OPTIMIZATION OF "MEAT LOAF" MEAT PRODUCT FORMULATION

Saule Abimuldina, Nadezhda Koftanyuk

S. Toraighyrov Pavlodar State University, Kazakhstan

Abstract

The article describes basic criteria for optimization of formulation – nutrition and biological value, physiological rate of consumption, and therapeutic and preventive effect in gastrointestinal diseases and diseases of musculoskeletal system.

Key words: *formulation, production process layout, food and biological value*

People's state of health is determined by their nutrition. The balanced diet in terms of content of micro- and macronutrients and energy value, the use of high technologies providing transformation of raw materials into easily digestible form contribute to the formation of healthy eating.

In this respect, a promising direction is the development of resource-saving technology of special-purpose dietary meat products, creation of which will expand the range of domestic competitive food products with the use of secondary meat for processing.

The notion of secondary meat and dairy products for processing does not mean their low nutritional and biological value. It is rather an issue of economic rationalization, since the cost of secondary raw materials (lung, udder, buttermilk, and whey) is about 2-3 times lower than the cost of basic raw materials. The resources of secondary raw materials account for about 40% of the total volume of meat and dairy raw materials and are not used very effectively [3]. The reasonability of using them is evidenced by both economic factors and the latest data on food and biological value.

Thus, secondary meat raw materials with high content of collagen have a number of positive biological functional properties (water-binding capacity, water-retaining power and texturing capacity) that allows using them in various food systems. Decomposition products of collagen in the process of digestion stimulate secretion of gastric juice as well as peristaltic function of stomach and intestines, thus displaying some dietary properties. Nonnutritive fibers of collagen raw materials maintain enzymatic, bacterial, immune and other systems of gastrointestinal tract. Besides, dietary fiber and connective-tissue proteins as sorbents promote binding and removal from body of harmful and toxic substances. Collagen helps to restore cartilage tissue of musculoskeletal system [2].

But foods that are high in dietary fiber have a positive impact only on a healthy body. In diseases of digestive system the effect from the use of this group of products is more likely to be negative, since rough dietary fiber will have in this case a traumatic impact.

Thus, with obvious food and biological value of connective-tissue proteins there is a problem of transforming them into easily digestible form which does not have a traumatic impact on gastrointestinal tract [1, 4].

World experience of research in this area indicates the effectiveness of the use for this purpose of enzyme preparations (pepsin, trypsin, pancreatin, papain, ficin, etc.). Some foreign countries have reached a high level of production of food ingredients from secondary meat raw materials based on enzymatic hydrolysis. According to the Laser-Reutersward (Sweden) digestibility of collagen after enzyme treatment accounts for 95%.

In Yugoslavia there has been done the research for obtaining hydrolysates from pig skins and using them in soups (M. Ziecik, M. Fik, etc.).

A number of methods for obtaining enzymatic hydrolysates have been proposed by French researchers, who used enzymes of animal (pancreatin, pepsin), vegetable (ficin, papain) and microbial (from B.subtilis, Str. fradial) origin.

In Germany they also receive hydrolysates from secondary raw materials on the basis of microbial drugs from B.subtilis, Asp.crizal, P Latex.

Russia has also conducted a research on the use of Str. Chromosenes, P. vortumani microbial preparations for obtaining hydrolysates used in the production of protein meat loaves, with up to 20% replacement of basic meat raw materials (L.V Antipova).

The Republic of Kazakhstan has done the research on the use of enzymes (pancreatin, pepsin) to convert secondary meat raw materials (lung) in easily digestible form in manufacturing cooked sausage products.

The use of hydrolysates of connective-tissue materials in the formulations of meat products will expand their assortment, increase functionality and introduce the pattern of efficient use of meat resources.

The solution of this problem raises both the issue of creating resource-saving technologies for production of dietary products using secondary raw materials and the need for development of equipment for processing connective-tissue material.

Taking into account current trends in the field of production of multicomponent meat products for dietary and specialized nutrition there have been developed basic specifications for designed products.

In developing the specifications there has been taken into consideration the composition of the product ingredients so that they could provide food and biological value as well as functional orientation. The specifications allow for replacement in meat products formulations the basic meat raw materials by secondary (lung, udder) and vegetable (cabbage) ones. The use of these raw materials possessing antioxidant and sorbent properties provides dietary orientation for designed meat products.

Besides, the development of basic specifications included the consideration of the requirements to structural parameters of meat and vegetable stuffing. High structural parameters can be achieved by improvement of both technological processes (chopping, beating, structuring) and chemical ones (hydrolysis of connective-tissue materials).

Taking into account the developed basic specifications we carried out the selection of raw materials of meat and vegetable origin for making up formulations of dietary food products on the basis of the analysis of materials of scientific and technical information.

The main criteria for this selection of raw materials were food and biological value, physiological rate of consumption and therapeutic effect in diseases of digestive and musculoskeletal systems.

The basis for the designed meat products was beef, horse meat and poultry which are sources of valuable protein and also possess dietary properties due to low fat content and balanced content of micro- and macronutrients.

The use in formulations of the products under development of secondary meat raw materials with a high content of connective tissue (lung, udder) provides a sorbent and an antioxidant effects. Connective-tissue proteins and dietary fiber of this group of raw materials contribute to binding and removal from the body of harmful and toxic substances. Decomposition products of collagen in the process of digestion stimulate secretion of gastric juice and peristalsis of stomach and intestines. Nonnutritive fibers of collagen raw materials maintain enzymatic, bacterial, immune and other systems of the body. Collagen also helps to restore cartilage and connective tissues of musculoskeletal system.

Gelatin, which is a part of the product, promotes blood clotting that determines its application in gastro-intestinal bleeding.

The enrichment of the product designed with iron-containing proteins is achieved through the introduction of liver.

The introduction of cabbage into the formulation provides sorbing effect, as pectins and cellulose fibers of cabbage bind and impede the absorption of cholesterol, bile acids, and carbohydrates in intestine, and accelerate their elimination from the body.

Antioxidant, sorbing and anti-inflammatory effect of milk thistle used in the composition of the products under development provides preventive and dietary orientation.

Whole rice or rice flour are used in products to improve their taste and structure forming properties. Thus, in case of high content of free moisture in the meat products and low component connection, with the introduction of rice during heat treatment there takes place a gelatinization of polysaccharide contained therein (amylose and amylopectin), which in interaction with ingredients of minced meat retain moisture forming a colloidal dispersion. At the same time polysaccharides of rice flour not only retain free moisture, but also interact with protein molecules of meat raw materials that allow improving the structure and facilitating the product formation.

Thus, the selection of raw materials and ingredients used in meat products under development will provide them with a high nutritional, biological value, functional orientation and economic viability.

Formulation modeling was performed with account of physiological standards of consumption and the requirements of SanPiN (Sanitary Regulations and Norms) to dietary and specialized food. The developed models of product formulation have been optimized for food and biological value.

On the basis of food and biological value of designed products the following conclusions can be made:

- protein: fat ratio in the products under development meets the requirements to dietary food and food for particular nutritional uses and amounts to 1 : 1.09;
- by amino acid composition the designed products fall into the category of products of high biological value, the amino acid score on limiting amino acids is: for meat loaf in Variant I is 84.7%;
- the use of cabbage in meat loaf formulation in powder provides improved functional properties of the product due to hydrating properties of cabbage.

On the basis of developed three variants of meat loaf formulations in laboratory conditions two production prototypes have been worked out.

At the stage of optimization of meat loaf formulations in terms of composition of ingredients, quality (organoleptic, physico-chemical and microbiological parameters), food and biological value there have been developed the prototypes of meat loaf in semi-industrial conditions (Table 1).

Table 1 – Meat loaf formulation

No.	Raw materials	Amount, kg per 100 kg of raw material	
		Variant I	Variant II
1	2	3	4
1.	Standard beef	25.0	17.0
2.	Poultry	35.0	35.0
3.	Beef lung	15.0	-
4	Udder	-	20.0
5	Fat	10.0	-
6.	Sunflower oil	-	12.5
7.	Rice	5.0	5.0

8.	Cabbage	5.0	7.0
9.	Egg	1.0	1.0
10.	Starch	3.0	1.5
11.	Milk thistle	1.0	1.0
	Total	100.0	100.0
Spices, kg/100 kg of minced meat			
1.	Cooking salt	2.4	2.2
2.	Caraway seeds	0.05	0.05

The quality of developed products was assessed by organoleptic, physico-chemical and microbiological parameters. Based on the data of microbiological studies there has been determined the shelf life of meat loaf and it amounts to three days.

The production of meat loaf prototypes was conducted according to the production process layout presented in Figure 1.

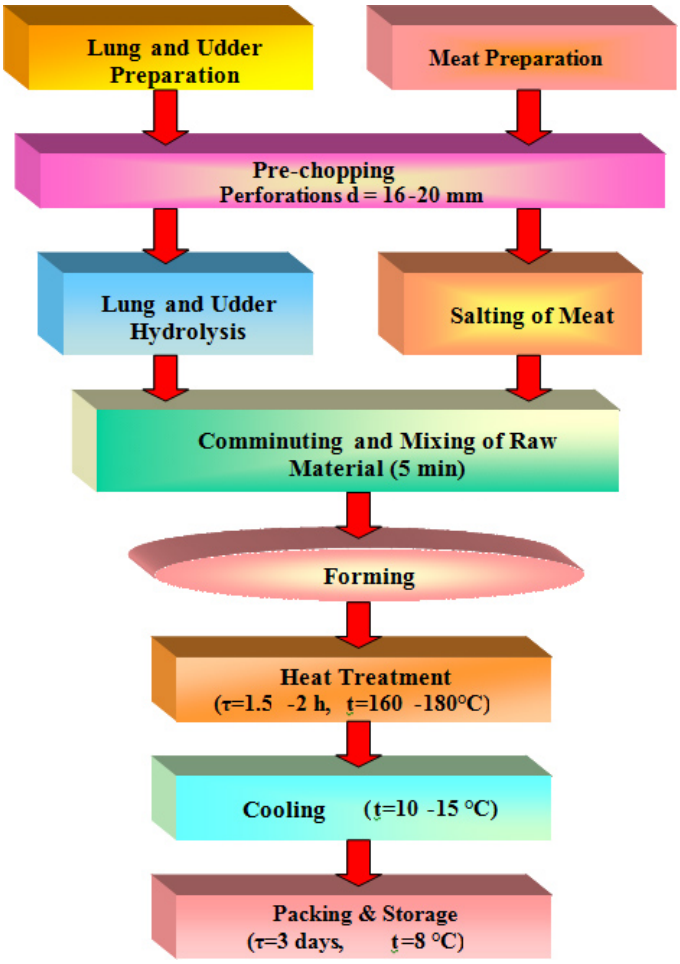

Figure 1 – Meat loaf production process diagram

The basis of meat loaf production technology is an existing technology. Changes have been made at the stage of preparation of connective- tissue materials (lung, udder). In order to convert it into a digestible form it was processed in hydrolyzing mixture in the amount of 2% of weight of the materials. This technological method will allow a 30 minute-cut in the length of heat treatment.

Description of meat loaf production process

Raw materials preparation

Beef meat is separated from tendons, connective tissue and fat and cut into pieces of 200-300 g. Connective-tissue raw materials (udder and lung) are cleaned, washed, cut into pieces of 200-300 g, soaked for 40-60 minutes, and comminuted to a size of 2-3 mm. It is then treated in hydrolysis mixture (2% of the total raw material) for 8-10 hours.

Dried cabbage is comminuted and soaked in water (t = 18-20 °C in ratio 1: 2) for 20-30 minutes before swelling.

Rice is purified from impurities, washed, dried and ground to a powder.

Pre-chopping

Trimmed beef and poultry are chopped in a meat grinder with perforations of the grinding plates ranging from 16 to 20 mm, salted and kept for 6 hours at a temperature of 2-4 °C. Salting of every 100 kg of meat takes 1.5-2 kg of salt, 100 g sugar.

Fat is diced in 6 × 6 mm or chopped in a meat grinder.

Comminuting and mixing

Salted and cured meat raw materials as well as prepared udder and lung are comminuted in grinding machine for 3-4 minutes with the addition of 25% of ice or cold water in the following order: lung, udder, then beef, chicken, salt, spices. At the next stage of grinding fat, onions, cereals, cabbage and crushed are added and comminuted for another 3-5 minutes. The received ground meat should have a homogenized structure with a grinding size of 30-80 mm.

Forming

Minced meat is tightly filled by hand or by special filling machines in pre-greased aluminum or ten-coated forms. Mass of each loaf is 0,5 ÷ 2,0 kg.

Heat treatment

The forms tightly stuffed with minced meat are placed in rotary ovens or multifunctional thermal chamber at a temperature of 160-180 °C for 1.5 to 2 hours depending on the mass of the loaf. Baking process is considered complete when the temperature inside the loaf is 70 °C.

Cooling

Baked product is cooled at a room temperature of 6-10 °C to an internal temperature of loaf equal to or less than 15 °C. Cooled loaf is wrapped in cellophane or other packaging materials.

Storage and sale

Meat loaf is stored in a refrigerated room at a temperature no higher than 8 °C and relative humidity of 75-80% up to 3 days.

According to the results of experimental studies, we can conclude that the developed composition of meat loaf formulations with high nutritional and biological value, due to the use of cheap secondary raw materials and application of processes with minimum power consumption is economically feasible.

Bibliography

1. Kurchanova Ye. Ye., Maksimov I. V. Plant sources of proteins in combined products // Food processing industry, No. 1. 2006. – P. 90. (Курчатова Е.Е., Максимов И.В. Растительные источники белка в комбинированных продуктах // Пищевая промышленность, № 1. 2006. – С.90.)
2. Pokrovsky A. A. Nutrition guide. – Mocsow : Medicine, 1981. – P. 6–8, P. 103–112. (Покровский А.А. Справочник по диетологии. - М.: Медицина, 1981. – С. 6-8, С. 103-112.)
3. Antipova L. V. Biotechnological aspects of rational use of secondary raw meat industry . – Moscow : AgroRIITERMDI, 1991 (Антипова Л.В. Биотехнологические аспекты рационального использования вторичного сырья мясной промышленности. – М.: АгроНИИТЭИММП, 1991.)
4. Strelko V. I. Rough dietary fibers as natural absorbers of poisons in the intestines // Science and Life. No. 12. 1980. (Стрелко В.И. Грубые пищевые волокна – естественные поглотители ядов в кишечнике // Наука и жизнь. № 12. 1980.)