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TECHNOLOGY AND QUALITY RESEARCH OF SEMI-FINISHED PRODUCTS FOR WHIPPED DESSERTS BASED ON UF RETENTATE OF SOUR CHEESE WHEY

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INTRODUCTION

Recently, there has been an increase in the volume of production of dairy foods through the introduction of resource-saving technologies. Considering today's world problem of protein deficiency, there is a need to improve the structure of milk processing into butter and cheese in the direction of more complete use of the obtained protein-carbohydrate dairy raw materials (PCDRM), in particular, whey for food purposes.

During milk processing, depending on the type of the main product, curd, sour cheese or casein whey is obtained[1, 2].

The main and most valuable components of PCDRM are proteins, lipids (milk fat) and carbohydrates (lactose). In addition to the main components, almost all components of the dry milk residue pass into the whey: mineral salts, non-protein nitrogenous compounds, vitamins, enzymes, hormones, immune bodies, organic acids and water[3, 4].

Whey contains some fractions of casein that are not coagulated by enzymes and acids (kappa-casein, etc.), and all fractions of soluble whey proteins – lactoalbumin, lactoglobulin, euglobulin, and pseudoglobulin. It is important that the amino acid set of PCDRM proteins includes all essential amino acids[5].

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One of the ways to increase the nutritional value of whey is its concentration by ultrafiltration (UF). The use of UF treatment allows concentration of food liquids without the influence of temperature, which helps to preserve the native properties of food nutrients, increase the degree of use of individual components of raw materials, and obtain food products of increased nutritional value.

An important problem is the use of whey in restaurants in the production of whipped desserts, which are in great demand among various strata of the population. The volume of products produced and sold at the present time does not correspond to the demand for it. This is to a certain extent related to a narrow range of semi-finished products with a high degree of readiness, the use of which would ensure the guaranteed quality of the final product.

Due to the above, research aimed at the development of new types of semi-finished products for whipped desserts (SFPWD) based on whey and its UF concentrate is relevant.

1. Development of a technological scheme of the production of a semi-finished product for whipped desserts based on sour cheese whey

The results of the research presented in works[6, 7], and the data known from the scientific and technical literature provided the basis for the development of a technological scheme for the production of semi-finished products for whipped desserts based on the UF retentate of sour cheese whey (Fig. 1).

The developed method of obtaining SFPWD UFRSCW covers[8]:

– preparation of raw materials (sieving white sugar and egg powder, filtering the UFRSCW);

– mixing of raw materials;

– pasteurization of the mixture at a temperature of 90…95 °C for (10…12)·60 s;

– cooling the mixture to a temperature of 18…20 °C;

– homogenization of the obtained mixture;

– semi-finished products packaging.

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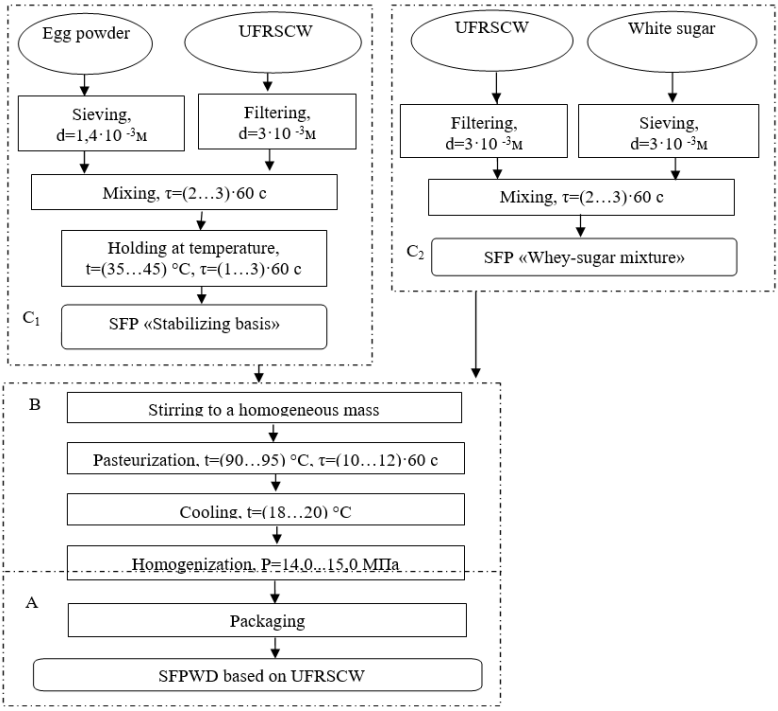

Fig. 1. Technological scheme of the production of SFPWD based on UF whey retentate

Subsystem C_1 – obtaining of the semi-finished product "Stabilizing base" is aimed at cleaning the raw materials (UFRSCW and egg powder) from extraneous mechanical impurities, to obtain the final product of proper quality, its mixing and holding at a temperature of 35…45 °C for (1…3)· 60 p.

Subsystem C_2 – obtaining the semi-finished product "Whey-sugar mixture" involves the preliminary preparation of UFRSCW, sugar and their mixing for (2…3)·60 s.

Subsystem B involves mixing the semi-finished products "Whey-sugar mixture" and "Stabilizing base", pasteurization of the resulting mixture at a temperature of 90…95 °C for 10…12 min., cooling it to a temperature of

18…20 °C and homogenization of the obtained mixture at a pressure of 14 …15 MPa[9, 10].

Subsystem A – obtaining "SFPWD based on UF whey retentate" involves packaging of the obtained mixture and its sale.

2. Study of the nutritional value of semi-finished products based on UFRSCW

The indicators of nutritional value of the developed semi-finished product were studied. Data on the nutritional value of the mixture for creamy ice cream, made according to traditional technology, were used as control indicators.

Organoleptic indicators of ice cream include taste, smell, consistency, color, and appearance. These indicators mainly shape the consumer's perception of the quality of ice cream.

According to organoleptic indicators, semi-finished products must meet the requirements specified in table. 1.

Table 1

Organoleptic indicators of the SFPWD based on UFRSCW

Indicator	Characteristics
Appearance	homogeneous liquid without separation of fat and suspended particles
Consistency	dense, viscous
Color	greenish-yellow, which corresponds to the color of the whey
Taste and smell	sour-milk, clean, without extraneous odors

The content of the main food substances in the developed semi-finished product, as well as its energy value are presented in the table. 2.

Based on the results of the studies presented in the table 2, it can be concluded that the protein content in the developed semi-finished product is higher by 2.1…2.2 % than in the control, and the fat content is lower by 2.3…2.6 %. At the same time, the total amount of carbohydrates and the

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energy value of the developed semi-finished product and the control sample did not differ significantly.

Table 2

Chemical composition of the SFPWD based on UFRSCW

Product	Content, g per 100 g				Energy value, kcal
	Dry substances	Proteins	Fats	Carbo-hydrates	
Control sample	34,0	3,3	10,0	19,0	0,8
SFPWD based on UFRSCW	33,8±1,6	5,4±0,2	7,5±0,3	20,3±1,1	1,1±0,05

Since SFPWD based on UFRSCW is characterized by a high protein content, its amino acid composition was investigated (table 3).

Table 3

Amino acid composition of the SFPWD based on UF whey retentate, % on natural substance (X±m, m≤0,05)

Amino acid	Control sample	SFPWD based on UFRSCW
Essential amino acids	1,28	2,94
including valine	0,16	0,38
isoleucine	0,18	0,38
leucine	0,32	0,72
lysine	0,22	0,52
methionine	0,07	0,18
threonine	0,15	0,32
tryptophan	0,04	0,08
phenylalanine	0,16	0,36
Replaceable amino acids	2,06	2,32
including alanine	0,09	0,11
arginine	0,09	0,12
aspartic acid	0,28	0,31
histidine	0,06	0,08
glutamic acid	0,71	0,82
proline	0,37	0,38
serine	0,19	0,23
tyrosine	0,18	0,21
cystine	0,01	0,06
Total amount of amino acids	3,34	5,26

During the study of semi-finished products, eighteen amino acids were identified in them, including all essential ones. The share of essential amino acids is 39.7 %. In the composition of essential amino acids, an increased amount of methionine and tryptophan is noted, among replaceable amino acids – of arginine, histidine, cystine.

The biological value of proteins of foods is determined by the conformity of the score of essential amino acids of their proteins to the FAO/WHO standard. Therefore, in order to determine the biological value of the developed semi-finished product, the amino acid score was calculated and compared with the standard (table 4).

Table 4

Amino acid score of the SFPWD based on UFRSCW

Amino acid	Protein content, mg per 1 g of protein (FAO/WHO)	% to standard	
		Control sample	SFPWD based on UFRSCW
Isoleucine	40	135	127
Leucine	70	138	134
Methionine + cystine	35	69	104
Lysine	55	120	139
Phenylalanine + tyrosine	60	170	152
Threonine	40	110	125
Valine	50	98	131
Tryptophan	10	106	109

The analysis of the obtained data shows that there are no limiting amino acids in the developed semi-finished product, when for the control sample the amino acids limiting the biological value are methionine + cystine.

The general characteristics of the protein substances of the semi-finished product indicate that it can be classified as a high-protein, complete and sufficiently balanced by amino acid composition product. The increased protein content makes it possible to recommend the inclusion of foods prepared with the use of SFPWD based on UFRSCW in protein-depleted rations.

The biological value of foods is also characterized by the degree of proteolysis of their proteins by enzymes of the gastrointestinal tract. The rate of cleavage of proteins of the SFPWD based on UFRSCW by food proteinases was studied (table 5).

Table 5

Digestion rate and relative biological value of SFPWD based on UFRSCW (X±m, m≤0,05)

Product	Degree of proteolysis, μg/eq%			RBV
	pepsin	trypsin	all	
Control sample	15,61	11,7	27,31	163
SFPWD based on UFRSCW	7,03	13,29	20,32	141

The results of studies of the relative biological value (RBV) of the semi-finished product show that its RBV is generally close to the similar indicator of the control sample, and the cells of the ciliate Tetrahymena periformis that grew on the sample were larger and more mobile than on the control sample.

Thus, the conducted studies testify to the high biological value of the developed semi-finished product.

The fatty acid composition of the fat of SFPWD based on UFRSCW was studied (table 6).

Table 6

Fatty acid composition of the SFPWD based on UFRSCW (X±m, m≤0,05)

Fatty acids	Content, g/100 g	Fatty acids	Content, g/100 g
Saturated, including:	3,71	Monounsaturated, including:	3,05
caproic	0,014	myristoleic	0,16
caprylic	0,014	palmitoleic	0,29
capryc	0,09	oleic	2,60
lauric	0,14	Polyunsaturated, including:	0,73
myristic	0,51	linoleic	0,7
pentadecylic	0,08	linolenic	0,03
palmitic	2,14		
margaric	0,04		
stearic	0,68		

As data analysis shows, the composition of the semi-finished product includes fourteen fatty acids[11]. The main mass of fatty acids is palmitic, myristic, butyric. Polyunsaturated fatty acids are indispensable, they

[11] Золотухіна І. В. Дослідження процесу заморожування м'якого морозива. *Стан і перспективи харчової науки та промисловості* : тези допов. Міжнар. наук.-техн. конф. / ТНТУ ім. І. Пулюя. Тернопіль, 2015. С. 58.

perform a number of important functions in the body (ensure normal body growth and metabolism, etc)[12].

The biological value of the developed semi-finished product is also affected by the content of mineral substances. The mineral composition of the SFPWD based on UFRSCW determines the nature of possible chemical transformations during the technological process: calcium ions determine the heat resistance of milk protein mixtures, copper and iron ions affect the processes of oxidation of fat and ascorbic acid, potassium and sodium ions affect the overall salt balance in the mixture[13].

The mineral composition of the SFPWD based on UFRSCW was studied, the results of the studies are shown in the table 7.

Table 7

The mineral composition of the SFPWD based on UFRSCW (X±m, m≤0,05)

Mineral substances	Content (per 100g of product)	
	Control sample	SFPWD based on UFRSCW
Macroelements, mg potassium	158	22,0
calcium	140	845,0
magnesium	22	276,0
sodium	50	23,0
sulfur	38	14,0
phosphorus	108	453,0
chloride	54	–
Microelements, μg iron	145	581,4
iodine	43	–
cobalt	1,3	1,6
manganese	14	31,6
copper	15	2,17
molybdenum	7	–
fluorine	22	–
zinc	323	172,1

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The results of research indicate that the mineral composition of the SFPWD based on UFRSCW is characterized by a higher content of calcium, phosphorus and magnesium. The balance of the Ca:P content of the developed semi-finished products is very close to optimal[14].

The vitamin composition of the SFPWD based on UFRSCW was studied, the results of the studies are shown in the table 8.

Table 8

The vitamin composition of the SFPWD based on UFRSCW (X±m, m≤0,05)

Vitamin	Content (per 100g of product)	
	Control sample	SFPWD based on UFRSCW
Vitamin A, mg	0,06	0,11
β-Carotene, mg	0,03	0,07
Vitamin D, mcg	0,02	0,22
Vitamin E, mg	0,30	0,72
Vitamin C, mg	0,60	0,56
Vitamin B_6, mg	0,07	0,06
Vitamin B_{12}, μg	0,34	0,95
Biotin, μg	2,18	6,24
Niacin, mg	0,05	0,59
Pantothenic acid, mg	0,35	0,89
Riboflavin, mg	0,20	0,48
Thiamine, mg	0,03	0,25
Folacin, mcg	5,00	–
Choline, mg	9,10	24,0

Analysis of the vitamin composition of the SFPWD based on UFRSCW showed that it is a good source of vitamin B_{12}, biotin, niacin, pantothenic acid, as well as choline.

3. Study of microbiological indicators of the SFPWD based on UFRSCW

To a large extent, the quality and safety of SFPWD is determined by its microbiological indicators. Semi-finished products, intended for whipped

[14] Дейниченко Г. В., Золотухіна І. В., Бєляєва І. М. Дослідження мінерального складу напівфабрикатів для м'якого морозива. *Розвиток харчових виробництв, ресторанного та готельного господарств і торгівлі* : тези доп. У 2-х ч. Міжнар. наук.-практ. конф. / Харк. держ. ун-т харч. та торг. Харків, 2014. Ч. 1. С. 226–227.

desserts preparation, are a favorable nutrient environment for the development of microorganisms, which can cause a negative impact on the quality of the finished product. Microbiological indicators make it possible to predict changes in organoleptic characteristics and physico-chemical indicators during the storage process, which, as a rule, is caused by the absorption of food substances of the product by the final microflora to maintain its own vital activity.

During the study of the microbiological characteristics of the SFPWD based on UFRSCW, the samples were stored at temperatures of 4±2 °C, 18±2 °C for 7 days. At the same time, every 24 hours, research was conducted on the total content of microorganisms, pathogenic and opportunistic microorganisms, and the content of molds and yeasts was also quantitatively evaluated. The results of the research are given in table 9.

Table 9

Microbiological characteristics of the SFPWD based on UFRSCW (X±m, m≤0,05)

Indicator	Storage temperature, °C	Storage duration, days				
		0	1	3	5	7
QMAFAnM, CFU/g, no more than 1×10^4	4±2	$1,2\times10^2$	$1,1\times10^3$	$6,8\times10^3$	$9,3\times10^3$	$1,1\times10^4$
	18±2	$1,2\times10^2$	$5,7\times10^3$	$1,0\times10^4$	–	–
Molds and yeasts, CFU/г, no more than 1×10^2	4±2	n/d in 1 g	n/d in 1 g	29	73	99
	18±2	n/d in 1 g	57	123	–	–
E. coli	4±2	not detected in 1 gram				
	18±2	not detected in 1 gram				

The analysis of the obtained results showed that the development of microorganisms had an exponential dependence in the developed SFPWD based on UFRSCW.

The given results make it possible to determine the shelf life of semi-finished products – 3…5 days at a storage temperature of 4±2 °C, up to 24 hours at a storage temperature of 18±2 °C.

The content of heavy metal salts was studied at the SFPWD based on UFRSCW. The research results showed that the content of copper, plumbum, mercury, tin, and cadmium salts did not exceed permissible

standards, which indicates the chemical harmlessness of the developed products.

Therefore, the conducted studies testify to the high quality of the SFPWD based on UFRSCW, its microbiological and chemical harmlessness.

CONCLUSIONS

Based on theoretical and experimental studies, a scientific concept was formulated and proved – the targeted use of nutrients of protein-carbohydrate milk raw materials, which is provided by UF-concentration, makes it possible to increase the nutritional and biological value of semi-finished products and culinary products, its technological stability, intensify the technological process, more fully use the nutritional potential of PCDRM.

The technology of protein-carbohydrate semi-finished products based on UF- sour cheese whey retentate was developed.

The chemical composition of semi-finished products based on the targeted use of whey nutrients from sour rennet was studied. The obtained results indicate that the developed semi-finished products exceed the control samples in terms of the content of the most nutrients. The content of protein in the SFPWD based on UFRSCW is higher by 2.1…2.2 % than in the control, fat is lower by 2.3…2.6 %.

SUMMARY

An important problem is the use of whey in restaurants in the production of whipped desserts, which are in great demand among various segments of the population. The volume of products produced and sold at the present time does not correspond to the demand for it. This is to a certain extent related to a narrow range of semi-finished products with a high degree of readiness, the use of which would ensure the guaranteed quality of the final product.

In connection with the above, research aimed at the development of new types of semi-finished products for whipped desserts based on whey and its UF concentrate is relevant.

The purpose of the work is the theoretical and experimental substantiation and development of technologies for semi-finished products based on sour cheese whey by applying its UF-concentration.

To achieve the goal, a number of interdependent tasks were solved:

– the process of UF-concentration of sour cheese whey in dead-end mode and in its bubbling mode are investigated;

– the influence of individual recipe components on the physico-chemical and functional-technological properties of model systems of

protein-carbohydrate semi-finished products based on UF retentates of sour cheese whey are investigated;

– rational prescriptions that ensure high organoleptic indicators and biological value of protein-carbohydrate semi-finished products based on UF-retentates of sour cheese whey are determined;

– technology of protein-carbohydrate semi-finished products based on UF retentates of sour cheese whey is developed, their quality and nutritional value, as well as changes in the storage process, are comprehensively investigated.

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