HEALTHY FOAMING AGENTS USE IN OXYGEN COCKTAILS

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Abstract. The study showed the expediency of using foaming agent of vegetable origin in protein oxygen cocktails. In accordance with the experimental data biopolymers and their concentration for protein oxygen foam stabilization were selected.

Key words: oxygen cocktail, hydroxypropyl methyl cellulose, foaming agents, foam ability.

Introduction

Research studies have shown that the nutrition of Lithuanian population is not healthy. In today's ration the food does not often contains enough vitamins, fiber, iodine, macro- and micronutrients [3,4]. The inhabitants of large cities face another actual problem, that is, lack of oxygen.

To avoid this problem which leads to hypoxia, the oxygen therapy is used. One of the most affordable and economically useful measures of oxygen therapy are oxygen enriched drinks - water, Smoothie, oxygen cocktails.

The study shows the relevance of oxygen cocktails for treatment and prevention purposes and as an aid for a variety of diseases. It gives an analytical overview of the components commonly used in cocktails recipes [12]. The oxygen cocktail is a foam system. Foams require several components: a liquid (water, juice, milk) and the foaming agent. To create a modern oxygen cocktail, as a liquid is a variety of herbal and plant extracts, juice, vitamin - mineral complexes. As foaming agents there may be surface active agents and compounds of high molecular weights. Currently used foaming agents for the production of oxygen cocktails are egg white powder, licorice extract, and gelatin. The foaming abilities of these substances are well established [1, 15]. These foaming agents are flawed and have side effects on human health. Egg protein powder can cause allergies and they have an unpleasant taste. Licorice extract is not recommended for cardiac patients, as a result of its use can cause changes in arterial pressure, heart rate changes and affect the kidneys. Gelatin is not recommended for people with chronic heart failure, with impaired water-salt metabolism, and in the presence of stones in the kidney.

The main problem in developing of the oxygen cocktails is the change of traditional foamers into allergy safer vegetable origin blowing agent, as well as balanced and physiologically useful oxygen cocktail creation. As mentioned above, current efforts are being made to create effective vegetable origin foam forming agent. The effect of high intensity ultrasound may produce structural modifications on of soy protein isolate through a friendly environmental process [11].

Physical and chemical characteristics, organoleptic properties and foaming capacity of whey and soya base are studied [9,16,17].

The results of foaming abilities of the nine kinds of surfactants in cocoa butter research showed that only phospholipids had the foaming ability in cocoa butter, and the higher content of phosphatidylcholine in phospholipids is, the stronger its foaming ability in the cocoa butter [19]. The influence of pH and ionic strength on the stability of foams prepared with amaranth protein isolate was analyzed [6]. Detected changes in the characteristics of the interfacial film as in the foam stability have been attributed to the increased unfolding, greater flexibility and net charge of amaranth proteins at acidic conditions.

Foaming of whey protein concentrate was improved by the presence of xanthan gum [10]. Foam stability and capacity were due to biopolymer segregative interactions.

Understanding how foaming properties of proteins are affected by factors such as pH, salt concentration and temperature is essential in predicting their performance and utilisation. In study [7] the effects of pH and salt concentration were studied on the foaming properties of pumpkin seed protein isolate and pumpkin seed protein isolate - xanthan /arabic gum blends. The foaming properties of the pumpkin seed protein isolate - xanthan /arabic gum blends were also compared with egg white.

Surface-active polysaccharides are attracting increasing interest for use in a variety of applications. In research [5] the phase separation of egg white and hydroxypropyl methyl cellulose (HPMC) mixtures was studied. Segregation occurred by complex formation at pH above 7 or below 3 egg white iso-electric point. Gelation and foaming properties of segregated mixtures was compared to single egg white performance. It was possible to improve gelation and foaming performance by adding HPMC. This improvement was mostly found at pH 3, below the iso-electric point of egg white.

Hydroxypropyl methyl cellulose was added into whipped cream for enhancing its textural and whipping properties. The results [22] indicated that the increase of HPMC level could decrease the surface protein concentration slightly. The overrun of whipped cream slightly increased when the HPMC level increased in the range of 0.025–0.125%. Firmness, cohesiveness, consistency and viscosity of whipped cream were analysed in this work. HPMC showed a positive dose-dependent effect on all these textural properties.

Fiber and hemp protein utilization in the production of oxygen cocktails is a new idea. Hemp protein powder can be added to power drinks, smoothies or yogurt; sprinkled over a variety of food, fruit or vegetables; used as a baking ingredient or added to nutrition bars for a healthy boost of protein. Hemp protein powder is the highest quality vegetable protein, with digestibility of more than 90%, thanks to the absence of trypsin inhibitors and perfectly balanced ratio of all 22 amino acids, including the 8 essential ones. Moreover, it is an exceptional source of B vitamins (B1, B2, B3, B6, B9), and also trace elements such as iron, magnesium, manganese, zinc, phosphorus, and potassium. Hemp Protein is one of nature's perfect superfoods.

Citrus fiber, that is produced of citrus fruit (orange, grapefruit, lemon, lime) processing by-products which make up 50% of the fruit pulp, enables to rationally use this abundant raw material and get a natural product having a physiological effect [14, 21] and good functional characteristics [8, 20].

Probable that using these compounds it will be possible to create safer oxygen cocktails having better organoleptic properties and functional characteristics, higher nutrient and energy content.

Nepovinnykh N.V. [13] studied the functional and technological properties and developed technology of new types of oxygen containing beverages (smoothies) on the basis of cheese whey, natural fruit and berry juices and purees and dietary fibres «Citri-Fi», including non-starch polysaccharides (guar gum and xanthan gum), contributing to the formation of a specific texture and drink as tabilizers oxygen foam. We could not find other research studies (in the sources available to us) where it had been investigated the influence of these fibers on the production of oxygen cocktails.

The aim of the research is functional oxygen cocktail foaming base creation and replacement of traditional foaming agents by using healthy biopolymers of vegetable origin.

Materials and Methods

In order to ensure the quality and stability of the foam and enrich cocktail with dietary fiber, orange peel fiber Citri-Fi with xanthan gum and guar gum or Hydroxypropyl methyl cellulose was used.

The main quality indicators of apple juice (producer V. Milkintas organic farm) used for the study were: pH = 3, titratable acidity - 54 malic acid g 100 g -1.

PH of the fruit liquid and additives was determined on the potentiometer WTW. Titratable acidity was determined in accordance with standard BS EN 12147:1999.

Quality parameters of whey protein (producer Agus, Poland): protein - min-max. 70-76%; carbohydrates - min-max. 10-12%; fat - min-max. 6-8%

Hemp protein powder (producer V. Milkintas' organic farm, Lithuania) with the protein content of min. 50%. Hemp protein is obtained mechanically by grinding and sieving the press cake after cold pressing the oil from the hemp seeds cultivated in Lithuania.

Table 1. Analytical results of hemp protein g/1

Component	Results
Moisture	6.35
Ash	5.24
Fat	9.53
Protein	32.21
Crude fibers	43.87
Carbohydrates (by difference)	2.80
Tocopherols (mg/kg)	12,5

CITRI-FI®100 FG, CITRI-FI®200 FG and CITRI-FI ®300 M40 (producer Fiberstar Inc., USA) are the all natural citrus fiber products, made from orange pulp by physical processing and blended with guar gum (CITRI-FI ® 200 FG) or xanthan gum (CITRI-FI ® 300 M40).

Table 2. Typical analytical results for Citri-Fi

Component	Results
Calories (FBDG Subtracted)	227 Calories / 100 g
Total Fat	1.08 %
Saturated Fat	0.31 %
Trans Fat	0.00 %
Monounsaturated fat	0.34 %
Cis-cis Polyunsaturated fat	0.38 %
Carbohydrates, Total	82.55 %
Fiber, Total Dietary	75.3 %
Soluble fiber	39.6 %
Insoluble fiber	35.7 %
Sugars	5.38 %
Protein by Dumas	7.53 %
Sodium	40.6 mg/100g
Moisture	6.38 %
Ash	2.46 %
E. coli by Plate Method	Negative per 10 g
Salmonella	Negative per 25 g

VIVAPUR HPMC is the hydroxypropyl methyl celluloses of high purity and complies to the purity criteria for food (see Table 3).

Table 3. Chemical and physical properties hydroxypropyl methyl cellulose VIVAPUR HPMC

Properties	Results
Assay for methoxyl groups	19% - 24 %
Assay for hydroxypropoxyl groups	4 % - 12 %
Loss on drying	max. 5 %
Sulphated ash	max. 1,5 %
pH-value	5-8
Molecular weight	13 000 – 200 000
Viscosity (USP-method)	80 mPa.s - 5600 mPa.s

Preparation of sample

Oxygen cocktails were prepared using Vision Aire oxygen concentrator and an oxygen cocktail mixer from 1-2 0C fruit juice, whey powder, and hemp protein.

The basis of the test sample was poured into the measuring vessel, then whisked it with a mixer until the foam ceased rising. The oxygen supply rate of 2 L/min remained constant during the experiment.

Methods of evaluating foaming properties

Foaming ability was determined as the ratio between the quantity of dispersion medium and the dispersed phase (1):

$$n = (V f / V 1) * 100 \%(1)$$

here V f - volume of dispersed phase, cm 3 ;

V 1 - volume of dispersion medium, cm 3.

Foam stability was established by measuring the strength and lifetime of the foam within 3 min which is required for assesing the foam as stable.

Results of testing are processed by mathematical statistics methods Excel. Standard deviation of obtained testing results is not greater than 0.05.

Results and Discussion

Research on the depending of oxygen foams on the nature of the foaming agents.

Traditionally for preparation of oxygen cocktail foaming agents are used, which contain egg white, licorice root or gelatin. In this work the foam properties of the egg white protein were established as compared to another foaming agents from vegetable origin. The concentrations of the foaming agents was chosen according to research. 100 ml of apple juice with Citri Fi 00 FG, Citri Fi 200 FG (orange fiber with guar gum), Citri Fi 300 M40 (orange fiber with xanthan gum), HPMC with concentration from 0,1% to 2 % have been prepared. In order to establish ability and stability of the foams with different foaming agents, the systems of cocktail were whipped using oxygen mixer for a few seconds. The results are summarized in Fig 1.

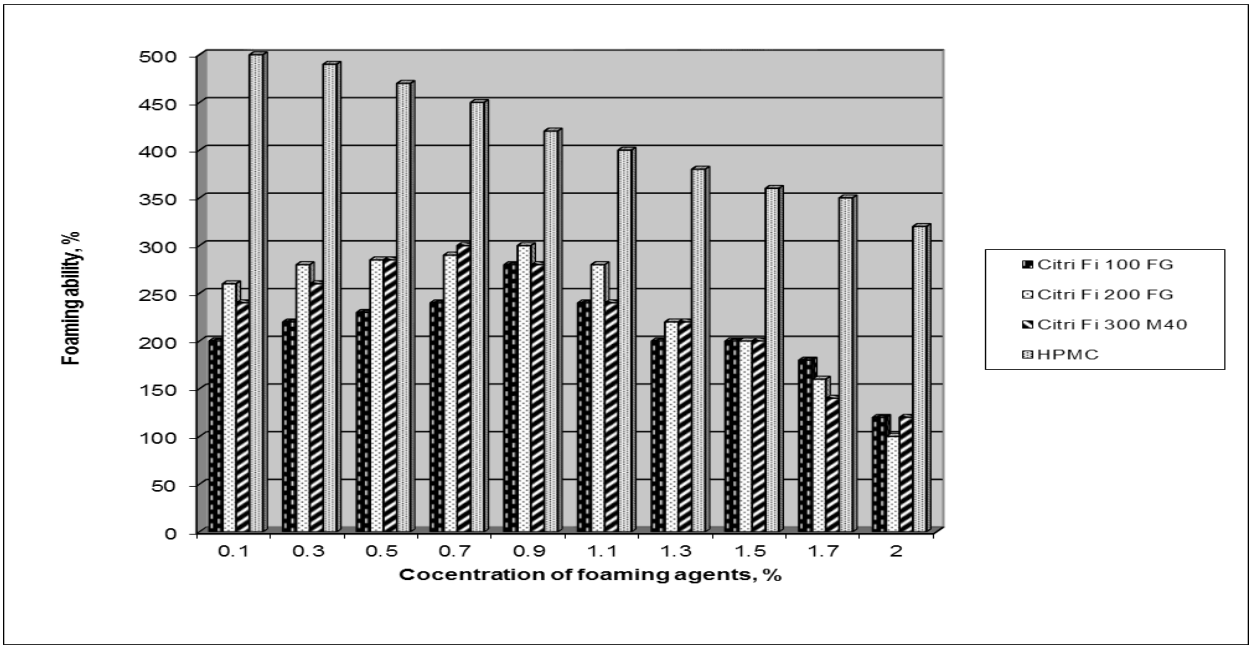

Fig. 1 Dependence of the foam ability for the oxygen cocktail from apple juice and different foaming agents in beginning of testing

During the testing the foaming ability of the samples containing foaming additives of various concentrations varies within the range of 100 ÷ 500 % i.e. from the low to high values (see Fig. 1). Data presented in Fig.1 indicate that foaming ability of HPMC compared to that of Citri Fi was 1.7 ÷ 5 times greater. Based on the studies, it was found that the addition of dietary fibres Citri-Fi at concentrations of 0.7 – 0.9 % and HMPC at concentrations of 0.1 - 0.3 % into the oxygen cocktails makes the highest volume of foams. In addition, it has been observed that when increasing the dose of dietary fibres in making cocktails, the viscosity and weight increased, drink has not been properly shaken, there separation of the product into phases has been detected, the system has become thermodynamically unstable (see Fig. 2).

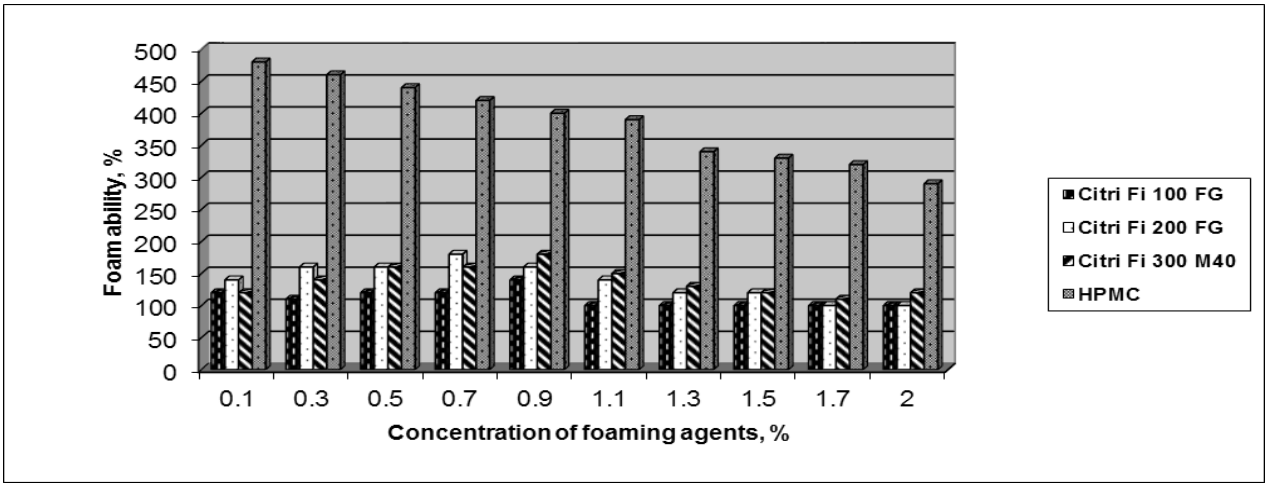

Fig. 2 Dependence of the foam ability on the oxygen cocktail from apple juice and different foaming agents after 3 min.

Research results presented in Fig.1, 2 allow us to state that foam stability for Citri Fi 100 FG, Citri Fi 200 FG and Citri Fi 300 M40 samples was low, average 2 min, where the foams indicate a rapid loss in their structure, and eventually collapsed.

Summing up testing results, it can be stated that HPMC is significantly more efficient if compared to Citri Fi fibers with guar or xantan gum, and its foaming ability is the highest when its concentration in the sample reaches 0.1 – 0.3 %.

In order to evaluate the foaming ability of HPMC by comparing the samples containing them to the egg white sample, the foaming ability and foam stability in the test beginning and after 3 min have been analyzed (see Fig 3).

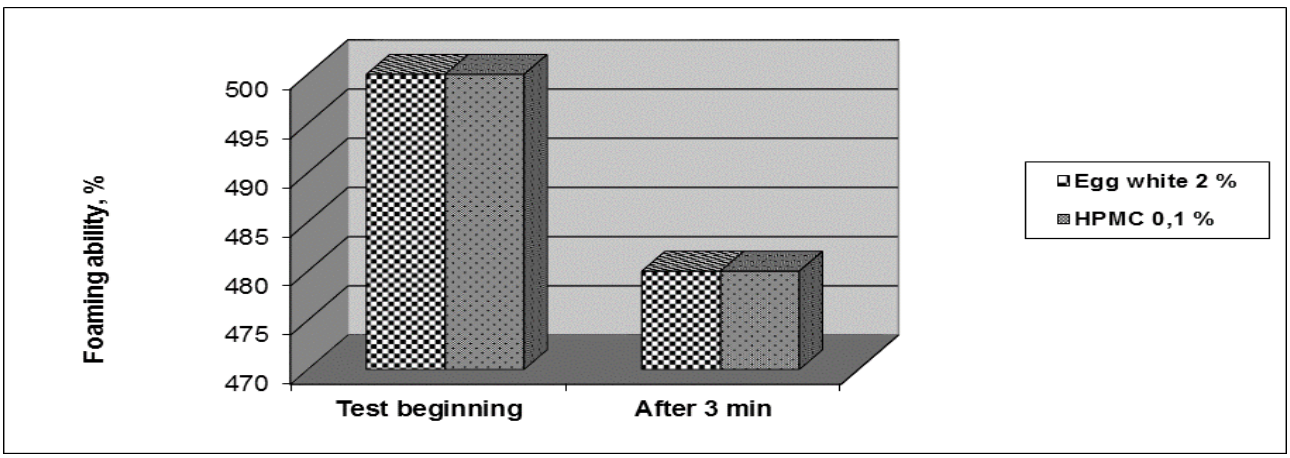

Fig. 3 Foaming ability and stability of egg white and HMPC

Testing results presented in Fig. 3 indicate that HPMC and egg white foaming ability and stability were similar. The further analysis deals with application of HPMC for stabilization of the protein oxygen foam.

Application of biopolymers for the stabilization of the protein oxygen foam

The results (see Fig. 1) revealed that the samples with HPMC had excellent foam ability and stability. Foaming properties are typical for cheese whey proteins [18]. The results of potential effects of HPMC and cheese whey, hemp protein are unknown.

In the research [2] the competitive adsorption between proteins (β-lactoglobulin and β-casein) and HPMC, as they are often used together, was investigated. Results have shown that HPMC formed highly elastic interfaces, more elastic even than protein β-lactoglobulin. HPMC was more surface active than the proteins, therefore at HPMC concentrations, the polysaccharide began to dominate the interfacial properties. Whereas surfactants reduce the elasticity of the protein adsorbed layer, the elastic properties of the polysaccharide enhanced the overall strength of the interface, which will potentially result in more stable foams.

In order to evaluate the foaming properties of HPMC and egg white, tested oxygen cocktail samples with cheese, whey powder and hemp protein have been tested. Research results on oxygen cocktails enriched in protein are presented in Fig. 4-5. Data showed that foaming ability of oxygen cocktail with hemp protein compared to oxygen cocktail with cheese whey was about 2 times bigger.

It has been observed that when increasing the concentration of protein in cocktail, the viscosity increased, volume of cocktails decreased due to not properly whisked drink. Volume of oxygen cocktail with cheese whey is too low, neither meets the requirements, nor consumer's needs. Analysis of the results (Fig. 5, 6) makes it possible to state that foaming ability of cheese whey is lower than hemp protein and this property is independent from the foaming agent.

Testing results have shown that the maximum oxygen concentration and foam stability of vegetable origin proteinaceous oxygen cocktail is ensured when the HPMC concentration is about 0.1%, hemp protein - 0.3%.

This work demonstrated the feasibility of using HPMC as foaming agent of oxygen beverages based on fruit juice and vegetable protein.

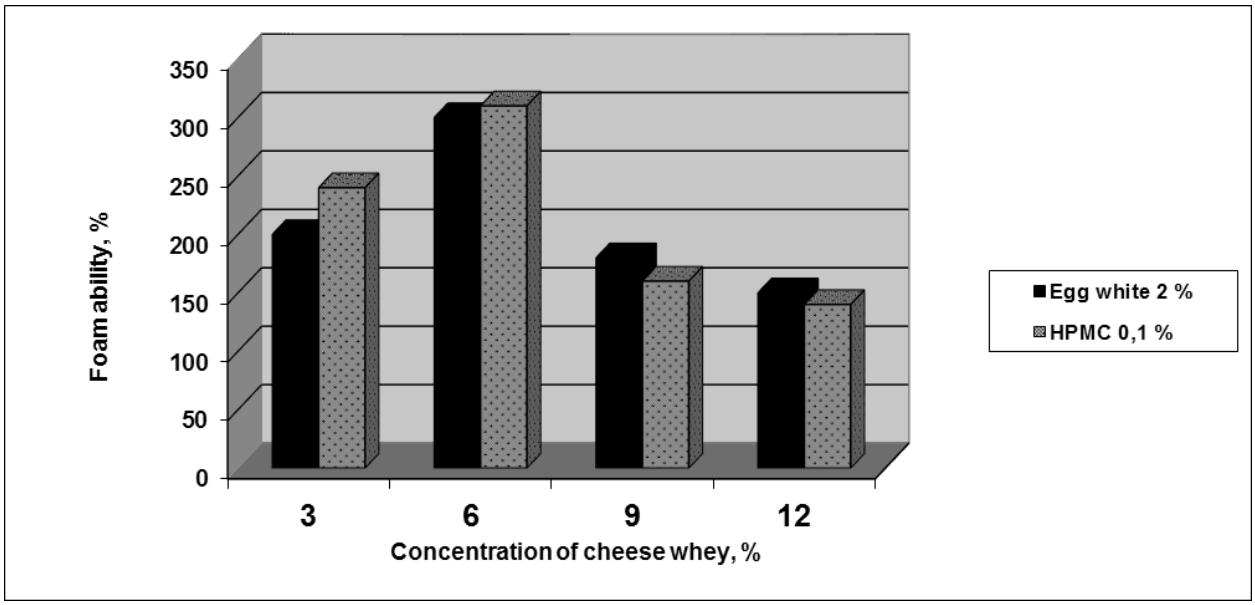

Fig. 4 Dependence of the foam ability for the oxygen cocktail made from apple juice and different foaming agents on the concentration of cheese whey after 3 min

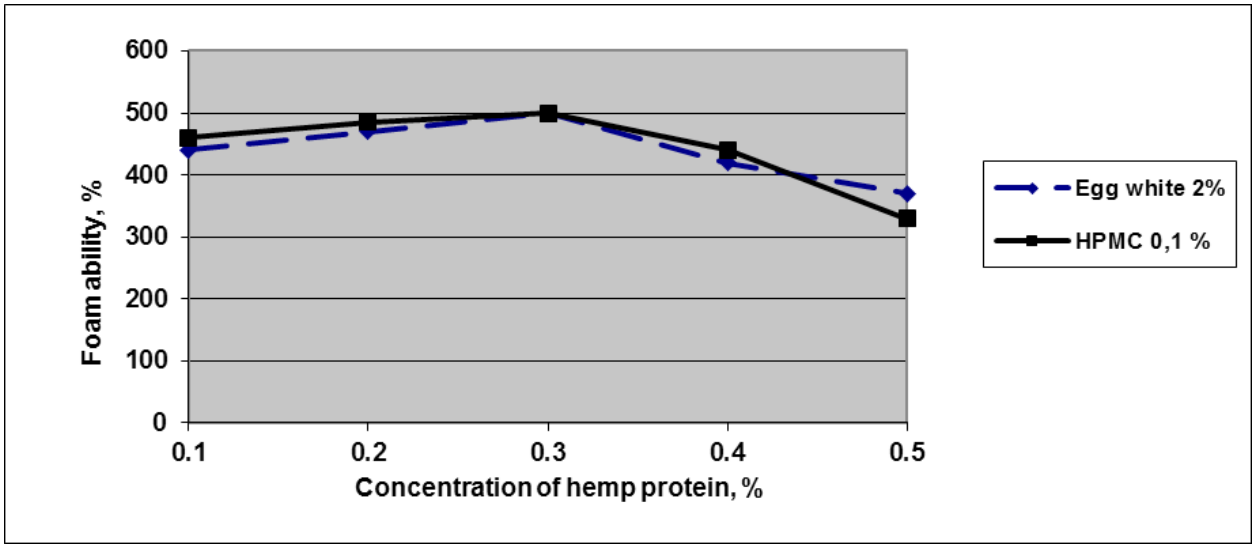

Fig. 5 Dependence of the foam ability for the oxygen cocktail made from apple juice and different foaming agents on the concentration of hemp protein after 3 min

Nutrition information of newly created food is an important public health tool to promote a balanced diet, therefore to enhance public health, nutritional and energy value of functional oxygen cocktail (Table 4) has been calculated. This information enables consumers to compare the nutritional values of similar food products and then make healthy food choices based on the relevant nutrition information.

Table 4. Calculations nutritional and energy value of funcional oxygen cocktail

Name of components	Mass, g	Protein, g	Fat, g	Carbo hydrates, g	Sugar, g	Energy value, kcal
Apple juice	100	0,1	0,1	10	9	40,4
Hemp protein	0,3	0,097	0,029	0,008	0,008	0,677
Hydroxypropyl methyl cellulose	0,1	0	0	0,1	0	0,4
Total:	**100,4**	**0,197**	**0,129**	**10,108**	**9,008**	**41,477**

Energy value of protein oxygen cocktail is low, but it has a high nutritional value. Cocktail is saturated with oxygen. It is recommended to use the newly created functional oxygen cocktail for those who are on special diets (e.g. people suffering from hypoxia, patients with chronic heart failure, diabetes or high blood lipid).

Sensory indicators quite strongly influence quality of food products. If the indicators do not meet quality requirements and customer needs, there will be no demand for cocktail and it will not be produced.

Sensory quality of protein oxygen was assessed by 10 tasters. Tasters assessed the oxygen cocktail with hemp protein positively (see Table 5).

Table 5. Sensory characteristics of functional oxygen cocktail

Name of sensory properties	Description of the characteristic
Taste	Pleasant, is not sweet, typical of hemp and apple juice
Odour	Delicate, fresh, typical of apple juice and hemp
Colour	Light beige to greenish
Consistency	Homogeneous foam, there isn't separation of the cocktail into phases

Sensory analysis (see Table 5) indicates that oxygen cocktail with hemp protein cocktail characterized by light beige to greenish colour is of pleasant taste, homogeneous foam consistency.

The research results showed the expediency of using foaming agent of vegetable origin in protein oxygen cocktails.

Conclusions

1. Citrus fiber Citri Fi 100 FG, Citri Fi 200 FG and Citri Fi 300 M40 foaming agents were able to provide foam with lower stability comparing to HPMC. Foam stability of fruit juice and Citri Fi samples was low, average 2 min, where the foams indicated a rapid loss in their structure, and eventually collapsed. HPMC and egg white foaming ability and stability were similar.
2. Foaming ability of cheese whey lower hemp protein and this property independent of the foaming agent HPMC and egg white foaming ability and stability in protein enriched oxygen cocktail were similar. This work demonstrated the feasibility of using HPMC as foaming agent of oxygen beverages based on fruit juice and vegetables protein. The maximum oxygen concentration and foam stability within the functional protein oxygen cocktail is ensured when HPMC concentration is about 0.1%, hemp protein - 0.3%.
3. Sensory analysis indicates that oxygen cocktail with hemp protein (light beige to greenish colour) is tasty and has homogeneous foam consistency. Energy value of protein oxygen cocktail is low but it has a high nutritional value. Cocktail saturated with oxygen is recommend for people suffering from hypoxia, patients with chronic heart failure.

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