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PROBIOTICS IN FERMENTED MEAT PRODUCTS*

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Abstract. Probiotic bacteria strains are successfully used in production of processed milk products, and certain juices, however, their use has not been observed in production of raw ripening meat products. In the case of meat products, raw products are deemed to be and actually are a suitable medium for the development of probiotic microorganisms. Scientific projects are being conducted on a European and even world scale. However, the health safety criterion should be of primary importance with respect to the use of probiotics. The application of certain bacteria strains deemed to have probiotic properties can be quite disputable. For that reason, further studies with regard to achieving absolute health safety of probiotic foodstuffs should be continued.

Key words: raw ripening meat products, probiotics, safety

INTRODUCTION

Probiotic bacteria play an extremely important role in the human organism by maintaining a balance in natural bacterial intestinal microbiota, controlling flatulence, by preventing and treating diarrhea, protecting against intestinal infections e.g. the irritable bowel syndrome, by stimulating the immunity system, antibacterial properties, suppression of survival of *Clostridium botulinum* endospores in the gastrointestinal system, or the ability to strengthening epithelial defense (in the stomach and small intestine) – e.g. prevention or fighting infections caused by *Helicobacter pylori* and *Salmonella Typhimurium.* They contribute to the decrease in cholesterol level by deconjugation of bile salts whose absence in the intestine makes cholesterol absorption difficult. They facilitate absorption of calcium, iron, and zinc [Bielecka 2002, Collins and Gibson

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1999, Kornacki et al. 1997, Libudzisz 2002]. It was also proved that bacteria have the ability to bind nitrosamines and other mutagenic substances. It was demonstrated that probiotic bacteria have antineoplastic activity, namely they control the development of fecal and putrefactive bacteria whose toxins have carcinogenic activity. They alleviate pain in vaginal fungal infection attack following an antibiotic therapy. Besides, they are responsible for production of PP vitamin, folic acid, H and B_6 vitamins. They partially digest milk proteins, due to which they lose their allergenic activity; probiotic bacteria secrete an enzyme that participates in digesting lactose thanks to which products containing them may be consumed by people with lactose intolerance without any obstacles [Bielecka 2002, Collins and Gibson 1999, Kornacki et al. 1997, Libudzisz 2002].

Producers of different foodstuffs are very much interested in probiotic bacteria on account of their importance in human organism functioning. Probiotic food inhabited by microbiota, mainly lactic acid bacteria, is expected to have prohealth activity. Probiotic bacteria include principally some species of the *Lactobacillus* genus*: L. acidophilus*, *L. casei* and *L. rhamnosus* [Arihara 2006, Incze 2002].

Probiotic bacteria strains are successfully used in production of processed milk products, and certain juices, however, their use has not been observed in production of raw ripening meat products. In the case of meat products, raw products are deemed to be and actually are a suitable medium for the development of probiotic microorganisms. They should contain in one gram ca. 10^6 of cells of lactic acid bacteria with probiotic properties.

Products fermented with intestinal bacteria taste differently than those manufactured in traditional ways – they are mildly acid and usually with an unspecified aroma. Such sensory properties may be unaccepted by consumers and for that reason the flavour is frequently corrected by addition of herbs, aromas, sweetening as well as by increasing dry mass content. In the latest fermented products, an addition of appropriate, so-called prebiotic saccharides is proposed, such as lactulose, fructo-oligosaccharides, or galacto-oligosaccharides, which selectively stimulate the growth of bifidobacteria in the alimentary tract [Bielecka 2002, Collins and Gibson 1999, Incze 2002, Libudzisz 2002].

MEAT IN HUMAN NUTRITION

Meat and meat products represent one of the most important components of human nutrition. Statistical data [Työppönen et al. 2003] indicate that annual meat consumption (data from 2004) in Poland amounts to ca. 72 kg, while the Spanish eat 122 kg meat per annum, the Danish – 116 kg, the German – 90 kg, the British – 87 kg, and Americans – 128 kg.

Meat is one of the most important sources of proteins of high nutritional value [Gawęcki and Hryniewiecki 2003]. The content of proteins in muscle tissue of different species of animals ranges from 15% to 20%. The content of amino acids in meat proteins is well balanced i.e. they contain all amino the human organism (essential amino acids). Solely connective tissue proteins have low biological value since they contain little tryptophan and cysteine (non-essential amino acids). Technological processes especially thermal and those connected with reduction of water content in the product (e.g. drying), may decrease bioavailability of amino acids thus reducing nutritional value of meat and meat products.

The energetic value of meat and meat products is diverse and depends on their water and fat content. Fat content ranges in a very wide scope, depending on the animal species, part of the carcass or type of the product. Meat is a basic source of numerous mineral components, mainly iron (so called hem iron, very well ingested), as well as zinc, copper, phosphorus and sulphur. Meat is a good source of B-complex vitamins and the content of particular vitamins from the B group considerably differs from one animal species to another. Only meat products are a source of vitamin B_{12}. In an average diet, meat and meat products cover ca. 70% of demand for vitamin B_{12}. Meat and meat products comprise also vitamins soluble in fat, primarily A and D and, in smaller amounts, vitamin E.

FERMENTED MEAT PRODUCTS

Fermentation and drying belong to the oldest methods of preserving and storing foods [Incze 2002, Työppönen et al. 2003]. Raw cured and ripened meat products (different kinds of sausage and smoke-cured meat products) are manufactured with the use of fermentation process i.e. a guided decomposition process involving the meat's own enzymes and enzymes of microbiological origin from the growth of microbiota [Hugas and Monfort 1997, Incze 2002]. Traditional production of raw cured meat products is based on fermentation of native or added carbohydrates by lactic acid bacteria found in meat or in its environment. During those transformations, in the products numerous substances come into being such as lactic acid, pyruvic acid, alcohols, aldehydes, ketones, and carboxylic acids. These compounds, in accordance with their amount, shape the quality and storage stability of a product.

Protein and fat transformation are strictly combined with hydrocarbon fraction transformations, both with that comprised in the raw material and that added in the production process. Protein decomposition processes are conducted by native meat enzymes and enzymes of growing microbiota. The decomposition of proteins influences to a high degree the development of sensory characteristics. As a result of fat decomposition, many compounds arise, responsible for properties determining flavour and aroma of a product. The finished product is microbiologically stabilized by the forming lactic acid and other organic acids and through water activity reduction (skin-drying) during the ripening process [Ammor and Mayo 2007, Benito et al. 2007, De Vuyst et al. 2008, Incze 2002, Pyrcz et al. 2005, Työppönen et al. 2003, Ventanas et al. 2006, Virgili et al. 2007].

There are numerous factors that influence fermented meat products. They may be grouped as follows:

– inner factors: types of microorganisms comprising the starter culture, the recipe, quality of components and additives, salt content, saccharides content, and meat size reduction degree;
– outer factors: temperature, relative air humidity, smoke and oxygen availability;
– analytical factors: acidity degree, water activity, redox potential, and mass decrement.

Fermentation plays a particular role in quality shaping of raw cured ripened meat products. Fermentation process, which is influenced by physical, chemical, biological, and microbiological factors, is very complex. As it often happens, as a result of excessive putrefactive bacteria growth, the fermentation process does not proceed correctly and even compounds harmful for the human organism form; and, principally, sensory, physical, and chemical quality of the product decreases. Protein decomposition occurs with the participation of microbiological enzymes and often results in deamination and decarboxylation, which is additionally supported by acid environment. Carbon dioxide and so-called biogenic amines are products of decarboxylation of amino acids. Tyramine and histamine are principal representatives of protein decarboxylation that are found at the highest quantity in meat. Presently, biogenic amines found in food may be deemed the cause of headaches, circulation disorders, and intoxication. When the fermentation process is managed properly, concentration of biogenic amines is low and consumption of raw cured meat products cannot be a cause of food poisoning [Kneifel 2002, Martín et al. 1999, Ventanas et al. 2006, Virgili et al. 2007].

Table 1. Microorganisms as starter cultures for processed meat products

Microorganisms contained in starter cultures	Type of metabolism	Favourable technological action
Lactic acid bacteria	producing lactic acid	inhibiting development of undesired bacteria
Lactobacillus plantarum		acceleration of food colors reaction (completion of the curing process)
Lactobacillus sake		drying process acceleration
Lactobacillus pentosus		
Lactobacillus casei		
Lactobacillus curvatus		
Lactobacillus alimentarius		
Pediococcus acidilacti		
Pediococcus pentosaceus		
Gram-positive cocci	nitrates reduction	curing process completion
Staphylococcus carnosus	using up the oxygen	curing colour stabilization
Staphylococcus xylosus	decomposition of peroxides	delaying rancidity
Micrococcus varians	lipolysis	flavour and aroma bouquet
Yeasts	using up the oxygen	curing colour stabilization
Debaryomyces hansenii	decomposition of peroxides	delaying rancidity
Candida famata		
Moulds	using up the oxygen decomposition of peroxides	flavour and aroma bouquet
Penicillium nalgiovense	lactic acid decomposition	
Penicillium camambertii/	proteolysis	
Candicum	lipolysis	

Source: the authors' own literature sources.

Microbiological processes play an important role in those transformation processes. In the technological process of production of raw cured meat products, technologically desired bacteria are multiplied while the development of pathogens and saprophytic bacteria is inhibited. The substitution of microbiota creates favourable conditions for enrichment of characteristics connected with flavour and durability. It is quite a common practice in manufacturing raw cured ripened products to apply starter cultures whose composition is extremely varied and often – unknown. Those starter cultures (Table 1) include mostly lactic acid bacteria, principally *Lactobacillus sakei*, *Lactobacillus curvatus*, *Lactobacillus plantarum* oraz *Lactobacillus lactis* [Ammor and Mayo 2007, Bielecka 2002, Hugas and Monfort 1997, Parvez et al. 2006, Työppönen et al. 2003].

RAW CURED SAUSAGES

Raw cured sausages represent coured processed meat products that are fit to be stored without being cooled (at the temperature of more than 10°C), as a rule designed for consumption in the raw state, which become fit for being spread or sliced following the ripening process combined with drying. Raw cured sausage is a mixture of different grades of meats preserved by curing and microbiological fermentation of its own or added carbohydrates. Sausage is fit for slicing if particles of muscle and fat tissue are bound with each other in a jelly state, due to released muscle protein. However, raw cured sausage can be spread when outer phase fat and particles slide on each other [Incze 2002].

Lactic acid bacteria (LAB) are the most common and the most important starter cultures in the production of fermented meat products. Those microorganisms produce lactic acid, which causes a decrease in pH value of the cured meat product down to ca. 4.8-5. Additionally, proteolitic enzymes produced by LAB play a major role in degradation of proteins and peptides, which results in forming free amino acids in skin-dried and fermented sausage. Those amino acids contribute to the ultimate shaping of the flavour of those products [Virgili et al. 2007].

Lactobacillus sakei, *L. curvatus* and *L. plantarum* are lactic acid bacteria which are the most frequently isolated from fermented sausage. Those microorganisms adapt themselves to the environment that prevails in the sausage during fermentation; they control the process of ripening and curb the growth of undesired microbiota. The applied method of isolation and selection of microorganisms from traditional Mediterranean skin-dried sausages and their subsequent use as starter cultures is extremely important on account of standardization of quality of fermented sausages and achieving attractive sensory properties as a final result of metabolic activity of lactic fermentation bacteria [Benito et al. 2007, Hugas and Monfort 1997, Työppönen et al. 2003]. In order to carry out a correct process of fermentation and obtain a desired quantity of lactic acid the sausage has to be stored at a temperature favoured by lactic acid bacteria (i.e. 27-37.8°C) for 10-15 hours so that the bacteria can begin to grow and transform hydrocarbons into lactic acid [De Vuyst et al. 2008].

Manufacturing raw cured sausages has a very long tradition and its origin is to be sought in Roman times in the Mediterranean area. At present, there is a wide variety of raw cured sausages, especially in Germany. The most important European country manufacturing raw cured sausages (in terms of quantity and quality) is Germany, followed by Italy, Spain, France, Holland, Belgium, and Austria. In Germany, a prevailing quantity of sausages is subject to smoking, and in Mediterranean countries, in France and Hungary, principally raw cured air-dried sausages are manufactured, which are characterized by clear mould development on their surface. An addition of starter culture bacteria is necessary for the production of raw cured sausages. They initiate the process of fermentation, control it and ensure microbiological safety to the finished product [Benito et al. 2007, De Vuyst et al. 2008, Hugas and Monfort 1997, Klingberg et al. 2005, Makała 2008, Pidcock et al. 2002, Pyrcz et al. 2005, Rebucci et al. 2007, Työppönen et al. 2003].

In previous times, raw cured sausage was manufactured only in the cool and cold seasons of the year. In this way, it was possible to avoid the risk of its spoilage. Sausage was stored and sold during the whole year. It is from those times that such names as "winter salami" or "summer sausage" sounding so opposing to each other come from. The development of ripening rooms made it possible to manufacture raw cured sausages of the same quality during the entire year, regardless of climatic conditions. Now one of the most important parameters to reach in production of raw cured sausages is to shorten ripening time and obtain defined sensory characteristics during that time. The trend to manufacture faster ripening products (pH within the range of 5.2-5.3 or slightly lower after 24 hrs) that should be ready for sale within ca. 14 days and sometimes even earlier results from economic reasons. For that reason, there is a demand for fast-acidifying starter cultures. That sort of products can be acidified thanks to the use of *Lactobacillus curvatus* or *Lactobacillus sake* bacteria. *Pediococcus* bacteria are of importance only at ripening temperature higher than 30°C, which is used in the American ripening scheme [Kneifel 2002, Makała 2008].

As compared with typical, especially long-ripening sausages, fast ripening raw cured sausages are characterized by a less expressed aroma and a slightly clearer colour. This is caused by the fact that as a result of a fast decrease in the pH value, *Staphylococci* caused transformations that contribute to the achievement of a characteristic aroma and colour are controlled. In connection with that, when selecting appropriate fast-acidifying bacteria starter cultures, it is necessary to select such *Staphylococci* strains that could be combined therewith. Individual *Staphylococci* strains differ from one another by, i.a., producing proteases (protein decomposing enzymes), peptidases (peptide decomposing enzymes) and lipases (fat decomposing enzymes) characterized by different activity [Hugas and Monfort 1997, Incze 2002, Martín et al. 1999, Pidcock et al. 2002, Virgili et al. 2007].

Salami-type raw cured sausages are a wide group of products differing in raw material composition, ripening time, external appearance, and flavour. The genuine recipe for the production of salami-type raw cured sausage, originally made from donkey meat, came into being in Italy. It is widely spread in such countries as Hungary, Germany, France, or Spain. Raw cured fermented sausages are also manufactured in Poland but in relatively small quantities. Both from the technical and financial point of view, ripening chambers represent a serious problem for meat processing plants, which accounts for an important reduction in manufacturing of that type of cured meat product ranges [Makała 2008, Virgili et al. 2007].

Salami consumption in Poland is not very high. Statistically, a Pole consumes ca. 0.10 kg of that meat product annually. For comparison, a German consumes ca. 5 kg of salami annually [Makała 2008]. Salami-type raw cured sausages are classified as durable smoke-cured meat products that can be stored up to six months. Production of salami involves such raw materials as ground or chopped lean pork and beef as well as pig back fat, which are mixed with corning salt or kitchen salt and potassium nitrate. For cured meat products, different spices and additives are also used. Ground meat is preserved due to fermentation process and air-drying. Low pH caused by fermentation and decreased water activity caused by the process of drying, inclusive of relatively high salt concentration create unfavourable environment for pathogenic bacteria growth. Such cured meat products are ready for consumption, finished products and they do not require heat treatment.

Chorizo is the most popular sort of raw cured sausage in Spain, and each region manufactures their own sorts of this sausage. During the drying and ripening, fermentation process takes place and hence comes its characteristic sourish flavour. Chorizo encompasses many varieties, e.g. chorizo ibèrico made exclusively from coarsely chopped meat of Iberian species of pigs. Chorizos from Soria and Pamplona, besides pork include also beef. Chorizo from Galicia characterizes a distinctive flavour. It is a sausage cured with smoke from oak tree and bay leaves. Besides regional chorizo, a specialty in the province of Extremadura is also salchichón and metka/Mettwurst-type pork cured meat product [Benito et al. 2007].

RAW RIPENING HAMS

Ripening products made from raw ham were manufactured as early as in the Middle Ages and their numerous sorts were known in the area of Central and Southern Europe. The notion of “ham” is principally reserved for the part coming from a hind leg.

Raw ripening hams are a group of meat products causing more difficulty in the manufacturing process than others. In products of that type, the selection of raw material plays an important role and diffusion of salt components is more difficult, which causes undesirable microbiota growth resulting in product decay or health hazard. Differentiated consistency of individual muscles creates technological problems too. Differences in consistency of individual muscles also result from fat present on their surface. A differentiated quantity of fat on the surface makes skin-drying uneven causing in effect a difference between muscles in a_w and thereby an excessive growth or suppression of growth of microorganisms. Hams are eliminated from the market as a result of decay symptoms such as soft consistency, chromatosis, and even perforation caused by excessive gas production. Ripening ham manufacturing requires a careful choice of raw material and control of the ripening process. Classification of raw cured hams depends on methods of cutting out meat from the hind and ripening methods (Table 2).

Table 2. Classification of raw hams and smoke-cured meat products

Cutting out method	Ripening methods	Product trade names
Non-divided hams	air-dried	Parma (Prosciutto), Veneto and San Daniele (without corning agents), Serrano, Iberico, Bayonne
	smoke-cured	Westfaelischer Schinken (Westphalia smoked ham), Holstein ham, Ammerland ham, skin-smoked ham
Layer hams	smoke-cured	Schwartzwald ham, South Tirol bacon (ripens with participation of mould)
Hams made from selected muscles	air-ripening smoke-cured	Raw cured ham tied up, Ardenne ham, Koburg ham, Crown Ham, cured pork shoulder
Divided hams	air-ripening	Bresaola, Fiocchetto
	smoke-cured	Nuβschinken, Schinkenspeck
Other smoke-cured meat products	air-dried	Pancetta (made from bacon) Italian Coppa (made from pork neck)
	smoke-cured	Smoked pork sirloin

Source: the authors' own study based on subject-related literature.

FERMENTED MEAT AS A CARRIER FOR PROBIOTIC BACTERIA

Probiotic meat products represent relatively new and not completely studied filed of the meat industry wherein of primordial importance is to find a compromise between safety, sensory quality and pro-health action of food. The trend to classify food as a medicine is stronger and stronger. This arises from the fact that some consumers would most willingly solve their health problems by means of appropriate nutrition.

Lactic acid bacteria have been very long used to alleviate or treat determined diseases. Lactobacillus and bifidobacteria strains are among the best-known probiotic microorganisms. They are widely used in milk processing and have been available on the market for a long time. Manufacturing probiotic meat products is much more difficult than manufacturing other products and they are in their initial development stage. The reasons are to be found on raw material characteristics. Probiotic bacteria strains that can be used in the manufacturing of fermented meat products should be capable of surviving in conditions found in fermented products and besides, they should take a dominant position with respect to other microorganisms found in the finished product. Besides, the product should maintain its sensory characteristics.

In 1998, Sameshima [Incze 2002] discovered that the characteristic flavour and aroma of raw sausages made with an addition of experimental probiotic bacteria, which had the ability of controlling the growth of pathogenic microbiota did not differ in anything from sausages in which commercial strains were used. Further [Työppönen et al. 2003] found that lactic acid bacteria added to raw sausages act as starter cultures and probiotics at the same time.

All this scientific evidence was published in order to study the effect of probiotic sausages on human health [Lücke 2000, Makras et al. 2004]. It was proved that daily consumption of 50 g of raw cured probiotic sausage effectively modulates the immune system [Rebucci et al. 2007]. Salami constitutes an adequate environment for the growth of probiotic microbiota. It was found in the few studies that have been conducted on probiotic meat products that daily consumption of 50 g of salami containing the *L. paracasei* strain as a starter culture stimulates the immune system in healthy subjects under examination.

Probiotic bacteria have to be added at the moment when the filling is being prepared and during the ripening process, they should produce a strong defense mechanism as bacteria atypical with respect to the natural microbiota present in raw fermented sausages. For these reasons, manufacturing and offering probiotic meat products is still at an initial stage as compared with probiotic dairy products.

There is a basic difference in raw material between groups of dairy and meat products [Incze 2002, Ruiz et al. 1999, Työppönen et al. 2003]. When manufacturing meat products the initial quantity of microorganisms in sausage filling cannot be dramatically reduced as it is in the case of milk pasteurization. Probiotic bacteria have to prove their domination through a suitably conducted ripening process. In raw cured sausage, water activity is lower than a_w in probiotic dairy products, which is tolerated by few groups of bacteria.

One of obvious technological possibilities is to use such bacteria that are closely related to meat environment and have suitable properties and pro-health characteristics. Bacteria with probiotic properties can be isolated by obtaining natural isolates from fermented sausage or from existing commercial meat starter cultures. Many probiotic bacteria strains have been isolated in that way. Such commercial strains as Lactobacillus *sakei* Lb3 and Pediococcus *acidilactici* PA-2 can be taken as examples because they are capable of surviving in an environment with parameters below those found in simulated conditions of the gastrointestinal system [Benito et al. 2007, De Vuyst et al. 2008, Makras et al. 2004, Rebucci et al. 2007].

In order to study probiotic properties of such lactic acid bacteria as *Lactobacillus casei/paracasei*, *L. rhamnosus,* and *L. sakei*, survival rate in gastric and intestinal juice was examined by *in vitro* adhesion to intestinal cells, production of organic acids and pathogenic microorganisms deactivation. Besides, it was proved that several *L. plantarum* strains display greater adhesion to intestine intima than *L. brevis* and *L. paracasei* (strain groups isolated from the sausage).

However, the fact that all properties are displayed does not necessarily result in intensification of pro-health properties, which is principally accounted for by the fact that the studies conducted are incomplete. In manufacture of fermented sausages, bacteria strains with documented probiotic properties can only be used. As these are usually strains isolated from human intestine, they should be able to compete with bacteria found in meat – in an environment that is not their natural environment. They are also supposed to be capable of surviving the process of fermentation and drying as well as that of cooling and storing and also of multiplying to the quantity that is deemed to correspond to pro-health properties [Benito et al. 2007, De Vuyst et al. 2008, Ruiz et al. 1999].

There are bases to suppose that the matrix in fermented sausage protects probiotic bacteria (*Lactobacillus*), which migrate in the gastrointestinal system. However, a potentially negative effect of the natural meat environment on cell survival rate should be taken into account in particular that connected with a high content of corning salt, low pH, and water activity caused by acidification and drying. As a matter of fact, cell survivability in fermented sausage environment depends principally on the bacteria strain used. For that reason, a most important factor is the choice of appropriate microorganisms that are applied as probiotic ones in fermented sausage [Ruiz et al. 1999].

Japanese scientists have studied the effect of adding six *L. acidophilus* bacteria strains (*L. acidophilus*, *L. crispatus*, *L. amylovorus*, *L. gallinarum*, *L. gasseri*, *L. johnsonii*) into fermented pork. They found that from among those six strains, *L. gasseri* had the best fermentation effect. That strain resists gastric and bile acids and the scientists also implied that the microorganisms under study had no harmful effect on the intestinal system. Additionally, inoculation from that strain effectively controls the growth and enterotoxin secretion of *Staphylococcus aureus during fermentation.* The results of Japanese scientists' studies proved that lactic fermentation bacteria can be successfully used for production of pro-health meat products in order to increase their nutritional value.

In Spain, studies were conducted on chorizo and salchichón type raw cured sausage, which can be carriers of probiotic bacteria and possess probiotic properties. The conducted experiment was aimed at selecting appropriate lactic acid bacteria (LAB) strains as probiotic strains that could be used for the manufacture of the above-mentioned products. Isolated lactic acid bacteria were assessed in terms of their ability to grow in conditions prevailing during sausage production process, tolerance of low pH, bile acids, and pancreatic fluid. The study demonstrated that it was *Lactobacillus* strains, especially *L. sakei* and *L. curvatus* that were defined as strains prevailing in European fermented sausages. Besides, those strains displayed an excellent capability of adapting themselves to technological conditions that prevail during their production and storage. Bacteria from those and other strains that survived in fermented sausages were defined as bacteria with probiotic properties [Ruiz et al. 1999].

It was demonstrated that *Lactobacillus reuteri*, when added to dried fermented sausages, effectively control survival of *E. coli* O157:H7 in said products [Ruiz et al. 1999].

The following bacteria have been qualified as probiotic cultures suitable for manufacturing chorizo and salchichón type sausages: Bifidobacterium and in particular *Bifidobacterium longum*, *Pediococcus* and *Lactococcus* bacteria species, *Pediococcus acidilactici*, *Lactobacillus sakei*, *Enterococcus* and especially *E. faecium*. Bacteriocin secreted by *E. faecium* controls the toxin produced by *Listeria monocytogenes*. *E. faecium* in combination with *Streptococcus thermophilus* make up a probiotic that lowers the cholesterol content in the blood. It is claimed that addition of those bacteria to food increases its safety and has a positive effect on human health, but, notwithstanding that, *E. faecium* is a pathogen and its application as a probiotic arouses controversy [Arihara 2006, Ruiz et al. 1999].

SUMMARY

An increase in foodstuffs probiotic properties aimed at their impact on selected characteristics of the human body (so-called functional food) is an important part of contemporary trends in food production development. One of principal functional products is probiotic food, i.e. products into which selected bacteria cultures were intentionally added, with documented probiotic properties.

It is starter cultures, principally lactic acid bacteria that are responsible for microbiological safety of fermented meat products. Those cultures initiate and direct the fermentation process, and provide the finished product with its characteristic sensory properties. The use of probiotic strains for meat products could assist consumers in fighting and preventing many diseases not only of the alimentary tract but also of the immune system.

The herein above considerations have demonstrated that there exists a considerable social need to manufacture and study raw cured meat products ripening with the use of bacteria with probiotic characteristics. An important advantage of fermented meat products is that only this group enables manufacturing food products that contain bacteria with probiotic characteristics. This, however, requires further research, breaking barriers and, first of all, compliance with the health safety criterion and acceptation of their sensory characteristics [Kołożyn-Krajewska 2002].

Probiotic bacteria strains are successfully used in the production of dairy products and some juices, but they are not used in the production of raw cured ripening meat products. It appears that the addition of probiotic bacteria strains is possible in the process of production of raw cured meat products. As a result of their use, products with desired and acceptable quality and pro-health characteristics could be obtained. It is then appropriate to take up research to find in what types of raw ripening meat products a growth and development of defined probiotic bacteria strains is possible. It is important to study whether probiotic bacteria will survive during the ripening process of raw ripening meat products and multiply in an appropriate quantity as well as to find what qualitative product changes will develop during its ripening process. The impact of probiotic bacteria on inhibition of growth of other groups of, principally pathogenic and putrefactive microorganisms will be assessed in studies aimed at the determination of optimum development conditions for probiotic bacteria in the process of fermentation (ripening) and storage of raw products during the period of their short shelf-life.

Studies on probiotic properties, which are important in the process of approving food products have to demonstrate that probiotic meat products can be recognised as functional food. A comprehensive assessment of probiotic properties of meat products has not been fully verified yet. Notwithstanding the fact that since 1998 those products have been advertised by Japanese manufacturers, there are still controversies with regard to their utility due to the absence of nutritional confirmation of the majority of scientifically obtained results. Besides, it is necessary to conduct numerous further studies that would substantiate launching and marketing new probiotic strains and fermented meat products. What is more important, those studies should definitely follow directives provided by FAO/WHO, inclusive of a detailed identification of probiotic strains and expected health benefits arising from their consumption.

Many scientists are still pondering whether probiotic bacteria are capable of surviving in conditions prevailing in ripening products and in the alimentary tract during their consumption. In their attempts of solving the riddle, they conduct experiments aimed at finding answers to questions that are bothering them.

On the other hand, a group of probiotic products with lactic acid bacteria added is naturally consolidated and safe for the consumer's health and, additionally, it causes in the human alimentary tract effects that are beneficial from the point of view of microbiological safety. This not only increases food microbiological safety but that of human nutrition as well. Lactic acid bacteria were used long before their existence was ascertained. Their nutritional and therapeutic impact on the human organism has been comprehensively studied and described with respect to dairy products. At present, a new era of their application is opening – selecting strains whose role for human health is supposed to be of importance from the nutritional and health-related point of view. Undoubtedly, the subject of probiotics and prebiotics is currently the research question “in vogue” all over the world. Scientific projects are being conducted on the European and even world scale.

However, the health safety criterion should be of primary importance with respect to the use of probiotics. The application of certain bacteria strains deemed to have probiotic properties can be quite disputable. For that reason, further studies with regard to achieving absolute health safety of probiotic foodstuffs should be continued [Arihara 2006, Aymerich et al. 2006, Franci et al. 2007, Hammes and Hertel 1998, Larrea et al. 2006, Nieto-Lozano et al. 2006, Parvez et al. 2006, Pidcock et al. 2002, Ramírez and Cava 2007, Socha and Stolarczyk 2002].

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ZASTOSOWANIE PROBIOTYKÓW W PRODUKCJI SUROWO DOJRZEWAJĄCYCH WYROBÓW MIĘSNYCH

Streszczenie. Szczepy bakterii probiotycznych z powodzeniem są stosowane w produkcji przetworów mlecznych, niektórych soków, natomiast nie obserwuje się ich wykorzystania w produkcji surowo dojrzewających wyrobów mięsnych. Uważa się bowiem, że wyroby surowe mogą być i są odpowiednim medium do rozwoju drobnoustrojów probiotycznych. Realizowane są projekty naukowe o zasięgu ogólnoeuropejskim, a nawet światowym. Na pierwszym miejscu zastosowania probiotyków, powinno się jednak znaleźć kryterium bezpieczeństwa zdrowotnego. Zastosowanie niektórych szczepów bakterii uznanych za probiotyczne może być dość dyskusyjne. Dlatego powinny być kontynuowane dalsze badania dotyczące zapewnienia bezwzględnego bezpieczeństwa zdrowotnego żywności probiotycznej.

Słowa kluczowe: produkty mięsne surowo dojrzewające, probiotyki, bezpieczeństwo

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