MEMBRANE CONCENTRATION OF NON-FAT MILK STUFF

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Abstract: The article presents features of membrane concentration of buttermilk with using ultrafiltration membranes PAN type.

Keywords: ultra filtration, non-fat milk stuff, whey, buttermilk

The using of semipermeable membranes is opening grate possibilities in food industries – breweries, water treatment plants, juice factories, milk factories, etc. The membrane methods are widespread for separation of liquids for getting theirs permeates or concentrates without using high or extremely low temperatures, for example evaporation or freezing-out.

The getting of protein concentrates from non-fat milk stuff is very important for milk plants because it gives some advantages. Almost all milk factories in Ukraine are discharge non-fat milk stuff to the sewage as wastes. It brings big problems with their own local wastewater treatment plants (WWTP) because the COD of the wastewater increases extremely that leads to cost increasing of the WWTP too. The next advantage is getting protein concentrates than can be used in many other food technologies. So it gives additional money instead of their loosing.

It was considered moderately hygrophilous Belarus membranes PAN type for the non-fat milk stuff concentration. First of all there were investigated their physicochemical states on distilled water (dead-end process) with different pressures, temperatures and pH in order to know optimal operating practices. The results of the experiments are given on the table 1.

Table 1. Investigated their physicochemical states on distilled water

Membrane type	Productivity*, $l/m^2 \cdot h$	Conditions		
		pH	T, ^0C	P, MPa
PAN-50	160.0…165.0	3.0...9.0	0...80.0	0.2...0.5
PAN-100	120.0…125.0	3.0...9.0	0...80.0	0.2...0.5

* T = 20.0 ºC and P = 0.1 Mpa

As shown on the table 1 the heading productivity of membranes PAN-50 and PAN-100 is 120/0…125.0 $l/m^2 \cdot h \cdot bar$ and 160.0…165.0 $l/m^2 \cdot h \cdot bar$ accordingly.

The critical up pressure of these membranes is 0.5 MPa. The increasing of the pressure will give increasing of the productivity but when it reaches to 0.7 MPa the material of membrane is damaging irreversibly. The optimal pressure for the process is 0.3 – 0.5 MPa.

The process temperature could be from 10.0 ºC till 80.0 ºC. The further increasing of the temperature is leading to polymer melting. The productivity under such conditions is decreasing no less then 30% and will not be reinstated.

The pH of the liquids that will contact with selective surface of membrane should be no less than 3.0 and no bigger than 9.0. These parameters are very important for choosing chemicals for regeneration of the membranes.

All non-fat milk stuffs for experiments were taken from the milk plant Zarechiye (Ukraine, Kharkiv).

The stuff that was used for ultra filtration concentration has a chemical parameters that shown on the table 2.

The experimental UF-setting is shown on the figure 1. It consists from frame (1), compressor or electric motor (2), manometer (3), stuffing-box (4), top cover (5), bottom cover (6), concentrate

effluent channel (7), permeate effluent channel (8), permeate capacity (9), pressure evacuation valve (10), compressor (11), thermostat (12); intensification device (13), rubber (14); semi-permeable membrane (15), LATP-1M (16), potentiometer KCP-4 (17), thermopair (18). Uf-module works in a dead-end operating condition.

Table 2. Stuff that was used for ultra filtration concentration has chemical parameters

Stuff	Components				
	Solids	Milk fat	Protein	Lactose	Mineral substances
Whey	5.0 - 6.0	0.1 - 0.2	0.8 - 2.1	4.7 - 4.8	0.5
Buttermilk	8.6 - 9.1	0.4 - 0.5	3.2 - 3.3	4.7 - 4.9	0.7

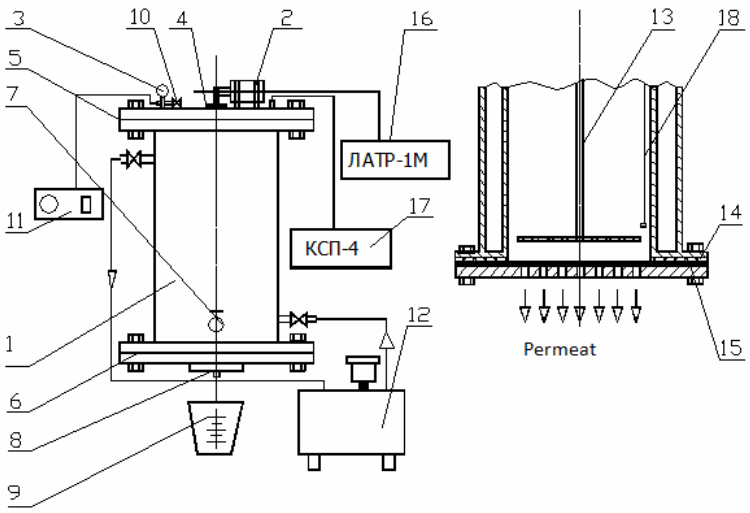

Figure 1. Experimental UF-setting

Membrane concentration of the whey.

The received results of ultrafiltration concentration by membranes PAN-50 and PAN-100 (dead-end process) are shown on the figure 2.

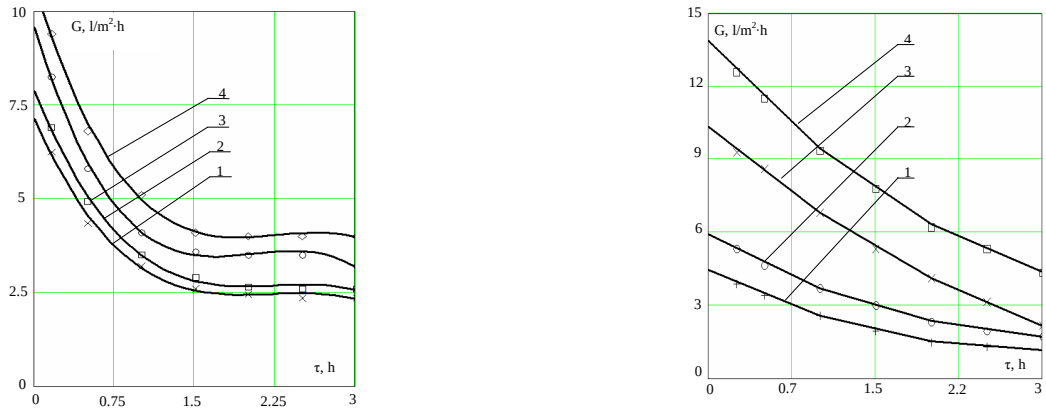

Figure 2. Dependence of productivity of UF-membranes type PAN from time with difference pressure during whey treatment: 1 – 0.2 MPa; 2 – 0.3 MPa; 3 – 0.4 MPa; 4 – 0.5 MPa

In figure 2 it can be seen that the productivity of UF-membranes is reduced with time extremely on first hour, than it changes fluently.

The optimal process pressure is 0.4-0.5 MPa. The further increasing of the pressure will not bring significant increasing of the productivity.

Membrane concentration of the buttermilk.

The graph of the experiments of the ultrafiltraion concentration by membranes PAN-50 and PAN-100 (dead-end process) shows the same behaviour (figure 3).

So it can be verified that the maximal pressure of the process of ultrafiltration concentration of non-fat milk stuff with semipermeable membranes PAN type should be no less than 0.4 MPa and no bigger than 0.5 MPa.

The backwashing should be approximately in ten minutes of membrane concentration. The CIP washing should be every 10.0-12.0 hours of the process.

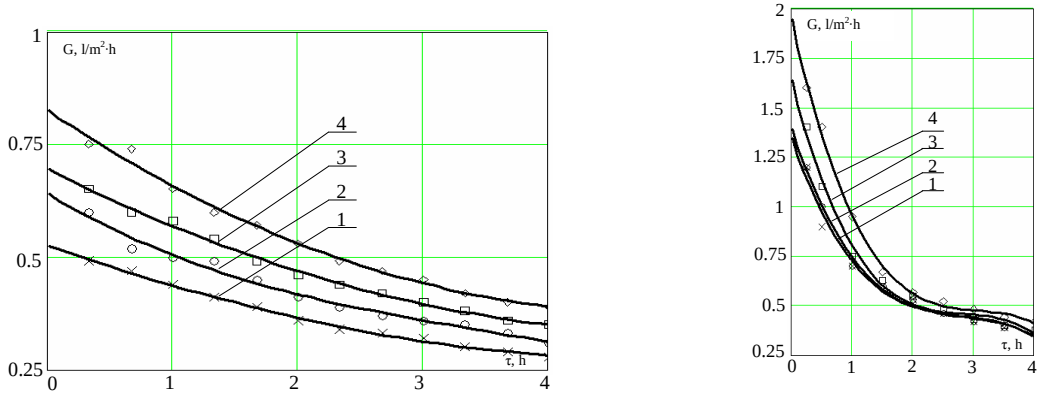

Figure 3. Dependence of productivity of UF-membranes type PAN from time with difference pressure during buttermilk treatment: 1 – 0.2 MPa; 2 – 0.3 MPa; 3 – 0.4 MPa; 4 – 0.5 MPa

Chemical composition of protein concentrates with various collection factors received in the result of ultrafiltration (UF) treatment of buttermilk is presented in the table 3.

Table 3 Chemical composition of protein concentrates with various collection factors

Indexes	Butter-milk	Protein concentrate with collection factor				Permeate			
		1.5	2.0	2.5	3.0				
Content,%									
dry substances	8.0	9.0	9.5	10.7	11.9	5.3	5.4	5.5	5.6
fat	0.43	0.62	0.8	1.0	1.21	–	–	–	–
protein	3.2	4.8	6.4	8.0	9.6	0.17	0.19	0.21	0.19
lactose	4.84	3.53	2.22	1.6	1.03	4.31	4.27	4.23	4.18
phospholipides, mg%	126.8	185.0	243.0	257.4	271.8	10.5	14.0	17.5	21.08
Standard acidity, ^{0}T	19.0	30.0	32.0	34.0	36.0	5.0	5.0	5.0	5.0
Active acidity (pH), unit	6.51	6.48	6.46	6.42	6.39	6.49	6.51	6.51	6.51
Density, kg/m^3	1031.0	1038.0	1044.0	1050.0	1056.0	1010.0	1012.0	1014.0	1015.0
Viscosity, 10^{-3}, Pa·s	2.01	2.45	3.14	4.02	5.18	1.71	1.71	1.71	1.71

As analysis of the table shows, during UF-collection in buttermilk concentrate, protein mass increases proportionally to the collection factor. With the raise of collection factor to 3.0 fat mass increases 2.7…2.9 times, phospholipids increase 2.0…2.2 times, amount of lactose at the same time reduces 4.5…4.7 times due to its transition to permeate. Density increases 4.5…4.7 times, viscosity raises 2.5…2.6 times and active acidity grows 1.8…1.9 times alongside with the increase of buttermilk collection factor, while pH practically doesn't change.

The aim of the further research is to develop technologies of semi-finished products on the basis of buttermilk and their ultrafiltration concentrate for whipped desserts.

During the development of new technologies not only chemical composition but functional properties of the output gained special importance, this stipulated necessity of their investigation.

In the technology of producing desserts, one of the determinative indexes of mixtures is their ability to absorb and keep particular volume of air or gas. Mixtures' ability to whip predetermines their composition, namely contents of surface-active substances.

To study influence of buttermilk and UF-concentrate on whipped desserts' quality the authors investigated foaming capacity, foam stability, emulsifying capacity and stability of the material indicated. It is determined that during the increase of the collection factor to 2.5, foaming capacity of buttermilk raises 1.3…1.4 times, foam stability grows up to 76…78%, emulsifying capacity increases 1.6…1.8 times, and emulsion stability raises 4.5…4.7 times.

Also regularities in changing thermal stability of buttermilk depending on collection factor and

acidity were determined. It was proved that use of UF-concentrate of buttermilk with the collection factor equal to 2.0 is rational in the technology of preparing semi-finished products for the production of whipped desserts.

Also the influence of some components on physical-chemical and functional-technological properties of model mixtures for whipped desserts was determined. Investigations, process schemes of producing semi-finished products for the production of whipped desserts on the basis of buttermilk and its UF-concentrate were developed. Indexes characterizing nutritive value of the developed semi-finished products are determined. It is found that products under investigation excel the cheque sample by the content of complete protein, vitamins, macroelements. Advanced biological value of semi-finished products is proved. It is determined that protein doesn't contain limiting amino acids.

All the above allowed us define directions of using semi-finished products on the basis of developed. Indexes characterizing nutritive value of the developed semi-finished products are determined. It is found that products under investigation excel the cheque sample by the content of complete protein, vitamins, macroelements. Advanced biological value of semi-finished products is proved. It is determined that protein doesn't contain limiting amino acids. Buttermilk and its UF-concentrate in technologies on manufacturing production for restaurant business. Use of semi-finished products for the production of whipped desserts based on buttermilk and its UF-concentrate is possible in three directions: for making soft ice-cream (cream, chocolate, cocoa), sweet dishes (mousses, whips) and beverages preparation (refreshing and non-alcoholic).

As the result of the investigation, about 20 personal technologies of dishes with the use of semi-finished products and food stuff with the increased nutritive value and high organoleptic parameters on the basis and with the use of buttermilk and its UF-derivative were developed.

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