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ALTERNATIVES TO MEAT PROTEIN

АЛЬТЕРНАТИВИ М'ЯСНОМУ БІЛКУ

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Abstract. *In the past, non-muscle proteins in meat products were used mainly for technological or economic reasons. The addition of milk proteins to canned sausages or the use of blood plasma are good examples of the use of non-muscle proteins to give products the desired processing properties. In addition, non-muscle proteins are generally cheaper than muscle proteins, which provides higher incomes for producers of meat and meat products. In addition to technological and economic reasons, environmental factors and the predicted shortage of animal proteins have also been mentioned in the last two decades. All this increases the need for meat substitutes in food products and the search for alternative sources of protein. Along with the use of known animal and plant proteins, other sources of protein, such as insects and microorganisms, are also being discussed, as well as new ways to produce muscle proteins using stem cells or in vitro culture of meat. The purpose of this review is to describe existing and potential sources of protein that can be used as meat analogues/substitutes or additives in meat products.*

Keywords*. Meat, protein, flavor, soy, caseinate, moisture, mineral residue, carbohydrates.*

Meat and meat products contain many essential nutrients that are absent in plant-based products[1-3]. In addition to their importance for the diet, meat and meat products are also valued for their characteristic taste and texture, which explains the high demand for them [4, 5]. In developing countries, meat consumption is also an expression of social status due to its relatively high cost. The increase in meat consumption is caused by income growth and a demographic surge. By 2050, the FAO predicts an increase in the consumption of meat and meat products in developing countries from 30 to 44 kg per capita, and the total consumption in the world should increase from 41 to 50 kg per capita. Growing demand requires global meat production to be increased by 200 million tons. The corresponding increase in land and water use will undoubtedly be accompanied by environmental problems [6-8]. To overcome the gap between the need for protein and its real consumption, it is necessary to use various substitutes for animal protein and supplements for meat products, as well as new sources of protein for human nutrition.

All over the world, vegetable proteins are used to replace muscle proteins in meat products. In the food industry, meat processing enterprises are the largest consumers of soy proteins [6]. In addition to soy, other vegetable sources of protein are considered, such as wheat, peas, lupins, rice, canola, and potatoes. A comprehensive review on this topic can be found in Asgar [10].

Plant proteins are available in the form of powdered ingredients, as well as in a dry, textured form. In most countries, the use of alternative proteins in meat products is regulated by law, however, the norms vary greatly from country to country [9]. Plant sources are characterized by a high protein content, but often they also contain antinutrients, the amount of which must be reduced during production. Soy proteins are obtained from soybeans (Glycinemax), which belongs to the legume family. Basically, soy protein isolate and concentrate are used for meat and meat products with a protein content of 90% and 70%, respectively [9, 11].

In addition to soy as additives to meat products or alternatives to meat it is possible to use other legumes and legumes [10, 11]. In Europe, pea proteins, which are produced from fodder peas, are of commercial interest. (Pisumsativum L.) and 65% consist of two components, legumin and vicillin [9]. The most common process of their production is carried out by a wet method. In the wet method, crushed peas are mixed with water to obtain a suspension that is adjusted to a pH of 9-10. To separate soluble proteins and carbohydrates, the suspension is centrifuged. Then the proteins are precipitated by acidification to the isoelectric point of the protein (~4.3-4.5). After protein neutralization, the extract is spray-dried to obtain a pea isolate with a protein content of 90%. [9]. Wheat gluten with its viscoelastic properties and strong structure is often used in combination with soy for the production of meat analogues [1,6]. Factors limiting the use of wheat as an additive to meat or meat products include the insolubility of wheat protein [1,7], as well as concerns about gluten disease and the allergenic potential of wheat protein. However, the allergenic potential can be reduced with the help of hydrolysis, which also improves the solubility of wheat gluten [11]. In addition, wheat gluten is a by-product in the production of wheat starch and bioethanol, and its use in meat products is described in various research papers [1, 2, 7].

A number of other vegetable proteins, mainly from oilseed plants, such as rapeseed, cotton, sunflower, and peanut, are at the stage of scientific research and active development [10]. In addition, potato and rice proteins are being studied, and potato proteins are already available on the market [1].

Proteins of animal origin can be divided into dairy and meat proteins, the latter of which are obtained from the by-products of the meat processing industry. Milk proteins, as a rule, are divided into two groups, namely casein and whey proteins, both of which are already actively used in minced and emulsified meat products. An example can be the use of whey protein concentrate or hydrolyzed casein in marinated or syringed meat products [2]. Sodium caseinate is widely used in canned meat products, such as meat roll and anchovies, and it is unlikely to be replaced [2,3]. Meat analogues were developed on the basis of milk proteins. Valess® is a product based on milk proteins sold by Campina Friesland [2,4]. Textured whey proteins, described in the work of Hale et al., demonstrated that they can replace up to 40% of the weight of hamburgers without any negative impact on taste and texture [2,5]. Barbuty Choy studied the use of milk proteins in chicken breast at the level of 2% (by weight), as well as with the addition of 51% water. It turned out that all milk proteins significantly reduce culinary losses compared to the control, while caseinate demonstrated the best result.Nevertheless, when comparing the level of protein (2% of total protein), whole milk and modified whey were the best ingredients [2,6]. Various milk proteins are available on the market and are widely used in the meat industry to improve textural characteristics, retain moisture and bind fat. For the production of protein ingredients, in addition to milk proteins, proteins obtained from the by-products of the meat processing industry, such as blood, bones and skin, are also used. Blood makes up approximately 7% of the body weight of mammals. Whole blood used for the production of meat products, such as blood sausage and black pudding. Blood is divided into several fractions containing various ingredients, for example, functional proteins of blood plasma, fibrinogen and hemoglobin, mainly used as dyes [7,8]. When producing meat products, it is recommended to use blood plasma proteins at the level of 0.5-2%. Collagen is obtained from animal skins, bone extracts, by-products, and skeletal muscles, but it is rarely used in food products [2,8]. Collagen can also be modified by heating or fermentation to obtain various dry functional protein ingredients that can be used in meat products [2,7, 8], as well as as an alternative to meat. In the future, biologically active and antimicrobial peptides from by-products of animal origin may become commercially interesting [2,9].

Until now, in Europe and most of the Western world, insects are not deliberately eaten. The only case of regular use of insects in the food industry is the use of carmine obtained from cochineal (Dactylopiuscoccus) as a dye. Back in 1885, VincentM. Holt published a small brochure in which he asked the question "Why do they not eat insects?", and 125 years later the FAO published a report on the potential and possibility of using forest insects as food [3]. At least 1,836 types of insects are eaten at all stages of development. Insects suitable for human consumption include grasshoppers, caterpillars, termites and aquatic insects, which are considered harmless [2]. Insects, which are often called mini-animals, really have a huge potential for use as a possible source of protein. Premalatha et al. write that insects are cold-blooded organisms and therefore spend much less food energy and nutrients than warm-blooded animals, and, therefore, insects produce more protein per kilogram of phytomass consumed than ordinary livestock. In addition, insects have much higher fecundity and significantly faster growth rates than ordinary pets. These features, combined with a very high nutritional value, prompted space scientists to think about using insects as food for humans in space travel [2].Insects have a high protein content (40-75 g per 100 g of dry weight), which is very well absorbed (77-98%). However, despite all the advantages that insects can offer as a source of protein, there is only a very small amount of information about the possibility of agricultural breeding of insects, the technological properties of their proteins, the possibility of creating food products based on insect proteins, and also about attracting the attention of consumers to such products There is also little information about the safety and shelf life of insect-based food products. Klunder et al. studied the microbiological characteristics of edible insects in fresh form, as well as in the process of processing and storage. Tests were also conducted with the cultivation of mealybug larvae (Tenebriomolitor) and house crickets (Achetadomesticus) [3]. However, further research is required, as well as consideration of cultural preferences, organoleptic aspects and allergenic potential, which is present when new sources of protein are introduced into the human diet.

Microorganisms suitable for protein production can be divided into four categories: bacteria, yeast, fungi and algae. Desirable characteristics are fast growth, the ability to develop in simple environments and high productivity [3,4]. Hydrocolloids obtained from seaweed, such as carrageenan and alginate, are already widely used in the meat industry to improve culinary yield and increase muscle value [3,5]. In recent publications, the possibility of using proteins from algae is discussed not only as a new source for animal feed, but also as a new source of protein in the human diet [3,6]. Schwenzfeier et al. demonstrated the potential of traselmis algae in comparison with plant proteins [3,7]. In addition to Tetraselmis algae, only a few other types of algae are discussed as human food, such as Spirulina (Arthrospira), Chlorella, Dunaliella and (to a lesser extent and only at the regional level) Nostoc and Aphanizomenon[3,8]. With the increase in knowledge about protein extraction from microalgae, as well as about the use of by-products as a protein-rich raw material, microalgae can become an important source of protein [4].

Bacteria demonstrate very high growth rates compared to algae and fungi, so they are of particular interest as a source of microbial protein. Along with the very small cell size, bacteria have a high content of nucleic acids, which makes them unsuitable for human consumption [3,4]. A wide range of bacteria is considered as raw material for protein production. Basically, methanol-using bacteria are used commercially [3,9].

Using mushrooms as food is not a new concept, as edible mushrooms have been part of the human diet for over 30,000 years and are now considered a delicacy. In addition to edible mushrooms, mycoproteins from mycelial cells are used to produce meat analogues fungi Fusarium venenatumare [1]. This product is currently on the market in 11 different countries under the brand name Quorn®. Mycoproteins are a qualitative sample of protein and have shown health benefits as they lower cholesterol levels and improve heart function [10,11]. However, side reactions are also known, but their detailed mechanism is not known [2].

Based on results, mainly from medical research in the field of stem cell isolation and identification, ex vivo cell cultures and tissue engineering theoretically allow the creation of meat in a petri dish. Various reviews on in vitro meat production are recommended to further explore this issue [4, 6, 7].

Tuomisto et al. published a study on the life cycle of cultured meat. It was proposed to use hydrolyzate as a nutrient and energy source for the growth of muscle cells cyanobacteria. The results showed that cultured meat production had 80-95% less greenhouse gas emissions and 98% less land use compared to conventional meat products. The overall impact during the production of cultured meat was also significantly lower compared to meat produced in the traditional way [4,8]

Conclusion.

With the growth of the population and the need for protein in meat products, it is necessary to introduce new sources of protein. Through the introduction of new sources of protein, new meat products can be developed. In addition, alternative proteins need to be developed and introduced by 2050 to meet the needs of 9 billion people. Further research is needed to realize the full potential of alternative protein sources as a substitute for meat in meat products.

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Анотація. *У минулому нем'язові білки в м'ясних продуктах використовувалися переважно з технологічних чи економічних причин. Додавання молочних білків у консервовані сосиски або застосування плазми є хорошими прикладами використання нем'язових білків для надання продуктам необхідних технологічних властивостей. Крім того, нем'язові білки в цілому дешевші за м'язові, що забезпечує більш високі доходи для виробників м'яса та м'ясних продуктів. Крім технологічних та економічних причин в останні два десятиліття згадуються також екологічні фактори та передбачений дефіцит тварин білків. Все це збільшує потребу в замінниках м'яса в харчових продуктах і пошуку альтернативних джерел білка. Поряд з використанням відомих тварин та рослинних білків все активніше обговорюються й інші джерела білка, такі як комахи та мікроорганізми, а також нові способи виробництва м'язових білків за допомогою стовбурових клітин або культивування м'яса invitro. Метою даного огляду є опис існуючих та потенційних джерел білка, які можуть використовуватися як аналоги/замінники м'яса або добавок у м'ясні продукти.*

Ключові слова: *М'ясо, білок, смак, соя, казеїнат, волога, мінеральний залишок, вуглеводи.*