DEVELOPMENT OF PROTEIN-FAT EMULSIONS BASED ON VITAMINIZED BLENDED VEGETABLE OILS

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Abstract

The article analyzes protein components of different nature, based on studies. It proves a possibility of their use as components of protein-fat emulsions for modeling rational recipes. It determines the rational physical parameters of the emulsification process that guarantee high-quality homogenous emulsions. It investigates the samples of protein-fat emulsions with using fatty components and partial replacing animal fats for vitaminized blending of vegetable oils.

According to the results of the studies of the influence of the recipe components on the quality of protein-fat emulsions and also practical recommendations for protein preparations, there were developed the recipes of multi-component protein-fat emulsions, including vitaminized blended vegetable oils and protein components: “Belkoton A91», «Forward 450», «Supro 500E».

Based on the received experimental data, there were determined the rational parameters of emulsification, namely, speed of the process − 3000 turns/min and total duration of the process – 6…10 min and also there was established, that it is expedient to enrich the content of meat pastes with protein-fat emulsions in amount 15…20 %.

Thus, the development of recipes of protein-fat emulsions (PFE) is an urgent problem for creating balanced meat products. It will allow to replace fat of the animal origin for vitaminized blended vegetable oils (VBVO) in them, in such a way enriching them with fatty acids and vitamins.

Keywords: protein-fat emulsion (PFE), vitaminized, blended vegetable oils (VBVO), emulsifying ability, protein preparations, meat pastes.

DOI: 10.21303/2504-5695.2018.00647

1. Introduction

The one of spread ways of correcting the composition of meat products is combining meat raw materials with vegetable components. They contain the unique complex of most important nutrients and different treating-prophylactic components. They also contain much vegetable protein, unsaturated fatty acids, rich mineral and vitamin composition. The use of vegetable raw materials is a natural concentrate of essential nutrients, allows to reach the effect of synergism and essential improvement of the healthy effect from consuming a combined meat product as opposite to analogous ones, enriched with synthetic biologically active substances [1–3].

The works [4–6] present the results of the studies that demonstrate that succulence and delicacy of meat products are essentially influenced by the fat content. It was demonstrated, that fat addition is necessary for providing standard quality indices of meat products. The authors also proved, that it is expedient to add fat in meat products as emulsions, because in such a way fat is better assimilated by the human organism [7, 8]. Emulsified fat and vitamins, dissolved in it, are absorbed better in the gastrointestinal tract at the expanse of increasing the surface of contact with enzymes that participate in digestion [9, 10].

Thus, the development of recipes of multi-component protein-fat emulsions (PFE) is an urgent task for creating balanced meat products. It will allow to replace fat of the animal origin for VBVO in them, in such a way enriching them with fatty acids and vitamins.

2. Materials and methods

The research materials: protein-fat emulsion (PFE); vitaminized blended vegetable oils (VBVO); protein preparations – «Belkoton A91», «Forward 450» and «Supro 500E» (Ukraine, "Engineering center protein product LTD") quality indices of the studied protein preparations are presented in **Table 1**; meat pastes and their composition: chicken meat, chicken liver, PFE in amount 15…20 %, bread, chicken eggs, carrot, onion, manna-croup, water, salt, spices and garlic.

Table 1

Quality indices of the studied protein preparations

Quality parameters	«Belkoton A91»	«Forward 450»	«Supro 500E»
	Physical-chemical parameters:		
Protein, % no less	90,0	63,5	90,0
Carbohydrates, %, no more	–	21,1	–
Ash, %, no more	2,0	4,7	4,0
Fat, %, no more	4,0	5,0	1,0
Moisture, %, no more	4,0	5,7	5,0
pH (1 % solution at 20 ºC)	5,6–7,0	6,4–6,8	6,9–7,6
	Microbiological parameters:		
MAFAnM, CFE in 1,0 g, no more	$1 \cdot 10^3$	$1 \cdot 10^3$	$1 \cdot 10^3$
CBGB, in 0,01 g, including salmonella in 25 g	Not allowed	Not allowed	Not allowed

The organoleptic studies were conducted by the testing group in 10 persons, including the faculty of the department of meat and meat products technology of the National University of food technologies, Kyiv, Ukraine.

Determination of the emulsifying ability of protein preparations was conducted by the method, elaborated by the authors Inklaar P. and Fourtuin J., presented in [6], by preparing emulsions based on 1 % – protein water dispersions and vegetable oil. Homogenization is conducted at rotation speed of the electric motor shaft 3000 turns/min.

For each sample there is prepared a series of emulsions with the fatty phase content from 10 % to 90 % with interval 10 %. Then emulsion is distributed in tubes with diameter 5 mm by a syringe, thermostated at temperature 85 °C during 20 min. After that it is cooled by running water and centrifuged for 30 min at 6000 turns/min. The stability criterion of emulsions at the initial fatty and water phases' ratio is a ratio of phases in the system, average for tubes.

Determination of the fat-binding ability (FBA) of emulsions.

The determinant role in the development of the processes of water- and fat-binding and also emulsion stability is played by the total content of protein substances in the system. FBA was determined by a sample in words, made by «Central Soya» (USA), based on determining the fat amount, retained by 1 g of a sample.

Determination of the water-binding ability (WBA).

The weight of PFE and meat systems was determined by Bygowshi method (Hungry) [6]. The complex of main functional properties of forcemeat products includes: weight, water-retaining ability (WRA), fat-retaining ability (FRA) and forcemeat stability.

Determination of water- (WRA) and fat-retaining (FRA) abilities, stability of meat pastes.

The forcemeat stability is the most important parameter that determines the product quality and is conditioned by the synchronous optimal development of WBA of raw forcemeat and WRA and FRA of thermally processed forcemeat. WRA and FRA and also forcemeat stability at the thermal processing were determined by the method of successive determination of main functional properties of forcemeat from one batch, elaborated by the workers of URIMD Salavatulina R.M., Ljubchenko and others [11].

Determination of water-binding ability (WBA) of meat pastes was conducted by the "Press-method", elaborated by Grau R. and Hamm R., modified by V. Volovinska and B. Kelman [6].

Determination of pH value of emulsions and meat pastes. The universal parameter is pH value of forcemeat – active reaction of the medium. The most distinct method of determining pH value in solutions is the potentiometric method, based on measuring the electromotive force (EMF) of an element, consisting of an electrode, which potential is conditioned by the concentration of hydrogen ions in the studied solution.

3. Results

Based on the analysis of the Ukrainian and foreign market of protein preparations of vegetable and animal origins for the adequate choice of an emulsor, there were studied the chemical and amino acid composition and functional-technological properties of the protein preparations: «Belkoton A91», «Forward 450» and «Supro 500E».

«Belkoton A91» − is a functional mixture, based on meat and connective tissue protein, with the high coefficient of the water- and fat-binding abilities. It is intended for being used in emulsifying meat systems with a cutter, mixer and top. This is a fine-dispersed powder of the creamy color with the specific taste and smell, produced of genetically non-modified products. It is used at producing forcemeat products for the dense structure and also for resisting the secondary heating. It is recommended to use the following ratio for preparing the emulsion − 1: 4:4 (Ukraine, "Engineering center protein product, Ukraine").

«Forward 450» − is a complex food supplement with high structural properties. It is a fine-dispersed homogenous powder of the light-creamy color with the specific taste and smell, produced of genetically non-modified products. It is used in the food industry as a technological supplement at producing meat products. The ratio, recommended for preparing the emulsion − 1:10:12 (Ukraine, "Engineering center protein product, Ukraine").

«Supro 500E» − is an isolated soy protein, received from the vegetable raw material (soybean). It provides the texture and stability of the emulsion in different meat systems. Having the high viscosity and solubility, it is hydrated fast and form thermostable emulsions in meat products. The emulsifying fat and water favor formation of the dense texture of a ready product. It is recommended to use the following ratio for preparing the emulsion − 1: 4: 4 (Ukraine, "Engineering center protein product, Ukraine").

The analysis of the chemical composition of dry protein preparations testifies to the fact that they can be a full-blown raw material for producing PFE. But it is not enough for choosing components for creating balanced products. So, there is a necessity to compare their amino acid composition with an etalon – protein of chicken eggs. The indices are presented in **Table 2.**

Table 2

Amino acid composition of the studied preparation compared with an etalon – protein of chicken eggs

Name of amino acid	Etalon (protein of chicken egg), mg/100 g	«Belkoton A91», mg/100 g	«Forward 450», mg/100	«Supro 500E», mg/100 g
Alanine	–	**4,60±0,02**	3,40±0,02	3,90±0,04
Arginine	6,70±0,06	**7,80±0,03**	5,50±0,03	6,90±0,03
Asparaginic acid	8,20±0,09	**12,50±0,09**	8,50±0,08	11,50±0,10
Cystine	2,30±0,01	**4,60±0,02**	2,80±0,01	4,00±0,06
Glutamic acid	12,60±1,10	**16,40±0,11**	11,90±0,09	16,30±0,12
Glycine	3,60±0,02	**3,20±0,02**	2,00±0,01	2,30±0,01
Histidine	2,40±0,01	**3,50±0,02**	1,60±0,01	2,20±0,02
Valine+methionine	8,50±0,06	**8,30±0,02**	4,75±0,02	7,80±0,09
Isoleucine	4,00±0,03	**3,90±0,02**	2,38±0,01	3,30±0,02
Leucine	7,00±0,06	**6,90±0,03**	5,20±0,03	6,02±0,05
Lysine	5,50±0,05	**5,40±0,02**	5,08±0,03	5,10±0,03
Proline	7,80±0,07	**6,10±0,04**	3,10±0,02	5,7±0,030
Serine	4,50±0,03	**4,40±0,02**	1,60±0,01	3,50±0,01
Threonine	4,00±0,02	**4,20±0,01**	2,20±0,02	4,10±0,01
Tryptophan	1,00±0,01	**1,20±0,01**	0,70±0,01	1,10±0,01
Phenylalanine	6,00±0,01	**6,91±0,01**	2,91±0,04	5,82±0,06

As it can be seen from **Table 2**, the full-blown animal proteins, that is a base of the protein preparations, – «Belkoton A91» – essentially exceed the vegetable «Supro 500E» and «Forward 450» in balance of the amino acid composition. That is they more correspond to needs of the human organism in irreplaceable amino acids.

It is recommended to use vitaminized blends of vegetable oils (VBVO) and selected proteins for producing PFE for adding in recipes of meat pastes.

Six recipes of PFE with VBVO were offered:

blend №1 – two-component VBVO (ω-6 ω-3 ratio is 10: 1): pumpkin (90 %) + flax (10 %);

blend №2 – three-component VBVO (ω-6 ω-3 ratio is 5: 1): sunflower (77,5 %) + camelina (13 %) + flax (9,5 %) and protein components: «Belkoton A91», «Forward 450», «Supro 500E».

The samples of the developed recipes of PFE are presented in **Table 3.**

It is known, that the main physical factors that influence the quality of an emulsified product are speed and duration of the emulsifying process. The authors experimentally proved that emulsification is most effective at rotation speed of the rotor of the dispersing device 3000 turns/min and the optimal duration of the process is 6–10 minutes.

Table 3
Recipes of protein-fat emulsions

Parameters	Variants of recipes of protein-fat emulsions						
	Control	**№ 1**	**№ 2**	**№ 3**	**№ 4**	**№ 5**	**№ 6**
Raw material, kg for 100 kg of emulsion:							
Belkoton A91	–	**10**	**10**	–	–	–	–
Forward 450	–	–	–	5	5	–	–
Supro 500E	–	–	–	–	–	10	10
Animal fats	45	–	–	–	–	–	–
Pork skin	10	–	–	–	–	–	–
Vitaminized blended vegetable oils:							
Blend №1 (two-comp.)	–	**45**	**–**	45	–	45	–
Blend №2 (three-comp.)	–	**–**	**45**	–	45	–	45
Water	45	**45**	**45**	50	50	45	45
Totally:	100	**100**	**100**	100	100	100	100
Ratio, %:							
protein:fat	1,0:3,0	**1,0:4,0**	**1,0:4,0**	1,0:6,1	1,0:6,7	1,0:5,6	1,0:6,6
protein:moisture	1,0:3,0	**1,0:4,0**	**1,0:4,1**	1,0:5,7	1,0:7,5	1,0:6,0	1,0:7,3

The preparation of protein-fat emulsions was conducted by the technological scheme, presented on **Fig. 1**, using the following components: protein preparations, two-component and three-component vitaminized blended vegetable oils and water.

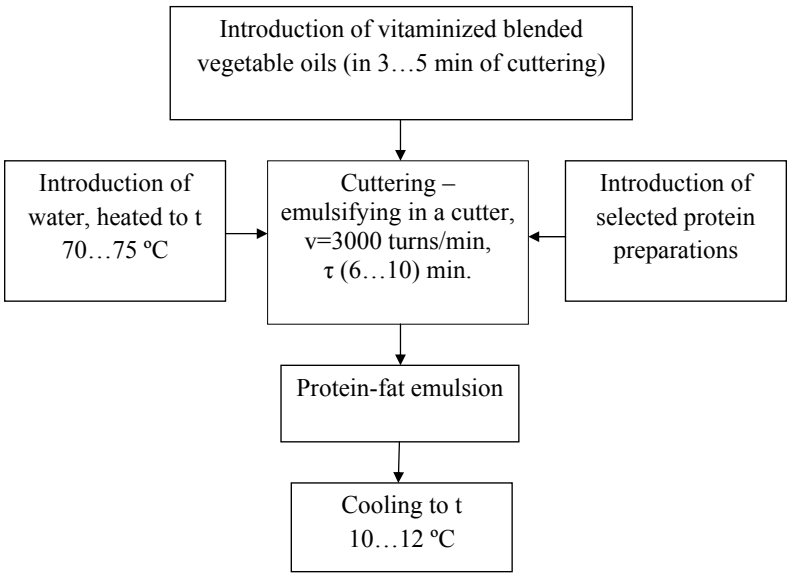

Fig. 1. Technological scheme of preparing PFE

The choice criterion of the rational variant of PFE recipes for meat pastes was the protein and fat ratio in the compositions and also the cost of experimental samples. The protein part of the recipe compositions is presented by poultry meat and the fat one – by the emulsion, based on vitaminized blended vegetable oils. VBVO introduction in the emulsion is conditioned by their high

biological value, provided by the content of β-carotene and tocopherol vitamins and high content of polyunsaturated fatty acids in them.

On this stage of the work the emulsifying properties were studied on the example of the protein supplement «Belkoton A91». There was used 1 % -solution of protein in the systems "fatty phase" (three-component vitaminized blended vegetable oil) – dispersion with «Belkoton A91».

The studies of the selected blend as a fatty phase and protein «Belkoton A91» at determining the emulsifying ability demonstrated that introduction of the fatty phase up to 50 % allows to get stable emulsions.

A series of the conducted studies demonstrated that introduction of vitaminized blended vegetable oils in PFE favors the improvement of their main parameters of the functional properties, which data are presented in **Table 4** [2].

Table 4

Comparative characteristics of the functional-technological properties of PFE

Samples of emulsions	Functional parameters, %					
	WRA	FRA	EA	ES	Losses at thermal processing	pH
Control	82,3±0,7	87,3±0,5	88,2±0,3	86,9±0,6	10,8±0,4	5,8±0,3
PFE **No. 1**	96,5±0,7	95,1±0,7	96,8±0,4	96,8±0,9	4,2±0,2	6,2±0,2
PFE **No. 2**	95,1±0,6	94,8±0,5	95,4±0,5	94,4±0,6	5,6±0,3	6,3±0,2
PFE No. 3	86,5±0,6	88,2±0,5	89,4±0,3	87,5±0,6	12,5±0,4	6,1±0,3
PFE No. 4	88,3±0,6	89,8±0,4	90,2±0,8	90,8±0,9	9,2±0,4	6,3±0,3
PFE No. 5	90,4±0,4	90,9±0,5	92,8±0,6	91,6±0,5	8,4±0,3	6,0±0,4
PFE No. 6	89,8±0,4	92,2±0,5	87,5±0,4	88,6±0,6	9,8±0,4	6,1±0,3

The water-retaining ability (WRA) of PFE with «Belkoton A91» is in average by 9,0 % higher comparing with other proteins. The increase of pH to 7,3 ... 7,4 favors the increase of the water-retaining ability (WRA) of the emulsion. The high level of the water-retaining ability (WRA) – 96,5 %, 95,1 %, fat-retaining ability (FRA) – 95,1 %, 94,8 % and emulsifying ability (EA) – 96,8 %, 95,4 % in samples with «Belkoton A91» provides stability of these emulsions (ES) that is in average by 4,0...6,0 % higher than in the control and other samples. It is reflected on losses at the thermal processing that are in average by 3...5 % less comparing with other samples.

The highest level of rheological and functional properties is fixed in PFE with the protein «Belkoton A91». So, it was selected in the combination with the two-component (pumpkin, flax oils) and three-component (sunflower, camelina, flax oils) vitaminized blended vegetable oils with ω-6: ω-3 ratio 10: 1 and ω-6 ω-3 ratio 5: 1 as a protein component in further studies for PFE recipes.

The one of factors that provides the quality of ready products is their taste-aromatic properties.

The analysis of the influence of protein-fat emulsions on organoleptic characteristics of model paste masses demonstrated that taste-aromatic features of oils, used at producing PFE, are reflected in ready products. Moreover, oils with the brightly expressed taste and smell are manifested even at their minimal share in a recipe.

The organoleptic assessment of paste masses with RFE, based on VBVO, testifies that their addition in pastes' recipes in amount 15...20 % doesn't worsen the taste, smell and doesn't influence the consistence of products [2].

At higher PFE concentrations (25...30 %) in the composition of paste masses, the color becomes pale, products get a side smell and taste, typical for vegetable oils, especially camelina and pumpkin.

That is why we recommend to introduce 15...20 % of developed PFE in recipes of meat pastes.

4. Conclusions

1. According to the results of the studies of the influence of the recipe components on the quality of protein-fat emulsions and also practical recommendations for protein preparations, there were developed the recipes of multi-component protein-fat emulsions, including vitaminized blended vegetable oils and protein components: «Belkoton A91», «Forward 450», «Supro 500E».

2. Based on the conducted studies (by organoleptic, rheological and functional-technical parameters), it was established that the most rational PFE composition is selected in samples № 1 and № 2 that include: animal protein «Belkoton A91» – 10 %, VBVO (two-component № 1: pumpkin (80 %) + flax (20 %) – 45 % or three-component № 2: sunflower (77,5 %) + camelina (13 %) + flax (9,5 %) – 45 % vitaminized blends on vegetable oils) and water – 45 %.

3. It was established, that for providing functional-technological properties of meat pastes, for improving their amino acid and vitamin composition, it is recommended to introduce PFE in amount 15...20 %.

One of advantages, created by PFE is their enrichment with the fatty acid and vitamin composition at the expanse of replacing animal fats for VBVO in them. A disadvantage – is a short storage term of PFE. It is recommended to use the developed PFE at meat enterprises as a replacement of animal fats in meat products for enriching them with fatty acid and vitamin compositions. In the further work it is planned to improve the quality and safety of new types of PFE and meat products with them by using exogenous bioantioxidants by the complex of studying parameters. It is also planned to work for increasing the guaranteed storage term of PFE.

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