

PROS & CONS: USING UNCONVENTIONAL RAW MATERIALS IN THE ROMANIAN MEAT PRODUCTS INDUSTRY

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Abstract

Unconventional raw materials have become alternative sources used in many food products due to their specific functional and nutritional properties. Their use as succedanea of raw materials or ingredients grew considering the technological, economic and social advantages generated.

The concern for the nutritional benefits of food makes the food industry manufacturers use sources of food as diverse as possible, as well as specific ways of processing them. These concerns should also take into account the quality of products and their acceptability by consumers.

This paper aims to study the economic impact of using vegetable and animal protein derivatives and to establish the field and limitations of this use in the Romanian meat processing industry by making a comparative analysis of these ingredients.

In this context, it is only natural that two issues arise. The first one deals with what is conventional and what is unconventional and to what degree and the second deals with arguments for and against the use of unconventional raw materials in the evolution of the national food supply.

Keywords

unconventional raw materials, vegetal and animal protein derivatives, Romanian meat industry, meat substitutes

JEL Classification

Q13, Q18, O13

Introduction

Increasing demand for diverse food has led to the emergence of innovative food products, either conventional products or conventional products with modified characteristics or entirely new products. This unprecedented growth in the range of available food products is meeting both consumer demands and the interests of the producers.

Obtaining these products was not possible only by using classic raw materials or existing manufacturing technologies. New processing technologies have been created and existing ones have been improved to produce products with a wide range of adaptive properties to different food systems.

Population growth, the limited nature of food resources, the evolution of human nutrition, the high rate of progress in the food industry, as well as economic, social and nutritional

causes are determinants that have led to the emergence of ingredients and food substitutions, the discovery and capitalization of some non-traditional and unconventional food sources and, implicitly, to the enhancement of the conventional foods offer with non-traditional and unconventional foods.

A main research direction in the food industry has been directed towards obtaining substitutes for protein substances, recognizing their primordial role in vital processes, their high nutritional quality, reflected by a high biological value. The solutions found should take into account the economic efficiency of obtaining those protein resources, addressed both in terms of quantity, using the ratio between production costs and the amount of protein obtained, and in terms of quality, by their amino acids content.

In order to find and use new sources of protein, intensive research has been done to capitalize on high-protein raw materials and the use of modern methods of obtaining protein derivatives for human nutrition.

1. Sucedanea of raw materials in the meat products industry – literature review

The succedaneum is a substance or a product that can replace, when needed, another substance or product, with similar properties (DEX, 2016). It is considered that succedanea perform a positive function in contemporary life, both socially and economically, allowing consumers from the most diverse categories greater access to certain products.

The basis for succedanea's development is represented by the rapid development of the industrial production, its diversification and automation, the improvement of the technologies used and the achievement of maximum economic efficiency.

The emergence of succedanea in the food industry is based on the following reasons:

- the possibility of capitalizing raw materials in a superior or different way from the usual practices;
- using cheaper or easier to obtain substitutes for classic raw materials.

Thus, food substitutes can be used as a main ingredient to obtain food replacement products (e.g. soybean milk, tofu) or as a partial substitute of a valuable base ingredient (eg replacing meat with soy or milk derivatives).

Food product substitutes are products made from cheap raw and auxiliary materials that mimic the general characteristics of the original products they substitute. These products contain all the major chemical components, including some psycho-sensory substances which impart their specific taste and flavor (Petrescu et al, 2002). If they are obtained and marketed in accordance with the legal provisions in force, food substitutes can be considered succedanea, with a positive function, and their promotion on the food market is a step forward for the food industry as long as it generates a range diversification.

Food products obtained by using new recipes, according to new technologies or containing new ingredients (used for the first time in a food product) must be submitted to the authorities for sanitary endorsement.

Food substitutes must be declared and marketed with distinctive inscriptions and symbols that distinguish them significantly from the foods they substitute. Their ingredients must be specified both in the products' official endorsement papers and on the label. In this way, product replacements are clearly distinguishable from counterfeited products.

The substitutes can be organized based on their animal or plant origins, and according to their use, either as a main source or as a supplement. These sources also have nutritional, hygienic, ethical and environmental specificities (Terrien, 2017).

Establishing the nutritional and economic value of protein sources means analyzing their chemical composition in terms of: total protein content (complete, collagen, elastin) and essential amino acid content, as percentage of protein.

Sources of vegetable protein used in the food industry are: *cereals, legume seeds, oilseeds, green plants, mushrooms.*

Seeds of leguminous and oleaginous plants are sources with high protein content. *Peas, beans, lentils, chickpeas*, but also **soybeans**, *sunflowers, peanuts, rape, cotton, flax* contain valuable proteins with a content that is more balanced in essential amino acids. The nutritional value of the oilseed protein is negatively influenced by the presence of anti-nutritive factors in the seed (trypsin inhibitors and hemagglutinins). Therefore, research has been directed towards destroying, eliminating, inactivating or reducing these anti-nutritive factors by chemical or thermal treatments that do not affect the quality of the proteins.

Vegetable protein derivatives are classified depending on the presentation form and the protein content into (Stancu & Segal, 1982):

- protein flours and meal, with up to 50% proteins;
- vegetable protein texture (textured flour and meal with up to 50% proteins);
- protein concentrates, rich or enriched in proteins (contain between 60-70% proteins);
- protein isolates (products very high in proteins, usually over 90%).

Because of their characteristics, vegetable protein derivatives are used in the food industry as *additives or substitutes of additives* of more expensive animal origin (Banu & al, 2009). They are widely used in bakery products, meat products, milk, canned foods, soups, sauces and sugary products (Shurtleff and Aoyagi, 2016).

In the processing of meat products, soy protein is used as a nutritional and functional substitute for protein of raw animal material (Jideani, 2011).

The main protein derivatives of vegetable origin used in the meat industry are: *textured soy protein* (at least 50% protein content), *soy protein concentrates* (minimum 70% protein content) and *soy protein isolates* (90% minimum protein content). Their hydration ratio varies between 1:2 and 1:5.

Textured products are an optimal substitute for meat in terms of quality, with high economic profitability. Qualities such as good hydration and water retention allow them to reduce production costs, improve texture, or increase protein and nutritional value in the production of raw sausages and salami. Also, textured soybeans are the alternative to meat known as food substitutes used in the production of minced meat products.

Protein concentrates are obtained from defatted soybean flour by extraction of soluble carbohydrates, sugars, minerals and some minor components. Soybean protein concentrates have a high nutritional value and great economic efficiency, having a wide range of uses due to their hydration and water retention capacity (1:4), their characteristic of improving emulsification and fat absorption, and their acting as a binding agent for the texture of meat preparations. They prevent the alteration of fat due to their high vitamin E content.

Soybean protein isolates are high solubility elements that are used in some applications in the meat industry for their gelling and emulsifying properties, forming a stable emulsion. Protein isolates contain at least 90% proteins, relative to dry matter. The most important functional characteristics of the protein isolates are, in addition to their emulsifying ability, gelling capacity and water retention, their adhesion/cohesion properties and aeration properties. These also increase the shelf life of the product.

Sources of animal protein that are increasingly used in the food industry are:

- *by-products from meat industrialization*: blood, by-products and non-edible waste (the meat paste from bones and non-edible organs - MDM, bones, collagen waste);
- *by-products from milk industrialization*: skimmed milk, whey and buttermilk (Stancu & Segal, 1982).

Proteins from animal sources are ingredients derived from meat, milk and egg and are derived from the animal itself and its by-products (skin, bones, blood, whey, etc., Tarté, 2015). The main ingredients of meat-derived proteins are essentially collagen (and gelatin) and proteins derived from the blood.

The addition of collagen to meat products as a binder has been shown to be advantageous and is believed to have potential as a substitute for starch and other hydrocolloids in product formulation.

Proteins from milk by-products are very valuable from a nutritional point of view, having a very balanced composition in essential amino acids: protein derivatives derived from dairy by-products have a higher biological value and a better digestibility than those resulting from meat industrialization.

Milk processing results in some by-products whose nutritional value is important, containing nitrogenous substances, carbohydrates and lipids, from which substitutes can be obtained for various uses in the food industry, including the meat industry. The main by-products resulting from the industrialization of milk are skimmed milk, whey (resulting from cheese production) and buttermilk (from the whipping of cream), their composition being determined by the physical and biochemical processes applied.

Of the by-products, skimmed-milk powder is often used in the food industry specifically in the meat industry. Co-precipitates and caseinates are also widely used in the meat industry to obtain textured protein which is used as raw material in the manufacture of meat substitutes and as nutritional protein additions in meat preparations. (Băisan, 2015).

2. Uses and limitations of protein derivatives in the Romanian meat industry

The meat products industry has the advantage of choosing from a wide range of substitutable raw materials and auxiliaries. Soy derivatives are found in final products in varying proportions, their purpose being to substitute animal proteins, having two roles: a functional one (acting as an emulsifier, water retention, stabilizing agent) and a nutritional one (to balance the protein level in the finished product composition).

From a legislative point of view, in Romania, Order no. 176 of 18 February 2009 of the Minister of Health repeals OSM no. 975/1998 regarding the approval of food hygiene norms according to which the addition of over 3% vegetable soybean protein in the composition of meat products is prohibited has been repealed. Therefore, at the moment, this percentage remains at the choice of producers, who must maintain a balanced collagen-protein ratio (between 20%-35%, according to WHO no. 569/2006) otherwise the future product will be affected by an accelerated fermentation process.

In practice, the most commonly used animal protein derivatives that are added to the recipes of cold meats are casein (milk protein), the meat paste from bones and rind emulsion. Of these, we will choose casein for a comparison of physicochemical, nutritional and functional characteristics with those of soybean vegetable derivatives, i.e. protein isolates and textured proteins.

By comparing the chemical characteristics of the protein derivatives selected for our study (soybean derivatives and casein derivatives) the similarities and differences between them can be observed (table no.1).

Table no. 1 Chemical characteristics of the protein derivatives

| Chemical characteristics | Casein | Soy protein isolate | Textured soybeans |
|--------------------------|----------|---------------------|-------------------|
| Humidity, % | max. 8 | max. 6 | 6-10 |
| Proteins (N*6.25), % | min. 90 | min. 90 | min. 50 |
| Lipids (fats), % | max. 1 | max. 1 | 1-5 |
| Lactose, % | max. 0.5 | - | - |
| Total ash, % | max. 4.5 | max. 5.5 | max. 12 |

Source: based on technical specifications defined by manufacturers

The chemical characteristics are established through the technical specifications defined by the manufacturer's and supplier's standards. Thus, by comparing, one can see that both the soy protein isolate and casein contain the same amount of protein, while textured soybeans contains a lower amount of protein, of at least 50% (Table no.1), resulting in a ratio of 2/2/1.1.

This shows the following practical implications: in order to produce the same amount of a product, with the same proteins percentage in the final product, for casein or isolate one will calculate the total cost for just half the quantity of textured soybeans. The cost reduction with the auxiliary raw materials, as part of the production costs, is an important factor in increasing profit.

The study worked with data regarding the costs of unconventional raw materials, by comparing the cost of soybean derivatives (vegetable protein) to the cost of casein (animal protein) thus highlighting the economic and financial impact of raw material substitution.

The analysis of protein derivatives prices shows a ratio between casein, isolate and protein texture of 4/2/1.

Thus, the costs of using textured soybeans can be compared to the costs generated by the use of casein and, separately, the cost of soy isolate versus casein costs can be analyzed within a specific production stream.

Taking into account the costs on a technological stream using soy protein isolate, knowing the quantity used on average for the production of each product, the losses caused by the thermal treatments applied, the price per kilogram for the soybean derivative and casein, but also the percentages in which these ingredients are added to the finished product, the production costs can be compared.

A reduction in the cost of auxiliary raw materials is observed, the costs with soy protein isolate being significantly lower, by approximately 15-17%, relative to the costs of using casein, which is an economic advantage for the producer. The use of soy protein isolate in the production of meat preparations allows for a reduction in the proportion of meat or animal protein (more expensive) in the product composition without reducing the protein content or significantly altering the quality of the product.

As far as the use of textured soybeans is concerned, the manufacturing recipes differ significantly in terms of quantity; for example, for chicken Bologna sausage a quantity of textured soybeans 3.5 times larger than the one in Oltenian sausages is used. In fact, the substitution of animal protein with vegetable protein also has, in addition to economic advantages, has the role of improving certain consistency characteristics of the product. Due to the soy protein's ability to absorb water and grease, it allows manufacturers to use meat with more fat. In the meat products industry the most used soy derivatives are protein isolates (more than 50%) due to the maximum amount of protein contained, qualitatively and quantitatively equivalent to animal protein, but also due to its accessibility in use (being added by injection, becoming an integral part of the product through a less obvious assimilation in the final product).

On the other hand, an emulsion can be formed from soy protein isolate or casein to replace 30-5% / 30-10% of the amount of fat in the product (Weiss et al, 2010).

Caseinates have a good ability to emulsify fats, a high viscosity in solution, similar to that of soy proteins. Soybeans have long been considered the most cost-effective ingredient, but recent studies on the effects of using powdered milk and caseinates show that they also contribute to the improvement of technological yield and texture. (Hongsprabhas, 2016; Gavriliuț, 2017).

Vegetable meat substitutes may contain only pure soy or may be mixed with dried cereal flour and dried oleaginous fruits; various types with specific tastes are available on the market: beefsteak, chops, sausages, meatballs, schnitzel etc. Protein derivatives with the best functional characteristics for use in the meat industry are vegetable protein isolates which,

due to their lack of specific flavor and their high protein content, can be used in higher percentages (10-20%) and allow for meat preparations, such as pressed ham, pastrami, smoked tenderloin etc., to be obtained.

Dehydrated milk, sodium caseinates, concentrates and isolates from whey protein are used in minced and emulsified meats, such as frankfurters and bologna sausages, as well as coarsely chopped products such as fresh sausages. Dairy proteins, including whey protein concentrates and partially hydrolyzed caseins, are used in marinated or injected meat.

National regulations on the marketing of meat products in Romania (Order No 560/2006) specify the products - differentiated according to the heat treatment applied – that may have in their content vegetable proteins or other animal proteins added as ingredients: meat products obtained by boiling and / or smoking and / or drying (salami, sausages, hams and reels, semi-canned meat, specialties, pastrami), meat products made from baking (stewed meat) and sterilized meat products such as mixed cans and meat pâté and paste.

Exceptions to this are smoked meat specialties (bacon, smoked bones), where only protein of vegetable origin may be used, but also cold smoked specialties, where the use of protein derivatives of any nature is not allowed. Also, in raw meat products (salami, sausages) only vegetable protein is used as an ingredient. The addition of animal or vegetable proteins is forbidden in the production of Sibiu salami, Plai sausages, gyudem and Babic.

Vegetable proteins are not allowed as raw material, but allowed as ingredient (along with animal protein) in canned pork in its own juice, canned beef in its own juice and meat pâté and paste. Another exception are dietary preserves and preserves for children where the addition of animal or vegetable protein derivatives is not allowed, either as a raw material or as an ingredient.

The widespread use of protein derivatives can be a solution for consumers who want to reduce meat consumption, such as younger, more educated, and female consumers (Slade, 2018). The different characteristics of meat substitutes suggest a wide variety of strategic solutions, which must be evaluated in order to best position them in the food industry (Terrien, 2017).

Conclusions

Protein derivatives of vegetable or animal origin are part of the category of unconventional raw materials used in the manufacture of meat preparations, aiming at improving the sensory and nutritional characteristics of processed meat products and increasing economic efficiency. For each country, the importance of one or other of these raw materials depends on its availability but also on the local consumer habits.

The main reasons why protein derivatives are used worldwide in many food and industrial products are the functional, nutritional and economic factors.

Protein derivatives are extremely versatile and functional, being added to meat preparations where they can act as an emulsifier, a consistency improving agent and are designed to increase the shelf life of the product.

Vegetable proteins, especially soy beans, are a cost-effective alternative to using animal protein in the manufacture of a wide range of meat preparations.

First, soy proteins are more stable and easier to predict than animal protein, which offers the advantage of an easier access to purchasing ingredients on the supply market. Also, the cost of using soy protein is lower than the cost of using animal proteins. Using soy protein is a way to maximize profit by providing control over raw material costs in the meat industry without affecting the quality and properties of the product.

Secondly, we are witnessing the development of the meat substitutes market, based on an increase in the number of consumers with a vegetarian diet, or with specific metabolic requirements (lactose intolerance) or health concerns that want to reduce meat consumption, given that the nutritional value of the soy protein is close to that of the animal protein.

However, many consumers do not prefer products from unconventional raw materials due to the specific taste of the product, its texture, appearance and smell, creating inconveniences in market growth.

Thirdly, a lower psycho-sensory value of protein derivatives requires more additions to the finished products to achieve greater consumer acceptability, which affects product innocuity.

Fourthly, the problem of limiting the use of unconventional raw materials also derives from their content in certain anti-nutritive substances, which affect the metabolic functionality and, implicitly, the nutritional value of the products.

Although manufacturers of the Romanian meat industry are required to declare on the label all the ingredients used, the acceptance of non-conventional products differs from one consumer to another, the option to eat being a selection process based on the triad of knowledge-skills-attitudes.

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