THE TECHNOLOGY OF CHEESE

STRUCTURED SEMI-PRODUCT WITH THE USE OF GELATIN

The monograph

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The monograph includes concentrated and integrated scientific information concerning the use of nonfat cheese and sunflower seed kernel for producing structured products at the restaurant business enterprises. This information is presented in the form of text, technological calculations, figures, diagrams, tables and it is meant for lecturers, postgraduates, students who are engaged in scientific work.

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INTRODUCTION

When analyzing the state of the domestic cheese market, its poor quality and high cost caused mainly by lack of the base raw material – milk in its production should be marked out. Therefore, dairy plants produce cheese mainly in summer. In winter, its output is reduced sharply and production works due to the stocks made in summer and autumn.

In Ukraine the development of new composite cheese semi-products that compensate nutritional problems and have expressed curative and prophylactic properties is conducted. Production of cheese semi-products fortified with dietary supplements of plant origin allows expanding range of products, increasing competitiveness of functional semi-finished food products and their nutritional value. A significant contribution to the development of these technologies was made by N.P. Zaharova, E.G. Naydenova, A.O. Bovkun, S.S. Gulyaev-Zaitsev and other scientists, but their works were not related to the use of the concentrate of sunflower seed kernel.

Protein of sunflower seed kernel occupies an important place among the plant proteins used in food technologies. Ukraine has a large raw material base of this culture because our country occupies one of the first places in the world, particularly in the CIS, in terms of sunflower seeds production for obtaining oil. Thus, sunflower cake with a broad range of functional and technological properties is not used effectively and it is not widespread in scientific and experimental works.

Taking into consideration the above mentioned, the upcoming trend in creating new semi-finished food products with effective introduction of plant protein to the recipe is the development of scientifically grounded technology of cheese structured semi-product with the use of the concentrate of sunflower seed kernel. Thus, the use of the protein of sunflower seed kernel with cheese allows obtaining cheese structured semi-product with high nutritional and biological value, microbiologically and environmentally friendly and cost-effective. In addition, the presented technology allows extending the range of cheese structured products in the consumer market of Ukraine.

The monograph contains materials that include specification and structural-functional properties of structure-forming agent, review of contemporary methods of the integrated use of milk raw material, particularly nonfat cheese with effective introduction of plant protein to the recipe and obtaining structured products on the base of this protein.

The first chapter presents analysis of the current state and prospects of structured products, the general specification of dairy proteins of cheese; consideration of their physical-chemical, functional-technological and structural-mechanical properties as well as substantiation of reserving cheese by freezing; prospects of the use of concentrate of sunflower seed kernel and gelatin in structured products composition; analysis of the chemical composition

of sunflower seed kernel; functional properties of gelatin.

The second chapter contains materials focused on substantiation of technological parameters of the structured products on the base of nonfat cheese thawed; substantiation of the recipe ingredients content, the choice of the structure-forming agent, fat ingredient; investigation of the structural-mechanical properties of the model system of cheese structured semi-product; investigation of the mechanism of complex formation of the model system ingredients.

The third chapter is devoted to the development of the recipe composition and technology of cheese structured semi-product on the base of nonfat cheese thawed with the use of sunflower seed kernel, with addition of refined deodorized oil and food vegetable oil as fat ingredient and gelatin as a structure-forming agent. Nutritional and biological value of cheese structured semi-product, safety indices, terms and conditions of storage, quality indices and recommendations on the use of cheese structured semi-product as a part of culinary products.

CHAPTER 1
MODERN TRENDS IN DEVELOPING TECHNOLOGY OF STRUCTURED PRODUCTS BASED ON NONFAT CHEESE AND PERSPECTIVES OF THE USE OF SUNFLOWER SEED KERNEL

1.1. Analysis of the current state and perspectives of developing the technology of structured products based on cheese

Nutrition system of a contemporary human is closely related to the socio-economic condition of the state. High level of poverty of the population of Ukraine, low subsistence level, deterioration of food products quality under conditions of economic crisis as well as the increase in consumption of food products of in industrial production result in a significant deterioration of nutritive status and state of health of population, especially in children and young people [24, 28, 29, 85, 108, 236, 238].

The processes of globalization in Ukraine taking place in the sphere of providing population with food products when under conditions of global economic crisis most manufacturers seek to reduce the cost of their products due to the use of dietary additives stipulate a real threat of deterioration in the quality of food products.

The market of milk and dairy products is one of the leading in the structure of the food industry of Ukraine. The main factors that hinder development of the domestic dairy products market are: reducing the number of cows, poor quality of raw milk, outdated technology, non-conformance of national standards and requirements concerning milk quality to European ones [144]. According to statistics [10, 31, 78, 86, 118, 203, 204] since 1990 the volume of milk production in Ukraine has decreased by 54.3%, first of all due to the agricultural enterprises and small farms and households had been the actual monopolists of producing milk as raw material during 2000-2010. This trend causes problems for dairy industry, first of all due to technological failure of private farms of the population to provide high quality of raw milk [85, 103-106].

These negative trends in the development of dairy farming have led to a reduction in the supply of raw materials for industrial processing practically fourfold during the period of 1990-2010 [103-106, 144, 153].

However, throughout the whole period there was a tendency of reducing annual consumption of milk and milk products by population of Ukraine in total – by 46.6% or from 373 kg (in 1990) to 206 kg (in 2010) per person corresponding to 54.3% of the rational consumption norm [153].

Cheese and products on its base are very popular in our country. When it comes to diets and most useful products then you can not do without cheese [4, 72, 103-105].

The high content of valuable milk protein, calcium and phosphorus, different amounts of fat make this product essential for all who are concerned

about healthy diet [24, 28-30, 32, 108, 223, 224].

Curd in one form or another cottage cheese is included in the diet of about 80% of the population of Ukraine. Standard 100gr pack of cheese satisfies 70% of the average daily requirement for protein. Protein contained in cheese has an adequate acid composition and it is easily digested. Fat included in cheese composition is very important for a balanced diet of people. It replenishes energy costs and performs structural-plastic and protective reactions in the body. Butterfat has the most difficult chemical composition of all fats of animal and vegetable origin. However, its fat and acid composition is not perfect. Increase of biological value of cheese can be achieved by modifying fat and acid composition due to the use of vegetable oils. Moreover, simultaneous use of protein raw material of milk and vegetable origin under conditions of high cost and shortage of quality raw milk as well as growing competition from the imported products allows ensuring its competitiveness, expanding range of products and reducing costs [52, 203].

Under modern conditions of production, dairy enterprises pay great attention to the expansion of the range of products with low production cost and high nutritional value. However, a growing interest from producers and consumers to the products based on cheese is observed. So, in this sense, a special interest is attracted by the possibility of using cheese as a protein base due to its functional properties in structured products technology of [106, 107, 110-113, 146].

Cheese as a source component for obtaining structured products can be considered as a concentrated suspension of casein particles in a solution of proteins, salts and other hydrophilic substances [18, 66, 67, 72].

It is known from the literature sources [3, 4, 7, 16, 18, 22, 34, 35, 47, 48, 70, 71, 74, 80, 147, 239] that production technology of traditional structured products based on cheese, as a rule, does not involve the use of protein-lipid raw materials of vegetable origin. Structure formation and maintenance of high nutritional value is achieved by the use of fat-containing recipe components, the composition of which include emulsified fat that is "natural" emulsions - milk, cream, sour cream, butterfat, melange.

However, in recent years there has been a tendency to create combined structured products with desired composition and properties. Such products must comply not only with modern medical and biological requirements, but also the traditions and habits prevailing among the population [119]. Products based on nonfat cheese with addition of ingredients of vegetable origin became widely-used among combined products. At present time a lot of technologies of products that involve the use of soya, pectin, barley malt extract, cereals are developed [130, 132, 134, 147, 190, 192].

Decrease in density of protein cheese, butterfat melting that leads to deformation of the product occurs while conducting heat treatment of structured products based on cheese with high fat content. Raw material that serves as a

structure-forming agent (eggs, flour, semolina) due to albumin denaturation, formation of gluten network of flour protein or absorption of water by gelatinized starch is used to prevent this [40, 41]. Other raw materials that are added (some dairy products, sugar) together with structure-forming agents contribute to the regulation of nutritional and biological value of the ready-to-eat meals. Introduction of different types of fillers (vegetable, fruit, cereal, etc.) allows increasing such important nutrients as dietary fiber, minerals and vitamins while reducing a certain amount of protein and fat.

Introduction of vegetable components in structured products based on cheese allows not only using efficiently milk protein raw material but also fortifying processed food products with carbohydrates, vitamins, valuable proteins and minerals [80, 110-113, 142, 173, 175, 177-181]. Vegetable and animal proteins complementing each other create rather active biologically amino acid complexes that provide interstitial synthesis. Thus, the total amino acid formula becomes more valuable biologically. That is why considerable attention of specialized research institutions and manufacturers has been recently paid to the structured products based on cheese with the use of raw material of vegetable origin. [44].

In comparison with butterfat vegetable oils have a number of advantages conditioned by the absence of cholesterol, the presence of vitamins, essential polyunsaturated fatty acids which contribute to cholesterol excretion.

Upon the analysis of the currently in use developments it can be stated that food additives based on vegetable raw material that allow obtaining finished products with increased nutritional and biological value, various recipe composition by means of which it is possible to extend range of products and reduce production cost become widely-used in production of structured products based on cheese.

1.2. The characteristic of chemical composition, functional and technological properties of cheese protein

Among dairy products which are in increasing demand the leading place is occupied by cheese which is considered to be an essential product for adults and children, for elderly people and patients [217, 221, 225, 230].

Cheese is a product that has high nutritional and biological value due to quite large content of protein and minerals (calcium, phosphorus, iron, magnesium, etc.). It is considered to be the product of all-purpose use and it distinguished by its high digestibility according to its chemical composition [18, 29] and that is why it is essential in a daily diet of each person [28-30, 32, 41, 109, 127, 202, 219, 221].

Cheese starter cultures of direct introduction (DVS-cultures) and CHY-MAX milk-coagulating enzyme are effectively used in current technologies to increase cheese yield by 8%. Composition of this enzyme is characterized by a 100% content of chymosin as an active enzyme that has a direct action to split

casein that conditions obtaining a quality bunch with release of transparent greenish whey without presence of protein [18, 142, 202].

According to the way of coagulation cheese is classified into acid and acid-rennet. Typically, acid cheese is made from skimmed milk.

During cheese production coagulation of proteins (with destruction of colloidal system of milk) occurs with decreasing negative charge of casein and transferring it into isoelectric state by adding, separately or in combination, acids (acid coagulation), rennet (rennet coagulation), by adding calcium chloride (calcium coagulation) [170, 217].

Coagulation phase details of which still are not adequately explored is a biochemical reaction that leads to aggregation of micelles. At the same time it is possible to consider hydrophobic links between residues of para-χ-casein, salt junctions (calcium and calcium phosphate) between α_{s1}-, α_{s2}- and β-casein, probably disulfide junctions between para-χ-casein and others. Micellar para-χ-casein has a pronounced hydrophobic character that is as a result of a bimolecular reaction generally hydrophilic source micelle gains hydrophobic areas that results in the appearance of phase separation surface and respectively increase in free (excess) interfacial energy that according to Gibbs-Helmholtz principle tends to spontaneous reduction in disperse systems [18, 66, 67, 72, 198, 201]. This process leads to decrease in entropy of the system as a result of increasing the proportion of ordered elements in the structure of surrounding water (hydrophobic interactions between molecules of para-χ-casein and water molecules are accompanied by the increase in entropy and transition of the system to a more favorable energy state). Also combining micelles into a single, compact structure that provides the least contact of hydrophobic areas with water is energetically favorable for the system. In turn, contacts between the same hydrophobic areas also lead to decreasing free energy of the system [66, 72, 217].

It should be noted that chemical composition of cheese varies depending on its fat content (Table 1.1) [9, 10, 11, 64, 72, 199]. Nonfat cheese has protein content of 4-6% more than fat one. At that the amount of fat in nonfat cheese does not exceed 2%, and in fat cheese - in the range of 2 to 18%.

According to free amino acids content (Table 1.2) cheese obtained by continuous method based on coagulation of proteins in the stream is slightly inferior to cheese obtained by periodic method but has better water-retaining property [72, 92].

Table 1.1

Chemical composition of cheese

Cheese	Content, %				
	proteins	fat	lactose	moisture	ash
Nonfat	18…22	not more than 2	1,5…2,0	76…80	1,3…1,6
Fat	14…16	18…22	1,9…2,1	65…69	1,5…2,0

Obviously, the differences in the content of free amino acids in cheese of investigated kinds is conditioned by the fact that in the production of cheese by periodic manner the starter acts in better conditions and for a longer time than in the production of cheese in a coagulator. However, the content of free amino acids in cheese produced by continuous method while proteins coagulation in the stream can be improved by selecting the appropriate amount of bacterial srarter [72].

Table 1.2

Amino acid composition of cheese proteins

Amino acid	Content in cheese, manufactured			
	periodic method, mg in 100 g		continuous method, mg in 100 g	
	product	dry substances	product	dry substances
Lysine	3,02	9,21	2,45	7,29
Histidine	0,14	0,42	0,12	0,37
Arginine	0,18	0,54	0,15	0,46
Aspartic acid	1,09	3,33	0,73	2,16
Threonine	0,53	1,61	0,26	0,78
Serine	0,68	2,07	0,27	0,82
Glutamic acid	6,42	19,57	3,46	10,31
Proline	2,73	8,31	1,54	4,58
Glycine	1,22	3,73	0,72	2,16
Alanine	0,44	1,35	0,32	0,94
Valine	0,36	1,08	0,22	0,64
Methionine	0,35	1,05	0,20	0,60
Isoleucine	0,49	1,49	0,13	0,38
Leucine	0,23	0,69	0,14	0,42
Tyrosine	0,88	2,69	0,53	1,59
Phenylalanine	0,48	1,47	0,33	0,97
Total	19,23	58,61	11,57	34,47

Data of Table. 1.3 also show a high biological value of cheese which is conditioned by the content of all essential amino acids (lysine, tryptophan, threonine, valine, methionine, isoleucine, leucine, phenylalanine).

Describing chemical composition of cheese its high calorie value should be taken into account: 100 g of fat cheese is 233...253 calories, 100 grams of nonfat cheese is 75...86 calories, 100 grams of beef is about 135 calories, 100 grams of fish is about 46 kcal [199, 224].

The content of calcium and phosphorus salts in cheese is in the ratio the most favorable for digesting by a human body (1,0:1,5…1,0:2,0).

Cheese obtained by continuous method contains ~124,2 mg% Ca on average, by periodic method ~117,5 mg% and phosphorus ~90,3 and ~77,0 mg% respectively.

Cheese obtained on the base of milk protein coagulation by continuous method in a stream has water-retaining ability by 6...8% more than that one obtained by periodic method presumably as a result of partial denaturation of whey proteins during pasteurization of milk that is by 8...10°C higher than during the production of periodic method (Table 1.3).

Table 1.3

Dependence of water-retaining ability of cheese protein on pasteurization temperature

Method of obtaining cheese	Milk pasteurization temperature, °C	Water-retainingg ability of protein, %
Periodic	76…82	46…48
Continuous	86…90	52…56

Interaction of denatured β-lactoglobulin with casein micelles occurs during high-temperature treatment of milk. Whey proteins has more hydrophilic property compared to casein that results in increasing its water-retaining ability and thermal stability. Hydrophilic properties of casein in turn affect the ability of acid and acid-rennet cheese hold and release moisture. Change of hydrophilic properties of casein should be considered when choosing pasteurization standard in the process of manufacturing fermented milk products including cheese [88, 202, 218].

Cheese produced by acid-rennet method has homogeneous, rather plastic consistency [72] and that one produced by acid method is characterized by heterogeneous, lumpy consistency. That as suggested by the author [66, 67] is related to the fact that the main valence bonds do not break during acid fermentation of milk. Therefore, tertiary and secondary protein structures do not swivel enough that limits surface activity and formation of spatial protein structures.

Cheese has thixotropic structure of coagulation type (able to restore after mechanical destruction). Between protein particles there are liquid layers that reduce the structure strength but at the same time they provide its plastisity and elasticity. Properly selected strain composition of starter cultures allows regulating actual acidity of the cheese and keep pH value in the range of 4.5...4.8 that is important for obtaining dense cheese and forming the product's taste [72, 218].