine and anserine (Table 3) (ARIHARA 2006, JIMÉNEZ-COLMENERO 2007).

Table 3. Bioactive compounds in 100 g of beef (mg) (PURCHAS et AL. 2004)
Tabela 3. Składniki bioaktywne w 100 g mięsa wołowego (mg) (PURCHAS i IN. 2004)

Compound	Fresh tissue			
	musculus semitendinosus	heart	liver	cheek *musculus masseter*
Taurine	38.6	22.3	45.8	382.4
Carnosine	452.6	32.6	77.5	42.9
Coenzyme Q10	2.18	6.05	4.6	6.79
Creatine	401	298	16	263
Creatinine	5.82	2.16	0.54	2.34

The above facts taken together allow the conclusion that meat and meat products are an important part of a mixed diet, ensuring adequate delivery of essential micronutrients and amino acids (BIESALSKI 2005). Although it must also be emphasized, particularly taking consumer opinion about meat into consideration, that meat and particularly meat products need modifications to give them a "healthier" appearance (FERNÁNDEZ-GINÉS et AL. 2005).

Strategies of achieving healthier meat and meat products

The strategies for achieving healthier meat and meat products involve modification at the farm level and manipulation of meat raw materials. Modification at farm level includes genetic selection, structure of diet and feeding levels, diet supplementation, growth-promoting and nutrient partitioning agents, immunization of animals and gene manipulation techniques. These procedures provide changes in such meat constituents as protein, fat content, fatty acid composition and antioxidants e.g. vitamin E and selenium level. Nutritional strategies dealing with fatty acids profile are easier to apply in monogastric animals than in ruminants due to biohydrogenation (SCOLLAN et AL. 2006).

Most desirable modification of meat composition includes a higher percentage of unsaturated fatty acids, especially n-3 fatty acids, including improvement of n-3 : n-6 ratio, PUFA : SFA ratio and reduction in fattiness. While changes in fatty acids profile depends mainly on nutrition, reduction of fat content in meat is connected both with nutrition and genetic aspects (JIMÉNEZ-COLMENERO et AL. 2001, SCOLLAN et AL. 2006).

Manipulation of meat raw materials refers mainly to reduction of fat content in meat by removing external and internal fat from the carcass, primal cuts and, if necessary, from retail cuts.

Procedures which allow altering the nutrition value of meat products, besides the pre-selection of meat raw material, include:

– the reformulation of meat products causing modification of the fatty acid profile and reduction of fat content, cholesterol, calories, sodium and nitrites content,
– incorporation of functional ingredients to meat products (JIMÉNEZ-COLMENERO et AL. 2001).

Fat and fatty acids profile

Meat and meat products are among the major sources of dietary fat. This makes attempts to adjust qualitative and quantitative lipid characteristics to essential dietary recommendations (JIMÉNEZ-COLMENERO 2007). Substantial fattiness reduction and an increased percentage of unsaturated fatty acids in meat composition is possible by selecting races, genetic lines and feeding strategies such as fresh grass, grass silage and incorporation of oil seeds, vegetable oils and fish oils into the animal diet. Desirable changes in fat content and fatty acids composition of processed meat are obtained mainly by replacing part of the animal fat present in the product, with another, adjusted to dietary guidelines, i.e. with less saturated fatty acids, richer in monounsaturated or polyunsaturated acids, and with no cholesterol. Fish and vegetable oils, often partially hydrogenated (changing fatty acids profile) and vegetable protein from e.g. soy, maize, oats (diluting the fat concentration), are applied for this purpose (JIMÉNEZ-COLMENERO et AL. 2001, GIVENS et AL. 2006).

Reduction of saturated fatty acids, especially myristic acid (14:0) and palmitic acid (16:0), is beneficial with respect to total and low-density lipoprotein cholesterol (LDL) levels. The higher MUFA and PUFA content, and particularly the increase in eicosapentaenoic acid (EPA, 20:5 n-3) and docasahexaenoic acid (DHA; 22:6 n-3) has an important role in reducing the risk of cardiovascular disease, which is linked to the balance of the LDL and the HDL (high-density lipoproteins) cholesterol. Saturated fatty acids, with less than 18 carbons, are LDL-cholesterol raising and HDL-cholesterol lowering; whereas MUFA and PUFA have, respectively, neutral and LDL-cholesterol-lowering effects. PUFA additionally affects HDL-cholesterol positively (VERBKE et AL. 1999). EPA and DHA may also have some role in reducing cancer, rheumatoid arthritis, obesity and type-2 diabetes. They are critical for proper brain and visual development in the foetus and in the maintenance of neural and visual tissues throughout life (SIMOPOULOS 2000, HAMOSH 2008, VINGRYS and WEYMOUTH 2008). Dietary modification of fatty acids composition also enables lowering of n-6 : n-3 ratio, what is important in relation to the evidence that increased intake of n-6 acids in state of n-3 deficiency is the major risk factor for cancers, coronary heart disease and cardiovascular disease (JIMÉNEZ-COLMENERO 2007). Dietary guidelines recommend the n-6 : n-3 ratio to be as 3:1 or even lower.

Animal diet supplementation with oils high in linolenic acids, besides such factors as breed, age and sex of the animals, results also in rise of conjugated linoleic acid (CLA) content (SCOLLAN et AL. 2006). Beef contains 1.2-14 mg of CLA per 1 g of fat and up to 130 mg per 100 g of lean tissue (Table 4). The most common isomer is the cis-9, trans-11 isomer, it has been linked to a multitude of potential health benefits, including antitumor, antiatherogenic and anticarcinogenic effects (BELURY 2003, DE LA TORRE et AL. 2006). In addition to these properties, CLA has antioxidative and immunomodulative effect and may also play a role in control of obesity (trans-10, cis-12 isomer reduces rate of fat deposition), reduction of the diabetes risk and modulation of bone metabolism (ARIHARA 2006). However, the amount of CLA found in meat is relatively small according to the recommended daily intake for health benefits in human, which is 2500-3500 mg per day (SCOLLAN et AL. 2006).

Table 4. CLA cis-9, trans-11 content in *longissimus* muscle of different cattle breeds (mg per 100 g of fresh meat) (SCOLLAN et AL. 2006)
Tabela 4. Zawartość CLA cis-9, trans-11 w mięśniu najdłuższym (*longissimus*) różnych ras bydła (mg w 100 g świeżego mięsa) (SCOLLAN i IN. 2006)

Breed	Diet/fat supplement	CLA cis-9, trans-11
Wagyu, steers	Sunflower oil	134
Wagyu × limousine, steers	Sunflower oil	76
Limousine, steers	Sunflower oil	59
Charolaise, steers	Grass silage, whole linseed	36
Krzyżówki, steers	Grass silage	35
German holstein, bulls	Pasture	17
German simmentale, bulls	Pasture	12
Duble muscled Belgian blue, bulls	Crushed linseed	4.3
Duble muscled Belgian blue, bulls	Extruded linseed	4.2

Sodium chloride modification

Excessive dietary sodium intake is associated with development of hypertension and consequently with increased risk of CVD. It has been established that the consumption of more than 6 g NaCl per day by one person is associated with an age-increase in blood pressure. Therefore, it has been recommended that the total amount of dietary salt should be maintained at about 5-6 g per day (RUUSUNEN and PUOLANNE 2005). Currently the daily sodium adult intake is approximately three times the recommended daily allowance. The main source of sodium in the diet is sodium chloride, common ingredient of many foods, including meat products. It affects such essential attributes of processed meat as the flavour, texture and shelf life. Typical meat product contains 2% salt, but in some cases, e.g. salami or cured meat, salt can reach a level of 4-5% (DESMOND 2006). As cured and processed meats contribute above 20% of the total sodium intake, the reduction of salt in meat industry seems to be a major issue. Basic strategies to reduce the sodium content in processed foods include the use of salt substitutes, in particular, potassium chloride (KCl) in combination with masking agents (yeast extracts, lactates, monosodium glutamate and nucleotides), the use of flavour enhancers which do not have a salty taste, but enhance the saltiness of products when used in combination with salt and optimizing the physical form of salt so that it becomes more taste bioavailable (DESMOND 2006).

Nitrate modification

Sodium nitrate is the technological ingredient of cured meat products which create a characteristic colour, contribute to the aroma and taste and inhibit the development of microorganisms, including pathogens. Dietary nitrate has been associated with methemoglobinemia and the formation of nitrosamines, which show carcinogenic, mutagenic and teratogenic activities. Level of nitrosamine production depends on the residual nitrite level, thus there are two basic strategies for reducing the potential health risks of nitrites in meat products. One is to reduce or eliminate the addition of nitrite, and the other is to use N-nitrosamine inhibitors (JIMÉNEZ-COLMENERO et AL. 2001). The total elimination of nitrites is relatively difficult because of complexity of their technological functions. Erythrosine, betanin, CCMP (cooked, cured meat pigment) and monascus extracts as coloring agents and sorbic acid and its salts, fumaric acids esters, parabenes, BHA and lactic acid bacteria have been studied as potential components replacing nitrites. Mixtures based on meat starter cultures, enzymes and vegetable juices and spices, are also tested as an alternative for nitrite curing. The second strategy of residual nitrite reduction – inhibition of nitrosamines formation – is possible with addition of ascorbates and erythorbate. It has been also shown that vitamin E added to meat products decreases the production of nitrosamines. In fact, in recent years residual nitrite level has been substantially reduced thanks to ascorbic acid or sodium ascorbate addition, what accelerates curing, allows for lower nitrate addition, inhibits nitrosamine formation and interrupts further carcinogenic metabolites formation. Other strategies which allow lowering the level of residual nitrite deal with manufacturing process and cover curing in modified atmosphere or in subpression and application of starting cultures (GWIAZDA and PISULA 2006, CIERACH 2007).

Minerals

Dietary supplementation of animals makes possible to enhance the level of minerals naturally occurring in meat, such as iron and selenium, which are deficient in diets of population in many countries (JIMÉNEZ-COLMENERO 2007). Iron deficiency is the most common and widespread nutritional disorder in the world. This micronutrient supports oxidative metabolism and it is essential for gas exchange at the tissue and cellular levels through hemoglobin oxygenation in red cells and myoglobin in skeletal muscle. Moreover, iron-containing enzymes are involved in cellular energy metabolism and in host-defense responses. These various roles are due to the biological catalytic activity of iron which has unfilled atomic orbitals that allow it to co-ordinate electron donors and participate in redox processes (BIESALSKI 2005). Selenium is another micronutrient of fundamental importance to human health. As a constituent of selenoproteins, it has structural and enzymic roles. It is best-known as an antioxidant since it is incorporated into the enzyme glutathione peroxidase, which acts as a cellular protector against free radical oxidative damage. Selenium is required for the proper functioning of the immune system and it is a key nutrient in counteracting certain viral infections. It is required for sperm mobility and its deficiency has been linked to adverse mood states. An elevated selenium intake may be associated with reduced oxidative stress and cancer risk, but these preventive functions need additional well controlled studies (RAIMAN 2000). Taking into consideration the protective role of this component in chronic degenerative diseases and low or diminishing selenium status in some parts of the world, notably in some European countries, enrichment of meat and meat products in selenium should be an issue of special concern (BIESALSKI 2005).

Antioxidants

Increased content of unsaturated fatty acids in food causes the hazard of lipid oxidation which leads both to undesirable changes in sensory characteristic of meat and creates a risk to human health because of possibility of atherogenic, mutagenic and cytotoxic compounds formation (FERNÁNDEZ-GINÉS et AL. 2005). Incorporation of such antioxidants as vitamin E, carotenoids and plant extracts into the animal diet and during manufacturing process reduces degree of lipid oxidation and additionally increases the level of these bioactive substances in tissues. Tocopherols are known for their efficient antioxidant capacity in foods and biological systems. Epidemiological studies provided the inverse relationship between coronary artery disease and vitamin E supplementation (PRYOR 2000).

Carotenoids are related to CVD risk reduction, cancer prevention and immunostimulation (TORRISEN 2000). Other antioxidants used for inhibition of lipid oxidation are natural antioxidants extracted from plants, such as rosemary, sage, tea, soybean, citrus peel, sesame seed, olives and grapes. The physiological implications of these bioactive compounds are nowadays deeply investigated. Green tea extract is known to decrease total cholesterol, increase the HDL fraction, and decrease lipoprotein oxidation (TANG et AL. 2001). Isoflavones, citrus and grape extract improve cardiovascular health in humans. A positive effect in increase of the oxidative stability of meat have its endogenous components such as ubiquinone, glutathione, carnitine, carnosine and anserine, which can be also incorporated into animal diets (Jiménez-Colmenero 2007).

Probiotics

Probiotics are living microbial food ingredients, originated mainly from *Lactobacillus* and *Bifidobacterium*, which administrated in adequate amounts provide beneficial effects, such as modulation of intestinal microflora, prevention of diarrhea and gastrointestinal disorders, immunomodulation and prevention or treatment of food allergies. Probiotics may also play some role in inhibition of pathogens such as *Helicobacter pylori* and *Salmonella* (McNaught and MacFie 2001, Santosa et al. 2006).

The idea of using probiotic bacteria as bioactive additives or fermenting agents in meat products is beginning to develop, however it seems to be an attractive approach for designing functional meat products. Within the meat product, the most suitable carriers to deliver probiotics into human gastrointestinal tract, may be dry sausages processed without heat treatment which can be inoculated with *Bifidobacterium lactis*, *Lactobacillus casei*, *L. paracasei* and *L. rhamnosus* (Työppöne et al. 2003, Arihara 2006). In order to achieve the health effect they have to survive the processing conditions (presence of nitrite, sodium chloride) and unfavourable environment of gastrointestinal tract (bile and acids presence, domestic microflora). The beneficial daily intake of probiotic bacteria is estimated to be minimum 1010-11 viable microbes, thus a 100 g portion of meat product containing 108 microbes in 1 g should be minimum daily dose (Työppöne et al. 2003). Dry sausages, salami, meat spreads and other fermented meat products containing probiotics are commercially available. Human studies with healthy volunteers revealed that a four-week consumption of sausages fermented with *L. paracasei* brought some probiotic effects dealing with elevated values of CD4 T helper cells, increased phagocytosis index and decreased expression of CD54 (glycoprotein responding to inflammatory regulators). There is also an expectation that in meat products, analogically to fermented milk products, probiotic bacteria may increase the formation of CLA (Arihara 2006).

Fiber and prebiotics

Regular dietary fiber intake provides many health benefits. Increased fiber consumption lowers blood pressure, serum cholesterol levels and regulates intestinal transit time. Soluble fiber improves glycemia and insulin sensitivity in non-diabetic and diabetic individuals. Individuals with high intakes of dietary fiber appear to be at significantly lower risk of developing coronary heart disease, stroke, hypertension, diabetes, obesity and certain gastrointestinal diseases. Fiber supplementation in obese patients significantly enhances weight loss. Prebiotic fibers appear to enhance immune function (Alzamora et al. 2005). The average fiber intake is less than half of the recommended level of 25-30 g per day, thus the incorporation of fiber into commonly consumed food, including meat products, could help correct this deficiency (JIMÉNEZ-COLMENERO 2007). Dietary fibers which are most commonly used come from oat, rye, rice, sugar beet, soy, apple, pea and citrus byproducts – lemon albedo and orange fiber powder. Fibers used in meat processing not only have beneficial physiological effects due to resistance to hydrolysis by human digestive enzymes, but also act as technological additives which have water binding properties, improve texture and emulsion stability and offset the effects of fat reduction in meat products (JIMÉNEZ-COLMENERO et AL. 2001, FERNÁNDEZ-GINÉS et AL. 2005). For fat substitution purpose fructooligosaccharides (FOS) and inulin are used. Inulin allows decreasing the energy value of altered meat products up to 30% of the conventional product without radical changes in sensory attributes (MENDOZA et AL. 2001). FOS and inulin are also used as prebiotics – nondigestible food ingredients which promote the growth and proliferation of beneficial bacteria in the intestinal tract, and thus, potentially yield or enhance the effect of probiotic bacteria. Prebiotics have also been shown to increase the absorption of certain minerals (such as calcium and magnesium) and may also help inhibit the growth of lesions, such as adenomas and carcinomas in the gut, and thus reduce the risk factors involved in colorectal diseases (ADOLFSSON 2004).

Many other bioactive components may be incorporated into meat products with such ingredients as: plants – being a source of proteins (soy, nuts, wheat protein); vegetables – rich in fiber, vitamins and other phytochemicals; and vegetable and fish oils which allow to modify the fatty acids composition of the final product.

*

Meat is an essential part of diversified diet ensuring adequate intake of aminoacids and micronutrients such as iron, selenium, zinc, vitamin B12 and folic acid. It is also a source of bioactive compounds such as CLA, carnosine and L-carnitine. Putting emphasis on these facts and introduction of additional physiological functionality into meat products creates a superior opportunity to improve the image of meat sector and better fulfill the needs of consumers. However, numerous aspects have to be taken into account in the development of these kinds of products. The new meat products must have not only high in nutritional value and health enhancing properties, but also have to be safe, tasty and convenient for consumption. Sensory attributes, especially taste, are among the most important factors that affect consumers' choice of functional foods (KRYSTALLIS et AL. 2008).

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ŻYWNOŚĆ FUNKCJONALNA POCHODZENIA ZWIERZĘCEGO. MIĘSO I PRZETWORY MIĘSNE

Streszczenie. Żywność funkcjonalna to wiodący obecnie trend w produkcji żywności, szczególnie w sektorze produktów mleczarskich, napojów bezalkoholowych i słodyczy. Wśród produktów funkcjonalnych pochodzenia zwierzęcego dominują mleczne produkty fermentowane z udziałem bakterii probiotycznych. Przemysł mięsny stosunkowo powoli włącza do swej oferty produkty funkcjonalne, pomimo że poszerzenie oferty w tym zakresie mogłoby zahamować spadkową tendencję spożycia mięsa i jego przetworów spowodowaną zarówno względami socjoekonomicznymi, jak i obawami zdrowotnymi. Strategie wytwarzania zdrowszego mięsa i produktów mięsnych obejmują modyfikacje na poziomie hodowli, jak również surowca. Na etapie hodowli działania obejmują selekcję genetyczną, dobór sposobu i poziomu żywienia oraz suplementowanie diet. Zmiany uzyskane tą drogą pozwalają na modyfikację zawartości takich składników mięsa, jak białko i tłuszcz, zmianę składu kwasów tłuszczowych czy poziomu antyoksydantów, takich jak witamina E czy selen. Najbardziej pożądane zmiany w zakresie wartości odżywczej dotyczą podwyższenia poziomu nienasyconych kwasów tłuszczowych (PUFA), głównie kwasów z grupy n-3, w tym także poprawę stosunku kwasów n-6 : n-3, PUFA : SFA oraz redukcję nasyconych kwasów tłuszczowych (SFA). Nowoczesnym podejściem do promocji mięsa jest podkreślanie jego wartości odżywczej i naturalnej zawartości składników korzystnych dla zdrowia, takich jak witaminy i składniki mineralne oraz substancje bioaktywne: L-karnityna, tauryna, kreatyna, cholina czy antyoksydanty, np. ubichinon i peptydy histydylowe.

Słowa kluczowe: mięso, produkty funkcjonalne, profil kwasów tłuszczowych, witaminy, składniki mineralne, probiotyki, błonnik

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