

Ministry of Education and Science of Ukraine

# ODESA NATIONAL UNIVERSITY OF TECHNOLOGY

International Competition of  
Student Scientific Works

# BLACK SEA SCIENCE 2023

## PROCEEDINGS



ODESA, ONUT 2023

Ministry of Education and Science of Ukraine

Odesa National University of Technology

International Competition of Student Scientific Works

# **BLACK SEA SCIENCE 2023**

**Proceedings**

Odesa, ONUT  
2023

## TECHNOLOGY OF LOW-CALORIE MAYONNAISE SAUCE OF INCREASED NUTRITIONAL AND BIOLOGICAL VALUE

**Authors:** Oleksandr Ovcharenko

Alina Belmas

**Advisor:** Olena Hrabovska

State University of Trade and Economics (Ukraine)

**Abstract.** *The scientific work is devoted to a topical topic, namely the development of low-calorie mayonnaise sauce technology. Monitoring of the market of mayonnaise sauces in Ukraine showed that this product is in high demand among the population, but the assortment of mayonnaise sauces with increased nutritional and biological value is not sufficient and needs to be expanded. On the other hand, an urgent task for scientists is the creation of resource-saving technologies for the processing of cheap secondary raw materials: the decoction obtained after cooking legumes - aquafaba. These secondary products are currently not used by industry.*

*The paper presents research on the technology of low-calorie mayonnaise sauce based on aquafaba and resistant porous starch enriched with quercetin, as well as the results of its quality assessment. This product will be of interest to vegetarians who do not eat food prepared from animal raw materials.*

*The technology of resistant porous starch is substantiated and highlighted in our previous works.*

**Key words:** *mayonnaise sauce, low-calorie, aquafaba, porous starch, quercetin.*

### I. INTRODUCTION

The requirements of nutrition science indicate the need for a new approach to the formation of the composition and properties of food products. Consumers are increasingly interested in the impact of various food products and their components on health, so it is urgent to create new food products that positively affect the functions of the human body. In the world, the study of ways of enriching food products with biologically active substances of natural origin arouses the interest of scientists.

The search for natural sorbents, which, without changing the taste and being neutral regarding the physiological effect on the body, are able to retain certain low-molecular biologically active compounds and exert a protective effect on them is relevant. These substances change the role of micro, which ensures the stability of vitamins and mineral supplements, for example, which are sensitive to ultraviolet radiation, light, oxygen, metals, humidity, and temperature changes. As a material for microcapsules, it is known to use proteins, and polysaccharides, in particular starch [9-12, 19]. By purposefully changing the structure of the material, it is possible to obtain starch, which can be a carrier and protective agent for biologically active substances, and show resistance to the action of enzymes in the gastrointestinal tract. Such modified starch can be used in the technology of food products to enrich them and provide structure and certain functional properties [2, 3].

Among the products of the restaurant industry, sauces are a separate segment. The variety of flavors of world cuisine is created with the help of sauces. Sauces

contribute to better assimilation of food nutrients by the human body, expand the assortment and increase the nutritional value of dishes [21].

Mayonnaise sauces are cold cooking sauces for which oil is used. Oil is an important source of unsaturated fatty acids, which play an important role in human nutrition. However, an excess of fat in a person's diet is harmful because it causes digestive disorders. In the production of low-fat mayonnaise, hydrocolloids - fat imitators are used to correcting the rich creamy taste. For the partial replacement of fats, modified starches are widely used, which exhibit the properties of emulsifiers, fillers, and thickeners. Usually, this effect is achieved with the necessary concentration of starch in water [3, 15]. The introduction of various natural plant ingredients into the traditional recipe of mayonnaise products makes it possible to recommend it for use by various groups of the population.

One of the trends in the creation of food products for health and preventive purposes is the exclusion of allergens and proteins of animal origin. The two main components of mayonnaise sauce are eggs and oil. It is known that eggs are the most common allergens that often cause a negative reaction in children. Avoiding the use of eggs is also important for people who follow a vegetarian diet [25, 27].

Mayonnaise products are highly popular among the population of Ukraine and occupy an important place in the nutrition structure. The industrial production of these food products is becoming more and more widespread, which requires manufacturers to expand the range of these products. Today, there is a shortage of low-calorie mayonnaises with useful natural health supplements on the market. To expand the range of structured products for special dietary purposes - sauces, creams - it is promising to use vegetable raw materials, which are grown in large quantities in Ukraine. Such relatively cheap raw materials are legumes, such as chickpeas, peas, and beans, which contain a significant amount of protein substances and starch, as well as sugars, saponins, and other organic substances. The decoction of legume fruits is called «aquafaba» (from lat. aqua — water, faba — beans) and is used in culinary practice as an emulsifier and foam stabilizer instead of egg white [1, 5, 7].

Therefore, the development of low-calorie mayonnaise technology with increased nutritional and biological value is an urgent task.

**The purpose of the work** is the scientific justification and development of the technology of low-calorie mayonnaise sauce of increased nutritional and biological value based on modified resistant enriched starch and aquafaba.

## II. LITERATURE ANALYSIS

Mayonnaise sauces occupy one of the leading places in the consumer market of Ukraine. The intensifying competition between manufacturers and trade organizations forces them to look for new means of influencing the decisions and motivation of consumers when choosing emulsion products. One of the ways to solve this problem is the expansion of the range of emulsion products, the introduction into production of low-calorie mayonnaise and sauces enriched with useful, natural additives for health and preventive purposes, which will help not only to satisfy the demand and tastes of consumers but also to ensure the healthy nutrition of the nation [7, 13, 14, 20].

Prospective directions for expanding the assortment and increasing the

nutritional value of sauces are the use of new types of raw materials, natural flavoring and flavoring and dietary additives; introduction of plant and animal fillers; reduction of the energy value of special purpose sauces (for dietary nutrition); development of semi-finished sauces of various degrees of readiness, in particular, vegetable concentrates with increased content of biologically active substances; improving the functional and technological properties of sauces, in particular, increasing their colloid stability due to the introduction of emulsifiers, thickeners, and stabilizers; increasing the economic efficiency of production.

The market of mayonnaise is considered quite flexible and mobile. Cold sauces (due to the short shelf life compared to other types of oil and fat products) are made to the order of the trade, which monitors the needs of consumers [21]. The mayonnaise segment occupies more than 60% of the sauce production structure by product category.

However, starting in 2012, the consumption of mayonnaise began to noticeably decrease. This product is associated among consumers with harmful food that hurts the body, and that is why a significant part of buyers tries to reduce its consumption.

Based on the volumes of consumption, the task of creating innovative types of mayonnaise products that will have new consumer properties, including enriched products, which will allow increasing the consumption of vegetable oils and reducing the deficit in particularly valuable nutrients [13-16] is urgent.

In Ukraine, the segment of low-calorie emulsion products is represented, for the most part, by mayonnaises and sauces with the addition of spicy and aromatic additives, spices, greens, etc. Some scientists are researching the use of diacylglycerols and blends of vegetable oils in mayonnaise technology, while the world is widely researching the development of innovative mayonnaise technologies enriched with prebiotics or biologically active substances of plant raw materials [15-17]. Emulsion fat products (in particular, mayonnaise and sauces) are enriched with biologically active substances, which are not available on the country's market. Therefore, the scientific and practical substantiation of the technologies of new innovative products - low-calorie functional purpose mayonnaises, enriched with biologically active compounds, is an urgent task.

### **2.1. Vegetable proteins as emulsifiers in the technology of emulsion food products**

In addition to traditional components, mayonnaises include emulsifiers, stabilizers, structure formers, as well as taste, functional and other food additives that give mayonnaise different tastes, aromas, nutritional and physiological value and allow to create of a large assortment of these products [20].

In the production of mayonnaise, various combinations of emulsifiers are most often used, which makes it possible to obtain highly stable emulsions with lower consumption of emulsifiers. Egg powder, which is a protein-phospholipid complex, is used as the main emulsifying component. Egg yolk forms the basis of the emulsion and affects the stability, consistency, color, and taste of the finished product [7, 22]. The emulsifying effect of egg yolk or egg powder is caused by lecithin and other phospholipids. The following types of egg products are used: egg powder, granulated

egg product, and dry egg yolk. The content of egg products in mayonnaise, depending on the recipe, ranges from 2 to 6% [23, 24].

Emulsifiers traditionally used in the production of mayonnaise are also skim milk and whey protein concentrate, which has high emulsifying properties and is widely used as a full-fledged substitute for egg powder in the production of mayonnaise and low-calorie salad dressings [16, 17, 22].

Vegetable proteins, most often soy, are used as emulsifiers. Today, an alternative to egg white is «aquafaba» - an ideal option for those who cannot eat eggs or who are fasting. It is also valued among vegetarians, as it can imitate the properties of egg whites and dairy products, and is used as a vegetable emulsifier in many bakery products. It should be noted that dishes prepared using aquafaba almost do not differ in taste from those using eggs.

Aquafaba, the thick liquid left over from cooking legumes such as chickpeas or beans, is suitable for making meringue, pasta cakes, ice cream, mayonnaise, and more. Like egg white, aquafaba after whipping can form a stable foam that does not settle for a long time [27, 28].

Legume seeds or fruits are mainly composed of carbohydrates (starch, sucrose, and fiber), proteins (albumins and globulins), and water. A typical nutritional composition of chickpeas is 19% protein, 61% carbohydrates, 6% lipids, and 14% water. In the process of boiling legumes, the starch in the fruits is pasteurized. This contributes to the fact that soluble particles of starch pass into the liquid in which they are cooked. After the beans have been boiled, they are separated from the liquid phase. The resulting liquid, containing water-soluble substances of legumes, remains. It is called aquafaba. This liquid can be frozen and stored for a long time. Under normal conditions, approximately 5% of the bean composition turns into liquid. Thanks to this, aquafaba acquires its emulsifying and structure-forming properties. It is known that bean isolate has a high fat-holding capacity [22, 26].

From the analysis of literary sources, it is known that bean proteins are represented by globulins (salt-soluble proteins) - about 55%; albumins (water-soluble) - about 19%; glutelins (not soluble in water) - about 18%. The fraction of prolamins are absent [1, 7]. In addition, it is known [27] that the starch grains of legumes contain a significant amount of amylose - the linear fraction of starch polysaccharides - which to some extent determines the structure-forming properties of aquafaba.

White bean proteins are distinguished by a high content of such essential amino acids as leucine – 17.4 g/100g, lysine – 15.9 g/100g, phenylalanine + tyrosine – 11.3 g/100g, valine – 11.2 g/100g. According to the results of the analysis of the amino acid composition [22-24], it was established that the sum of essential amino acids in whey exceeds their amount in ideal protein by 1.9 times, and in white beans by 2.2 times.

In addition, white beans are rich in macro- and microelements: 100 g satisfies the daily need for potassium by 22-44%, magnesium by 20-34%, phosphorus by 45%, calcium by 13%, and among microelements, 100 g of beans most satisfy the daily need for iron - 30-59%; manganese - 67%; copper – 58%; molybdenum - up to 50% and zinc - 29-32%. Beans are also rich in B vitamins and tocopherol (E).

In the industrial production of legumes, aquafaba is a waste, so the development of sauce products using aquafaba as an emulsifier and structure former is promising [1,

7, 28]. Thus, the use of aquafaba will increase the nutritional and biological value of low-calorie mayonnaise sauces, exclude eggs from the recipe of sauce products and create an emulsion mayonnaise sauce for special dietary consumption.

## **2.2. Starch-based emulsion stabilizers**

In some cases, only an emulsifier is enough to form a stable emulsion of high-calorie mayonnaise. If the fat content is reduced, stabilizers are added to the formulations, which ensure their stability and prevent delamination. They help to increase the viscosity of the dispersed medium, prevent the coalescence of small oil droplets, and therefore are hydrophilic in nature [2-4]. In the production of low-fat mayonnaise, modified starches are widely used to partially replace fats, which exhibit the properties of emulsifiers, fillers, and thickeners [16, 17].

Modified is a starch with directionally changed properties as a result of physical, chemical, biochemical, or combined processing. As a result, the natural features are significantly changed, sometimes the undesirable properties of polysaccharides are eliminated or reduced, and their valuable properties are strengthened. These products are classified as food additives.

For example, modified starches from Emsland-Starke GmbH (Germany) go through the stages of swelling and heating in the production process, so they can be dissolved in cold water. They are successfully used in the «cold» technology of preparing mayonnaise emulsions [21].

In addition to providing stable rheological characteristics of emulsion sauce, modified starch can serve as a protective material for biologically active substances. It is known that by freezing starch pellets under certain conditions it is possible to obtain porous starch with pores of different sizes. The formation of porous starch can occur as a result of ice formation in pastes. At the same time, strong frameworks are formed from starch with ice crystals included in them [3-4, 11, 13]. Porous starches have a highly developed surface. In a partially dehydrated state, they absorb a large amount of water. This type of starch is similar to a microcapsule that contains and stores active substances.

Scientific literature mentions the use of porous starch for food purposes after impregnation with sugar syrups, fruit and berry syrups, broths, and other liquid fillers. In the USA, porous starch has found use in medicine. Assumptions were made before the use of porous starches as adsorbents for special purposes, for the preparation of «dry perfumes». They can be useful as capsules for aroma oils, antioxidants, medicines, and agricultural materials for grain coating [11, 12].

Today, the relevance of using preparations from plant raw materials is increasing. Their advantage is low toxicity and the possibility of long-term use without the risk of side effects [19, 10].

Of particular interest are flavonoids, which are found in almost all plants to a greater or lesser extent.

Increased interest in flavonoids is due to their high and diverse biological activity. The low toxicity of flavonoid compounds, along with the selective pharmacological effect on the human body, makes it possible to widely involve them in the creation of new medicinal preparations [12, 13].

As medicinal products, the flavonols rutin and quercetin, which belong to the group of vitamin P, are of practical use. They are especially rich in green tea leaves, buckwheat flowers and leaves, Japanese sophora, citrus fruits, rose hips, and mountain ash.

Quercetin dilates blood vessels, increases their tone, and exhibits antispasmodic properties. It is used for increased permeability and fragility of capillaries in hypertension, atherosclerosis, and rheumatism. Having antioxidant properties, quercetin protects cell membranes and inhibits their aging process. In addition, this flavonoid prevents the accumulation of cholesterol on the walls of blood vessels. Regular consumption of quercetin normalizes blood pressure, improves blood circulation, and significantly reduces the risk of cardiovascular diseases and the formation of blood clots. Therefore, in our opinion, the use of quercetin to enrich the mayonnaise sauce would be appropriate. As a neutral carrier for quercetin and to protect it from the environment, it was decided to use porous modified starch.

Modified starch, in addition, should play the role of not only a hydrophilic carrier for quercetin but also filler, an emulsion stabilizer, while not affecting the glycemic index of the product. This is because, during the freezing and thawing of starch pastes, a partial retrogradation of starch polysaccharides takes place with the formation of a strong structure that is not susceptible to the action of enzymes of the gastrointestinal tract. That is, the obtained modified starch belongs to the group of resistant. Resistant starch is of interest to food developers and nutritionists for two reasons, the first being the physiological benefits and the second being the unique functional properties that cannot be obtained with traditional insoluble dietary fibers. Resistant starch improves the color and taste of some foods compared to the use of traditional insoluble dietary fibers [2-4].

Therefore, based on the analysis of literary sources, research tasks were formulated: to investigate the possibility of obtaining a vitamin complex of quercetin by its sorption on porous starch; to investigate the emulsifying properties of the system: porous starch with quercetin - aquafaba - sunflower oil; to develop the technology of low-calorie mayonnaise sauce of increased nutritional and biological value; provide a qualitative assessment of the developed sauce.

### **III. OBJECT, SUBJECT, AND METHODS OF RESEARCH**

The *object of research* is the technology of low-calorie mayonnaise sauce with increased nutritional and biological value.

The *subject of research* is modified corn starch with quercetin; aquafaba - liquid obtained as a result of boiling white beans; vegetable oil, model compositions of emulsion sauces with different ratios of aquafaba and emulsified oil; emulsion sauce.

*Preparation of aquafaba.* To prepare aquafaba, white beans or chickpeas were soaked for 2 hours and boiled for 60 minutes with a ratio of beans to the water of 1.5: 3.5. The strained liquid (aquafaba) was cooled.

All raw materials and materials used in the research, in terms of quality and safety, met the requirements of the regulatory documentation in force in Ukraine or the quality certificates of the manufacturers and were approved for use by the Ministry of Health of Ukraine.

*Preparation of porous starch with quercetin.* The technique [4, 11, 12] modified by us was used to prepare porous starch with quercetin. A suspension of 40 (20) g of air-dry corn starch was prepared with a concentration of 10% using a quercetin solution with a concentration of 1% as the aqueous phase. For the pasteurization of starch, the suspension of starch with quercetin was treated in a microwave oven for 5 min at medium power. When the paste cooled, it was necessary to avoid the formation of a film on the surface. Next, the starch paste was subjected to freezing at temperatures of  $-5...-10$  °C for 12...15 hours. For rapid thawing, the frozen mass was heated to  $30...35$  °C. Then water was squeezed out of the spongy structure of retrograded starch, and dehydrated with ethanol. The resulting structure was quite strong and flexible, able to recover after removing the load. The obtained sample was dried at a temperature of 45 °C, crushed, and sieved.

*Research methods* – standard generally accepted and special physicochemical, organoleptic, mathematical, and statistical methods of processing experimental data using modern computer programs.

X-ray diffraction analysis (XRD) of the initial forms of corn starch, quercetin, and the resulting product was carried out on a DRON-M1 X-ray diffractometer with two Soler slits.

The resulting starch was examined using an scanning electronic microscope LEO 1420 (Germany).

Determination of the content of amino acids in mayonnaise sauce was carried out in the laboratories of the Institute of Food Resources of the National Academy of Sciences of Ukraine (Kyiv).

Resistance property of criomodified starch was investigated by a procedure using 3,5-dinitrosalicylic acid [2].

Emulsion stability – a conventional unit that indicates the percent of intact emulsion remaining after stability studies – was determined according to the approved methodology (DSTU 30004.2).

Mayonnaise sauce was obtained by emulsification using a laboratory top-drive mixer ULAB US-2000A.

## IV. RESULTS

### 4.1. Study of the structure and properties of porous starch with quercetin (PSK)

In order to obtain porous starch, information was used that during deep freezing of starch pastes, the formation of ice crystals leads to the compaction of polysaccharide chains (retrogradation) and the formation of internal channels.

As a result of thawing the frozen starches paste, water syneresis occurs from the starch gel. The combination of freezing-thawing stages leads to the formation of resistant starch.

The formation of pores of different sizes depends on the concentration of starch paste. We used 10% starch paste to make porous starch.

It was assumed that, due to the porous structure, such a modified starch can adsorb low molecular weight biologically active substances. In our study, we used the

flavonol quercetin.

A sample of porous starch with quercetin was obtained by the method described above. It was investigated in order to refine the structure.

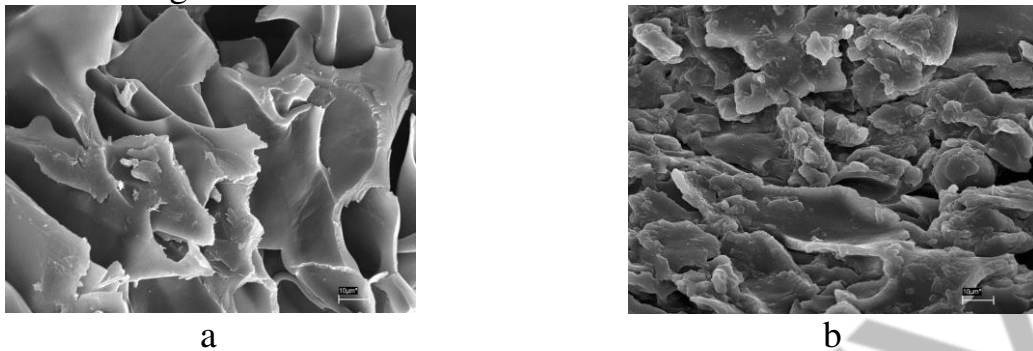


Fig. 1. Micrograph of sections of porous starch taken with a skinning electron microscope: a – cross section, b – longitudinal section

Microphotographs of sections of porous corn starch (Fig. 1), taken with a scanning electron microscope, clearly show the structure of pores.

The results of X-ray phase analysis of corn native and porous starches, as well as quercetin and porous starch with quercetin are presented in fig. 2.

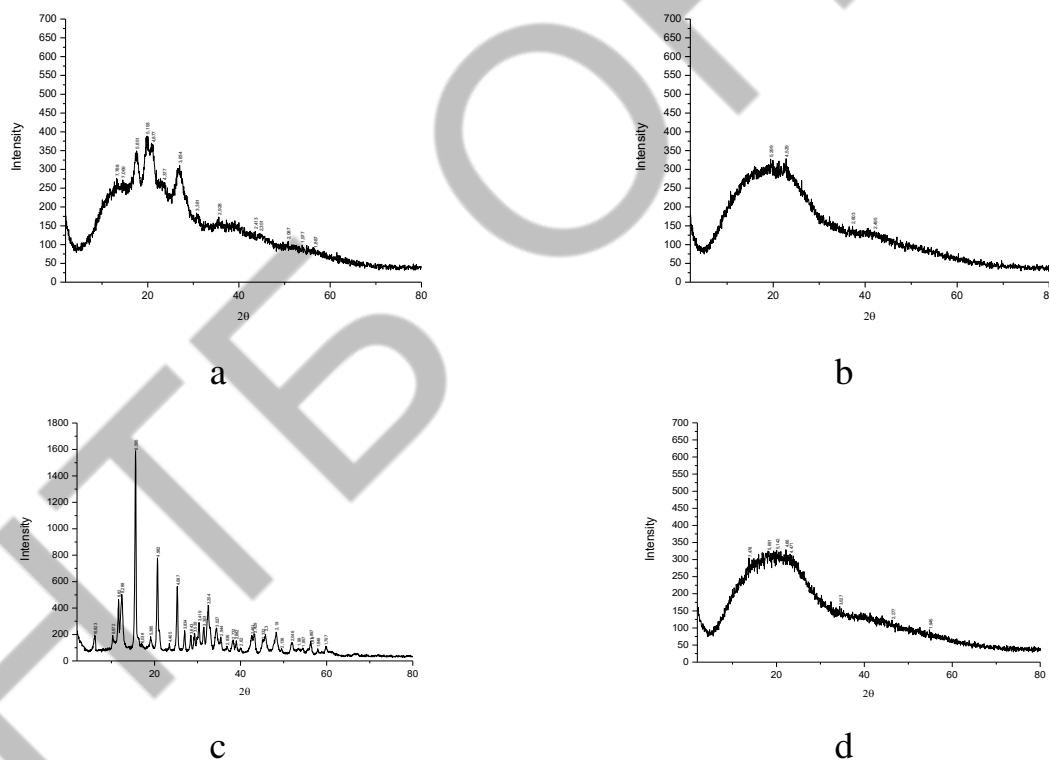


Fig. 2. Radiographs of samples: a – corn starch, b – porous corn starch, c – quercetin, d – porous corn starch with quercetin

Analysis of radiographs showed changes in crystallinity that occurs during freezing-thawing of starch pastes. Native starch has an amorphous-crystalline structure, as evidenced by the X-ray pattern shown in Fig. 2, a. Porous starch has an amorphous structure with barely noticeable remains of crystallinity (Fig. 2, b). The quercetin used in the work gave its characteristic diffraction pattern (Fig. 2, c).

X-ray phase analysis of the product of the interaction of porous corn starch with quercetin showed (Fig. 2, d) that quercetin in it is in a non-crystalline form (or in the form of crystals with a size of less than  $10^{-9}$  m) while preserving the amorphous form of porous starch.

The degree of resistance was determined by the residual content of reducing substances after enzymatic hydrolysis of starch with the enzyme preparation «Pancreatin», which contains digestive enzymes [2, 3].

Research results show that porous starch has greater resistance to enzymatic hydrolysis than native starch. As the concentration of the starches paste from which the porous starch was prepared decreases, its resistance to the action of enzymes decreases. The degree of resistance of the obtained starch is about 60 %. Thus, the use of porous resistant starch with quercetin in food products will allow enriching the products with quercetin, while most of the starch will be removed from the organism.

Based on the analysis of literary sources and our own research on the technology of resistant PSK, the following tasks were formulated: to combine in the development of an emulsion product PSK and aquafaba as a basis; experimentally determine the amount of oil and the conditions of emulsion stability over time.

#### 4.2. Investigation of the emulsion stability based on aquafaba and PSK

The innovative production model of the new generation mayonnaise sauce involves the use of a mixture of aquafaba sunflower oil, which has emulsifying and structure-forming properties, and porous resistant starch enriched with quercetin as the main component.

A study was conducted to determine the influence of the amount of aquafaba and oil on the stability of the emulsion. It was established that with an increase in the oil content, the stability of the emulsion increases (Fig. 3). Thus, with an aquafaba content of 40...60% and an oil content of 60%, the stability of the emulsion is  $98 \pm 2\%$ , which meets the requirements of regulatory documentation for mayonnaise.

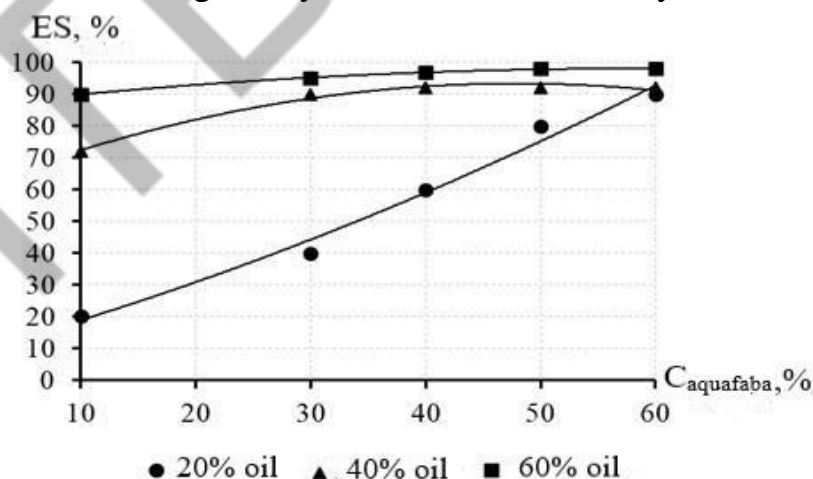


Fig. 3. Emulsion stability depending on aquafaba and sunflower oil content, %

It should be noted that systems with an oil content of 40% (which meets the requirements for a low-calorie mayonnaise sauce) and with an aquafaba content of 40...60%, the stability of the emulsion is  $94 \pm 2\%$  and practically does not change, although the viscosity of the system in this range increases. The addition of porous

starch with quercetin makes it possible to increase the stability of the emulsion to the normative value, not lower than 97%. Based on the analysis of emulsion stability values, it is possible to recommend a rational ratio for obtaining low-calorie emulsion sauces - Aquafaba: oil = 40...60 : 40.

The principle technological scheme (Fig. 4) provides for the preparation of aquafaba by cooling and emulsification, the gradual addition of porous starch with quercetin and mustard, mixing until a homogeneous mass is formed. To form a stable emulsion, the oil is injected in a thin stream during vigorous emulsification of the product.

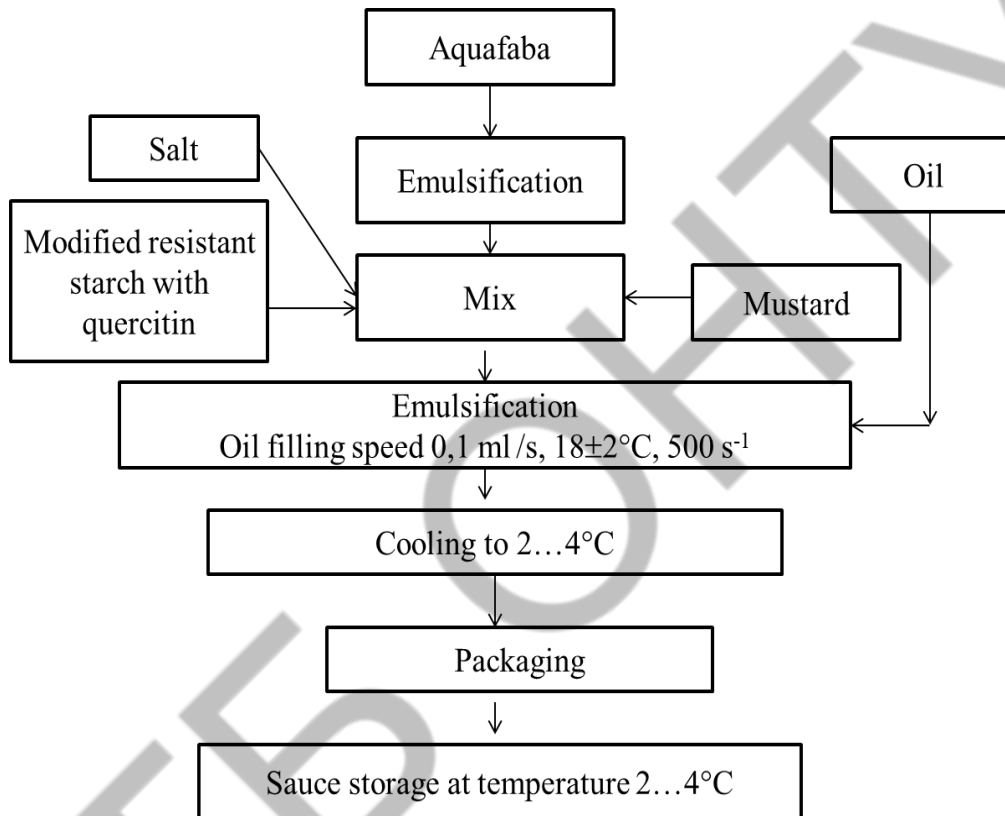


Fig. 4. Principle technological scheme for the production of low-calorie mayonnaise sauce

The technological scheme for the production of mayonnaise sauce provides for the addition of oil to the mixture of dispersed aquafaba and PSK (4...5%). The emulsification process was carried out at an oil addition rate of 0.1 ml/s at a temperature of 17...20 °C while rotating the stirrer at a speed of 500 s<sup>-1</sup> for (1.1...1.2)× 60 s (laboratory stirrer ULAB US-2000A) to prevent stratification of the system (Fig. 4).

On the basis of the conducted research, the recipe of low-calorie mayonnaise sauce «AQUAFABA» was developed based on a decoction of white beans with the addition of resistant porous starch with quercetin (table. 1).

Table 1. Recipe composition of emulsion sauce «AQUAFABA»

Component name	Recipe composition of the sauce	
	Brutto, g	Netto, g
Refined, deodorized sunflower oil	40	40
Porous starch with quercetin	5	5
Aquafaba	50	50
Mustard	5	5
Salt	0,5	0,5
Output of the finished product	-	100

The developed mayonnaise sauce can be recommended for any dishes, in particular, for salads and white meat.

#### 4.3. Research on the quality of low-calorie mayonnaise sauce «AQUAFABA»

The obtained low-calorie mayonnaise sauce is characterized by a complex of quality indicators, among which the most important are nutritional and biological value.

The content of the main food substances and the energy value of the emulsion-type sauce compared to the control are shown in the Table 2. The classical recipe of «Provencal» mayonnaise with a fat content of 67% was used as a control.

Table 2. Chemical composition and energy value of the sauce, g/100g of product

Indicator	Unit of measurement	Sauce	
		Control	«AQUAFABA»
The mass fraction: - moisture	g/100g of product	21	25
- mineral elements		1,5	3,36
- proteins		2,8	5,7
- fats		67	40
- carbohydrates		3,7	22
Energy value	Kcal	629	345

The developed mayonnaise sauce is characterized by an increased content of proteins and minerals compared to the control. The amount of carbohydrates increased by almost 6 times due to the use of white bean decoction (aquafaba). Fat content and energy value, on the contrary, decreased due to a decrease in oil content.

The analysis of the amino acid composition of the proteins of the sauce (Table 3) showed that due to the proteins of the beans, the mayonnaise sauce «AQUAFABA» is characterized by a significant increase in all amino acids compared to the control, including essential. In particular, the content of valine, isoleucine, leucine and lysine increased approximately 2 times. The content of threonine and tryptophan increased by 2.6 and 2.8 times, respectively. The content of methionine and phenylalanine increased by more than 1.5 times compared to the control sample. A decrease in the content of arginine and glutamic acid was noted. The ratio between amino acids has

changed, which is explained by the presence of proteins of plant origin only in the composition of the sauce.

Table 3. Amino acid composition of proteins of «AQUAFABA» mayonnaise sauce compared to the control

Amino acid	Control	Sauce «AQUAFABA»	Deviation, %
<i>Essential:</i>			
Valin	93	187	101,08
Isoleucine	90	192	113,33
Leucine	137	316	130,66
Lysine	115	273	137,39
Methionine	42	64	52,38
Threonine	82	217	164,63
Tryptophan	20	55	175,00
Phenylalanine	69	110	59,42
<i>Substitute:</i>			
Alanine	84	161	91,67
Arginine	115	104	-9,57
Aspartic acid	113	343	203,54
Histidine	38	64	68,42
Glycine	50	77	54,00
Glutamic acid	203	66	-67,49
Proline	69	209	202,90
Serin	136	167	22,79
Tyrosine	69	98	42,03
Cystine	28	67	139,29

Mayonnaise sauce is characterized by an increased content of vitamins C, A and group B, P (bioflavonoids); of minerals – K, Ca, Mg, P. The use of aquafaba, which is a solution of high-molecular compounds of legumes, contributed to the appearance of vitamins B<sub>5</sub>, B<sub>9</sub>, B<sub>12</sub> and E in the sauce.

According to our calculations, 100 g of mayonnaise sauce contains about 400 mg of flavonol quercetin due to its introduction into the recipe with porous starch. Given the recommendation to consume 500 to 1,000 mg of quercetin per day for preventive purposes, eating a low-calorie mayonnaise sauce will help ensure the daily need for this vitamin.

Resistant starch is classified as a new type of dietary fiber. Its presence gives products new functional properties: increasing the feeling of satiety, suppressing hunger, which prevents excessive food consumption and reduces the risk of obesity

The obtained data confirm that the use of aquafaba and porous starch with quercetin in the base of emulsion sauces contributes to the enrichment of the final product with vegetable proteins, essential amino acids, carbohydrates, vitamins and mineral elements.

Emulsion sauce based on MRK and aquafaba has an attractive appearance, improved color compared to control samples, balanced taste and aroma indicators, uniform consistency (Table 4).

Table 4. Organoleptic characteristics of «Aquafaba» emulsion sauce

Organoleptic indicators			
Appearance	Color	Taste and smell	Consistence
A thick, structured low-flowing mass, without flouriness and sediment, without delamination	The light cream color is uniform over the entire mass, the surface is glossy	Clean, without extraneous odors, without pronounced smell, sour-salty taste, without extraneous flavors	Uniform consistency, without delamination, without crystallization centers

The organoleptic profile of the emulsion sauce "AQUAFABA" and the control sauce «Mayonnaise - 67%» is presented in Fig. 5.

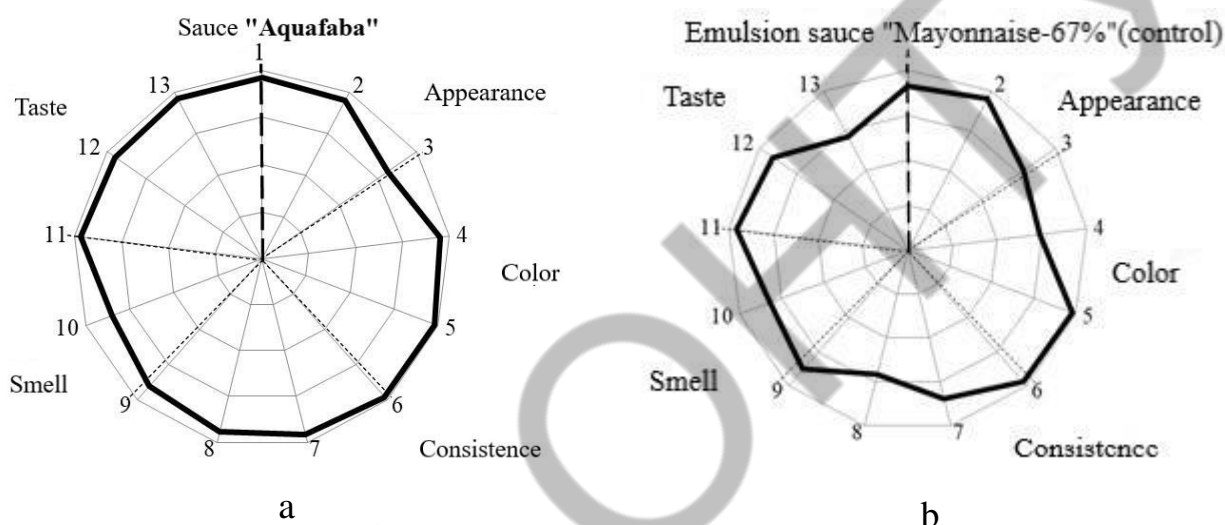


Fig. 5. Organoleptic profile: a – «AQUAFABA» sauce (S=5.24),  
b – control (S=4.87)

From the analysis of profilograms (Fig. 5), it can be seen that the set of defining characteristics of organoleptic indicators is more balanced in the low-calorie mayonnaise sauce according to the developed technology compared to the control.

## V. CONCLUSIONS

Based on the results of the research, a resource-saving technology of low-calorie mayonnaise sauce of increased nutritional and biological value was developed with the replacement of egg whites with aquafaba - a decoction of white beans and with the addition of resistant porous starch with quercetin. The perspective of using aquafaba and modified starch to regulate the emulsifying and stabilizing properties of the sauce has been proven. The rational ratio of aquafaba and vegetable oil as (40...60) : 40 is substantiated, which makes it possible to obtain emulsion systems with a stability of  $97\pm 2\%$ .

The formulation of emulsion low-lactose sauce «AQUAFABA» was developed, its chemical composition and energy value were determined.

The developed mayonnaise sauce is characterized by an increased content of proteins and minerals compared to the control. The amount of carbohydrates increased

by almost 6 times due to the use of white bean decoction (aquafaba) and porous starch with quercetin. Fat content and energy value, on the contrary, decreased due to a decrease in oil content.

An organoleptic evaluation of the quality of the developed sauce was carried out and it was established that the set of defining characteristics of organoleptic indicators is more balanced in the «AQUAFABA» emulsion sauce compared to the control.

The social effect of the introduction of the developed technology of low-calorie mayonnaise sauce consists in providing the population with a product of daily use of increased nutritional and biological value. This product will be of interest to vegetarians who do not eat food prepared from animal raw materials.

## VI. REFERENCES

1. Aquafaba, what is its chemical composition? (2018). Retrieved from <https://frikaker.wordpress.com/2018/05/27/aquafaba-what-is-its-chemical-composition/>.
2. Avramenko, A.D., Hrabovska, O.V. (2021). *Testing cryomodified starch for resistance to enzymes*, Materials of the 10th All-Ukrainian scientific and practical conference, «Innovative technologies in the hotel and restaurant business». Kyiv: NUHT.
3. Avramenko, A., Hrabovska, O. (2022). *Dietary supplements based on resistant porous starch*, Materials of the 1st international scientific and practical conference «Actual problems of chemistry and chemical technology». Kyiv: NUHT.
4. Avramenko, A., Hrabovska, O. (2021). *Production of porous starch and its use in the food industry*, International scientific conference of young scientist and students «Youth scientific achievements to the 21st century nutrition problem solution». Kyiv: NUHT.
5. Alsalman, F. B., Tulbek, M., Nickerson, M., Ramaswamy, H. S. (2020). Evaluation and optimization of functional and antinutritional properties of aquafaba. *Legume Science*, 30, 1-16. doi:10.1002/leg3.30.
6. Babenko, V. I., Bakhmach, V. O., Mank, V. V., Berdashkova, L. O. (2015). Patent of Ukraine 103236. Kyiv: National University of Food Technologies.
7. Buhl, T. F., Christensen, C. H., Hammershøj, M. (2019). Aquafaba as an egg white substitute in food foams and emulsions: Protein composition and functional behavior. *Food Hydrocolloids*, 96(8). doi:10.1016/j.foodhyd.2019.05.041.
8. Bon, E.M., Shemanska E.I. (2017). Patent of Ukraine 116507. Kyiv: National University of Food Technologies.
9. Choudhury, N., Meghwa, M., Das, K. (2021). Microencapsulation: An overview on concepts, methods, properties and applications in foods. *Food Frontiers*, 2, 426–442.
10. Correa-Filho, L.C., Moldao-Martins, M., Alves V.D. (2019). Advances in the Application of Microcapsules as Carriers of Functional Compounds for Food Products. *Applied Sciences*, 9(571), 1-18.
11. Hrabovska, O.V., Avramenko, A.D. (2020). *Encapsulation of biologically active substances in a polysaccharide matrix for the enrichment of food products*, Materials of the international conference «Quality and safety of food products and raw materials - today's problems». Lviv: Ed. «Raster-7».
12. Hrabovska, O.V., Avramenko, A.D. (2022) *Encapsulation technology for the protection of biologically active compounds from the influence of the external environment*, Abstracts of reports of the international scientific and practical internet conference «Actual problems and prospects for the development of the agro-food sector, the hospitality industry and trade». Kharkiv: State Biotechnological University.
13. Hrabovska, O.V., Fedorova, D.V., Hnitsevich, V.A., Darmina, A.D., Ovcharenko, O.R. (2021). Technology of emulsion-type sauces for special dietary consumption. *International independent scientific journal*, 1(26), 31-36.

14. Hrabovska, O.V., Fedorova, D.V., Hnitsevich, V.A, Darmina, A.D., Ovcharenko, O.R. (2022). Utility model patent № u 2022 03237. Kyiv: State university of trade and economics.
15. Hrabovska, O. V., Ovcharenko, O. R., Belmas, A. O. (2022). *The use of resistant starch in the technology of low-calorie mayonnaise sauce*, Materials of the II All-Ukrainian scientific and practical conference «Innovative and resource-saving technologies of food production». Poltava: PDAU.
16. Hrabovska O.V., Ovcharenko O.R., Belmas A.O. (2022). *Technology of low-calorie mayonnaise sauce for special dietary consumption*, International Scientific and Practical Internet Conference «Actual problems and prospects for the development of the agro-food sector, hospitality and trade industry». Kharkiv: DBTU.
17. Hrabovska, O.V., Yevdomaha, T.I., Darmina, A.D. (2021). *Technology of low-lactose functional purpose sauce*, Abstracts of XVI International Scientific and Practical Conference «Science and society, patterns and trends of development». Vienna: Austria.
18. Hnitsevich, V.A., Honchar, Yu.M., Eudomachus, T.I. (2019). Patent of Ukraine 136990. Kyiv: Kyiv national university of trade and economics.
19. Jeyakumari, A., Zynudheen, A.A., Parvathy, U. (2016). Microencapsulation of bioactive food ingredients and controlled release-a review. *MOJ Food Process Technol*, 2(6), 214–224.
20. Karpenko, P.O. (Ed.), Prytul'ska, N.V., Kravchenko, M.F. and others. (2019). *Health nutrition: study guide*. Kyiv: Kyiv. national trade and economy University.
21. Kravchenko, M.F., Fedorova, D.V., Mazaraki, A.A. (Ed.). (2018). *Sauces: a study guide*. Kyiv: Kyiv. National university of trade and economics.
22. Mayonnaise from aquafaba. Recovered from <https://1000.menu/cooking/35243-maionez-iz-akvafaby>.
23. Mustafa, R., He, Y., Shim, Y. Y., Reaney, M. J. T. (2018). Aquafaba, wastewater from chickpea canning, functions as an egg replacer in sponge cake. *International Journal of Food Science & Technology*, 53(10), 2247-2255.
24. Mustafa, R., Reaney, M. J. T. (2019). Aquafaba, from Food Waste to a Value-Added Product. *Food Wastes and By-products*. Retrieved from <https://doi.org/10.1002/9781119534167.ch4>.
25. Ovcharenko, O.R. (2021). *Aquafaba is a complete substitute for animal protein*, Materials of the VII all-Ukrainian student scientific conference «Hotel-restaurant and tourism business: realities and prospects». Kyiv: KNTEU.
26. Shim, Y. Y., Mustafa, R., Shen, J., Ratanapariyanuch, K., Reaney, M. J. T. (2018). Composition and Properties of Aquafaba: Water Recovered from Commercially Canned Chickpeas. *Journal of Visualized Experiments*, 132. doi: 10.3791/56305.
27. The Official Aquafaba Website. (2016). Retrieved from <http://aquafaba.com/>
28. Valle, M. (2015). «Aquafaba»: chickpea brine is a surprisingly egg-cellent baking substitute. *The Guardian*. Retrieved from <https://www.theguardian.com/lifeandstyle/2015/sep/29/aquafaba-chickpea-liquid-baking-egg-white-substitute>.

## TABLE OF CONTENTS

<b>1. FOOD SCIENCE AND TECHNOLOGIES.....</b>	<b>5</b>
IMPROVEMENT OF THE TECHNOLOGY OF MEAT PASTRY SEMI-FINISHED PRODUCTS USING GLUTEN-FREE VEGETABLE RAW MATERIALS Author: Serhii Chernyshov Advisors: Anna Helikh, Nataliia Bolhova Sumy National Agrarian University (Ukraine).....	6
THE EFFECT OF DIFFERENT STORAGE TEMPERATURES AND LIGHT EXPOSURE ON CAROTENOID STABILITY OF MARIGOLD FLOWERS (Tagetes erecta L.) Author: Sara Kolar Advisor: Kristina Kljak Faculty of Agriculture, University of Zagreb (Croatia).....	15
STANDARTIZATION OF RADIATION-TREATED POULTRY MEAT Author: Gulzhan Kurtibayeva <sup>1</sup> Advisor: Danko Igor <sup>2</sup> , Uazhanova Raushangul <sup>1</sup> <sup>1</sup> Almaty Technological University (Kazakhstan) <sup>2</sup> Institute of Nuclear Physics (Kazakhstan).....	28
TECHNOLOGY OF LOW-CALORIE MAYONNAISE SAUCE OF INCREASED NUTRITIONAL AND BIOLOGICAL VALUE Authors: Oleksandr Ovcharenko, Alina Belmas Advisor: Olena Hrabovska State University of Trade and Economics (Ukraine).....	50
SCIENTIFIC AND PRACTICAL FUNDAMENTALS OF PRODUCTION COMPOUND FEEDS FOR DECORATIVE AND SINGING BIRDS Author: Tetiana Pashchenko Advisor: Tetiana Bordun Odesa National University of Technology (Ukraine).....	65
PRODUCTION TECHNOLOGY OF "BORODINSKY" BREAD IN THE TERMS OF "TERNOVSKY HLIBSAVOD" LLC Authors: Diana Pogrebnyak, Nika Shishkina Advisors: Natalya Shevchuk, Olena Petrova Mykolaiv National Agrarian University (Ukraine).....	80
SEMI-FINISHED PRODUCT TECHNOLOGY FOR FROZEN DESSERTS Authors: Yaroslav Shelenkov, Oleksiy Haydaienko Advisor: Alina Slashcheva Donetsk National University of Economics and Trade named after Mykhailo Tugan-Baranovsky (Ukraine).....	94
DEVELOPMENT OF THE TECHNOLOGY OF SAUSAGE PRODUCTS FROM AFRICAN CATFISH Author: Tetiana Tryhuba Advisor: Alina Menchynska National University of Life and Environmental Sciences of Ukraine (Ukraine).....	108