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USING KOMBUCHA, CHIA SEEDS, AND PUMPKIN TO MAKE SMOOTHIES FOR RESTAURANT ESTABLISHMENTS

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Abstract

The article contains the research results in developing a smoothie recipe as a health drink with characteristic organoleptic properties. We used kombucha, pumpkin, and non-traditional raw material – chia seeds. Kombucha was prepared by fermenting the tea wort with a deposited culture of microorganisms *Medusomyces gisevii* DP-21. Turmeric was used to enrich the drink with beta-carotene. Chia seeds and pumpkin were used to give the drink an original appearance and structure and increase its biological value. The metabolic scheme of *Medusomyces gisevii* culture is given. The products of its metabolism, in particular microbiological cellulose, were characterized. The general indicators of chia seeds, particularly the chemical composition, were determined. The scheme of gel formation by chia seeds and water-holding capacity are given. Physico-chemical indicators of pumpkin and its use in smoothies in fresh, balanced, and baked form are given. The selection of components for the preparation of smoothies was carried out, considering the consumption of taste descriptors. The organoleptic profile of the smoothie was determined, and the optimal ratios of ingredients were: kombucha – 35 %, chia seeds – 10 %, turmeric – 1 %, and pumpkin – 54 %. The sensory analysis results for color, appearance, smell, taste, and consistency are given. As a result of the conducted research, a drink recipe was developed, and the perspective of using kombucha as a basis for preparing smoothies, as well as chia seeds, turmeric, and baked pumpkin, was proven, which ensures obtaining a qualitatively new food product in restaurants establishments.

Keywords: smoothies; fermented drinks; kombucha; chia seeds; pumpkin; organoleptic indicators, *restaurant establishments.*

ВИКОРИСТАННЯ КОМБУЧІ, НАСІННЯ ЧІА ТА ГАРБУЗА ДЛЯ ПРИГОТУВАННЯ СМУЗІ В ЗАКЛАДАХ РЕСТОРАННОГО ГОСПОДАРСТВА

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Анотація

Стаття містить результати досліджень у розробці рецептури смузі як оздоровчого напою з характерними органолептичними властивостями. Використовували комбучу, гарбуз та нетрадиційну сировину – насіння чіа. Комбучу готували шляхом ферментації чайного сусла депонованою культурою мікроорганізмів *Medusomyces gisevii* DP-21. Для збагачення напою бета-каротином використано куркуму. Насіння чіа та гарбуз використано для надання напою оригінального зовнішнього вигляду, структури напою та підвищення його біологічної цінності. Наведено схему метаболізму культури *Medusomyces gisevii.* Охарактеризовано продукти її метаболізму, зокрема мікробіологічної целюлози. Визначені загальні показники насіння чіа, зокрема хімічний склад. Наведено схему утворення гелю насінням чіа, визначена водоутримувальна здатність та встановлений оптимальний гідромодуль 1 : 10. Наведені фізико-хімічні показники гарбуза та його використання в смузі в свіжому, баланшованому та запеченому вигляді. Підбір компонентів для приготування смузі проводили з урахуванням поєднання смакових дескрипторів. Визначений органолептичний профіль смузі, оптимальні співвідношення складових: комбуча – 35 %, насіння чіа – 10 %, куркума – 1 % та гарбуз – 54 %. Наведено результати сенсорного аналізу за кольором, зовнішнім виглядом, запахом, смаком та консистенцією. В результаті проведених досліджень розроблено рецептуру напою, доведена перспективність використання комбучі як основи для приготування смузі, а також насіння чіа, куркуми та запеченого гарбуза, що забезпечує отримання якісно нового харчового продукту в закладах ресторанної гостинності.

Ключові слова: смузі; ферментовані напої; комбуча; насіння чіа; гарбуз; органолептичні показники; заклади ресторанного господарства.

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Introduction

The issue of food safety is closely related to the problems of the optimal content and ratio of biologically active substances (carbohydrates, lipids, proteins, nucleic acids, vitamins, organic acids, enzymes, macro- and microelements, etc.), which positively affect physiological processes in the human body [1].

For complete nutrition, products must contain more than 600 groups of nutrients from over 20 thousand compounds of plant, animal, and microbiological origin. There are no food products with such compatibility of components. Therefore, only a combination of different nutrients in the diet provides the body with the necessary components. Nutritional disorders lead to a decrease in the body's resistance to infections and a decrease in immunity. Therefore, a person's diet must ensure adequacy to the body's needs and ensure physiological needs [1; 2].

According to the WHO, human health depends on lifestyle by 68–74 %, and nutrition is one of the most essential components [3]. Studies from different countries of the world indicate a significant change in the structure of modern human nutrition. The diet is known to be dominated by dense food containing carbohydrates, lipids, and salts [4; 5]. An increase in their amount in the human body leads to metabolic disorders and the functioning of the body as a whole.

Monitoring nutritional status indicates its inconsistency with the concept of balanced nutrition and is characterized by a deficiency of amino acids, vitamins, and micronutrients [6; 7]. In recent years, a new view of food as a means of preventing and treating diseases has been formulated since insufficient consumption of essential food nutrients has a negative effect on human health, reduces physical and mental activity and resistance to diseases, and enhances the negative effect of environmental factors [8].

Among the existing groups of food products with increased nutritional and biological value, non-alcoholic beverages play a significant role in creating new products. In developed countries, drinks dominate food products due to their convenient and natural consumption and enrichment of the human body with essential nutrients [9].

Promisingly in terms of providing the body with biologically active substances are smoothies prepared from fresh, frozen, dried fruits, vegetables, and berries, as well as spices, bran, cereals, dairy products, etc.

Smoothie preparation in hotel and restaurant establishments and at home is usually not standardized. Such drinks are prepared mainly on the basis of flavor without considering the specifics of the interaction of ingredients with each other.

It is important to find non-traditional, multifunctional raw materials that expand the range and increase the finished product's biological value. Such raw materials for preparing smoothies in restaurant establishments can be fermented drinks, pumpkin, and chia seeds.

Recently, fermented drinks, particularly kombucha [10], have been in significant consumer demand. They are the most promising in functional nutrition in terms of their medical and biological effects on the human body. The fermented drinks technology is based on using plant raw materials and cultures of microorganisms. In the process of their vital activity, a complex of valuable and useful biologically active substances (organic acids, amino acids, vitamins, enzymes, etc.) is formed. Fermented drinks have a high biological value due to the natural balance of the content of biologically active substances [2].

In the market of non-alcoholic fermented drinks, the most promising is kombucha, which has high organoleptic properties and can be widely used in health food. Currently, kombucha is the fastest-growing and one of the most popular fermented beverages in the world market for functional beverages. Owing to consumer demand for healthy drinks, the global kombucha market was 1.5 billion US dollars in 2018 (from 2014 to 2018, the annual growth rate was 23 %). In 2019, it grew to 1.67 billion, and in 2020 – to 2.2 billion, and by 2025 it is projected to reach 3.5–5.0 billion US dollars.

It should be noted that the current trend among consumers is superfoods of predominantly plant origin, the content of valuable substances that should be predominant. Using vegetables, roots, seeds, nuts, leafy greens, etc., can expand the range of such products. In smoothie technologies, pumpkin and chia seeds are used as a type of superfood.

Pumpkin belongs to vegetable and gourd crops and is used in nutrition. Its fruit and seeds are of great importance and, due to the content of pectin substances, carotene, vitamins B_1, B_2, B_5, B_6, E, PP, K, T, minerals, carotene, carbohydrates, dietary fibre, contribute to therapeutic and preventive nutrition. The components of pumpkin reduce the risk of cardiovascular, oncological and gastrointestinal diseases [11].

Pumpkin is widespread in Ukraine, unpretentious and well stored for a long time. Therefore, the use of pumpkin in beverage technologies is justified because of the biologically active content of the substance and the possibility of its use in different regions of Ukraine.

Chia seeds are edible seeds of Spanish sage cultivated in Central American countries. In chia seeds, a significant amount of carbohydrates is represented by dietary fibre, which normalizes peristalsis. It contains omega-3 and omega-6 polyunsaturated fatty acids [12–14]. Chia seeds prevent the formation of cholesterol deposits, are used to prevent atherosclerosis, regulate blood sugar levels, have a beneficial effect on the nervous system, normalize blood pressure, strengthen immunity, normalize the microflora of the gastrointestinal tract [15–19].

The aim of the research study was to determine the optimal ratios of smoothie components using kombucha, pumpkin and chia seeds.

To achieve this goal, rational ratios in the technologies of smoothies based on kombucha, pumpkin, and chia drinks were determined, as well as the organoleptic profile of the drink.

In developing recipes for multi-component food products, the principles of food combinatorics were followed in the studies, and the possibility of chemical interaction of ingredients was considered. Combinations and methods of introducing and processing raw materials were chosen to ensure the efficiency of technological processes.

Materials and methods

Drinking water was used in the studies according to DSanPiN 2.2.4-171-10, tea leaves according to DSTU 7174:2010, sugar according to DSTU 4623-2006, pumpkin according to DSTU 3190-95, chia seeds according to TU 9164-002-24003345-2014. The finished drink was investigated for compliance with the requirements of DSTU 4069:2016. Standardized methods were used in the research process. The main physicochemical and organoleptic indicators were determined in the raw materials, semi-finished products, and drinks. Sensory evaluation was determined using the method of DSTU ISO 6564:2005 «Sensory analysis. Methodology. Methods of creating a flavour spectrum».

The chemical composition of chia seeds was determined by chromatographic and spectrophotometric methods. The following methods were used to determine the indicators:

– mass fraction of soluble solids – by refractometric method of DSTU ISO 2173:2007;

– active acidity (pH) – by potentiometric method of DSTU EN 1132:2005;

– mass fraction of titrated acids (calculated as malic or citric acid) – by volumetric titration method of DSTU EN 12147-2003;

– total phenolic content – Folin–Ciocalteu method (gallic acid equivalents) of DSTU 3845-99;

– vitamin C content – by iodometric method;

– pectin content – by Ca-pectate method.

Kombucha was made from the wort obtained by brewing tea, which was set in an amount of 1% and dissolved in an aqueous solution of sugar at a temperature of 95–100 ^{0}C with subsequent cooling. The fermentation process was carried out using a deposited culture of *Medusomyces Gisevii* DP-21 after cultivation for 14 days at a temperature of 25 ^{0}C. The fermentation process was completed when the drink's acidity reached 3.5...4.5 cm^3 of NaOH solution with a concentration of 1 mol/dm^3 per 100 cm^3 of wort.

In the research, crushed fresh, blanched and baked pumpkin was used, followed by its grinding. Chia seeds were used after infusing them in a kombucha solution.

The organoleptic characteristics of the drink were determined by appearance, colour, taste, consistency and aroma.

Results and discussion

To prepare the smoothie, we used kombucha, chia seeds, and fresh pumpkin, both native and after heat treatment.

Kombucha has antioxidant, anticarcinogenic, anti-inflammatory, antidiabetic and antibacterial properties [20; 21]. This drink restores the structure of cells, which positively affects human well-being. It tones, gives vigour, relieves fatigue, headache and nervous tension, and has a probiotic effect. The drink contains carbohydrates and organic acids, mainly acetic, gluconic, oxalic, citric, malic, lactic, pyruvic, ascorbic acids, and vitamins of group B. Chia seeds can give the finished product an original appearance and increase its energy and biological value. Pumpkin can increase biological value and provide the necessary texture and specific organoleptic properties due to pectin substances and carotenoids. Combining kombucha with chia seeds and pumpkin in smoothies allows such products to be highly commercialized in restaurant establishments and expands its range. Combining kombucha with chia seeds and pumpkin in smoothies allows such products to be

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highly commercialized in restaurant settings and expands their range. At the same time, chefs can combine such a product with many other dishes and drinks.

Fig. 1 shows the metabolism of *Medusomyces gisevii* («tea fungus»), which illustrates the hydrolysis of sucrose to glucose and fructose with the participation of yeasts, mainly of the genus *Saccharomyces*. The fermentation process occurs with the formation of ethyl alcohol and subsequent oxidation by *Acetobacter* bacteria to acetic acid [21–23].

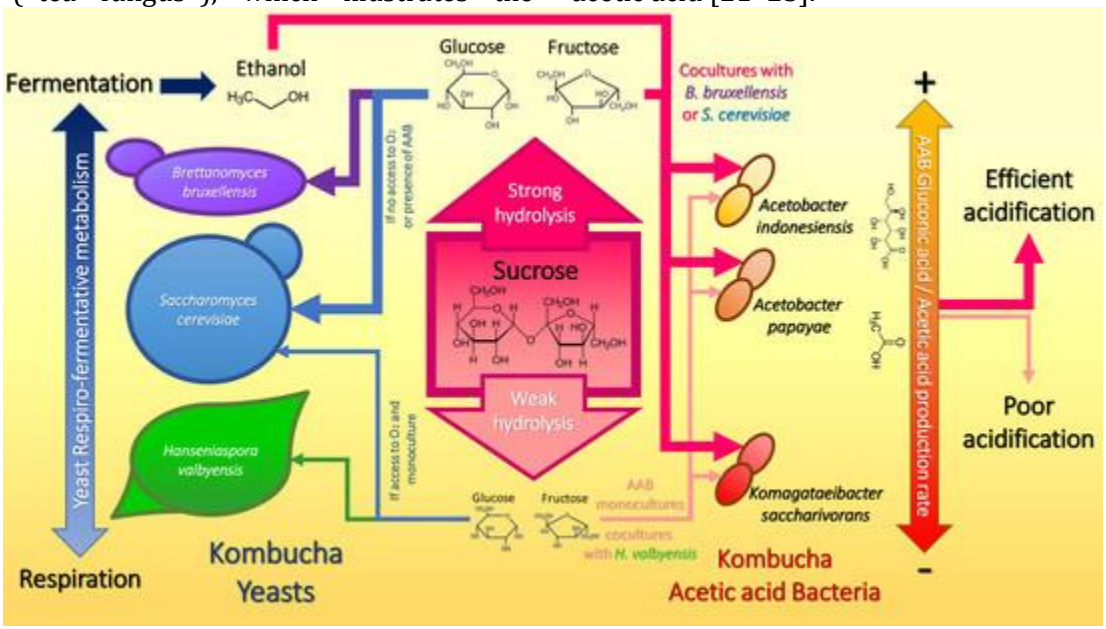

Fig. 1. Metabolism scheme of *Medusomyces gisevii* culture

Medusomyces gisevii culture contains yeasts of various species and bacteria that produce end products of metabolism and biomass of microorganisms. At the beginning of the fermentation process, the yeast invertase catalyzes the hydrolysis of sucrose to glucose and fructose. Then, alcoholic fermentation produces ethanol, carbon dioxide, secondary products and by-products. The alcoholic fermentation process is accompanied by lactic acid fermentation of sugars and the conversion of simple carbohydrates by bacteria to various organic compounds. Acetic acid bacteria convert ethyl alcohol into acetic acid and other metabolic products, generating microbial cellulose.

As a result of combined alcoholic, lactic, acetic fermentation and other polyfermentative processes of microbial cells, a fermented kombucha drink and biomass in the form of a microbial film are formed, which can be used in other productions.

The appearance of the *Medusomyces gisevii* culture is shown in Fig. 2.

Fig. 2. *Medusomyces gisevii* culture

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Bacterial cellulose, formed by the cultivation of *Medusomyces gisevii*, has the appearance of thin threads formed mainly on the drink's surface. It consists of microfibrils much smaller than plant cellulose, which causes a high surface area, increased water absorption, greater mechanical strength, biocompatibility, non-toxicity, and high porosity. This is the prerequisite for its use in food technologies and increasing biological value.

Fermented kombucha drink with a small amount of bacterial cellulose combined with other ingredients, particularly chia seeds, can be used as a thickener in smoothie technology.

Chia seeds were used to ensure the original properties of the smoothie. The indicators of the experimental sample of chia seeds are given in Tables 2, 3, and 4.

Table 2

General indicators of chia seeds

Indicator	Characteristic
Appearance, colour	A mixture of multi-coloured grains (white, grey, brown) with black spots, size – 1–2 mm
Taste	Clean with a pleasant nutty smell, without foreign odours, characteristic of this seed
Mass fraction of moisture, %	4.2
Carbohydrates, %	42
Proteins, %	19
Lipids, %	31
Acid value, mg KOH/g	0.45
pH	6.2
QMAFAnM, CFU/g	450
Moulds and yeasts, CFU/g	2

Chia seeds were found to have high nutritional and biological value, containing carbohydrates, proteins, and lipids.

Table 3

Chemical composition of chia seeds

Indicator	Content
Carbohydrates, %	
mono- and disaccharides	14.5
non-starch polysaccharides:	27.5
insoluble in water	22.0
soluble in water	5.5
Amino acids, mg/g protein	
Isoleucine	44.814
Leucine	80.666
Lysine	58.899
Methionine + cysteine	28.809
Phenylalanine + tyrosine	97.951
Threonine	42.894
Tryptophan	14.085
Valine	67.222
Vitamins, mg /100 g of seeds	
E	1.16
C	5.5
PP	6.73
B_1	0.45
B_2	0.08
B_6	0.11
B_9	0.15
Mineral elements, mg /100 g of seeds	
Calcium	536
Phosphorus	760
Potassium	565
Iron	6.7
Zinc	3.6
Selenium	0.055
Copper	1.4
Polyphenolic compounds, mg /100 g of seeds	132.4

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Table 4

Fatty acid composition of chia seeds

Fatty acids	Mass fracture	
	Content, g/100 g of seeds	Dry matter, %
Saturated (SFA)	3.12	10.15
Monounsaturated (MUFA)	2.23	7.25
Polyunsaturated (PUFA)	23.3	78.34

The data indicate that chia seeds are a source of carbohydrates, proteins and minerals. Non-starch polysaccharides mainly constituted the carbohydrates of the studied chia seed sample. The insoluble fraction contained cellulose and lignin, essential for ensuring the normal functioning of the human gastrointestinal tract. Soluble non-starch polysaccharides of chia seeds are represented by hemicellulose, pectin and mucous substances. Their physiological role is to normalize cholesterol metabolism, the ability to bind and remove heavy metals, radionuclides, etc., from the human body. Soluble non-starch polysaccharides have specific technological properties that determine their effect on food systems, exceptionally high hygroscopicity, and the ability to increase the viscosity of aqueous systems, which was subsequently considered when developing smoothie recipes.

The content of fatty acids in chia seeds was about 30 % and was represented by polyunsaturated (linoleic and linolenic), saturated (palmitic), and monounsaturated (oleic). The content of polyunsaturated acids with plastic and regulatory functions in the body was: linolenic (ω-3 acid) – 59.51 %, linoleic (ω-6 acid) – 18.83 %. It was considered that raw materials with polyunsaturated fatty acids are usually not used in non-alcoholic drink technologies. Therefore, the application of chia seeds allowed to increase the health-improving effect of the smoothie.

The appearance of the smoothie is crucial in terms of sales performance of the finished product Significant interest in chia seeds is due not only to their beneficial properties but also to the presence of functional and technological properties. The functional feature of chia seeds is their high hydrophilicity and ability to form viscous gels due to the polysaccharide composition characteristics. Gel formation occurs due to the swelling of mucous substances in water, which contain fibrous components of 18–45 nm, stretching and connecting to form nano-sized three-dimensional networks (Fig. 3). Therefore, chia seeds swell in aqueous solutions and give the drink an original appearance and attract the consumer. Hydrophilic complexes of mucous substances retain water molecules in the cells of the formed network, creating a «freezing» effect and forming a gel. Therefore, using chia seeds increases the biological value of the smoothie and gives the finished product an original appearance.

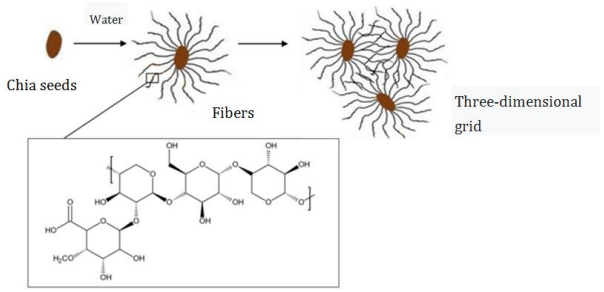

Fig. 3. Scheme of chia seed gel formation

The working suspension of chia seeds for the smoothie was prepared by mixing drinking water and seeds at a hydromodule of 1 : 1 to 1 : 20. Hydration was carried out at 25 ℃ for 20 min until a gel-like mixture was obtained with the required consistency of the smoothie. The water-holding capacity of chia seeds of the experimental sample is given in Table 5.

Table 5

Water-holding capacity of chia seeds

Indicator	Hydromodule				
	1 : 1	1 : 5	1 : 10	1 : 15	1 : 20
Water-holding capacity, %	180	540	970	970	975

The water-holding capacity increased with the increase in the hydromodule. Thus, with a hydromodule of 1 : 1, it increased by 80 %. With a hydromodule of 1 : 20, the increase was 5.4 times compared to a hydromodule of 1 : 1. After a hydromodule of 1 : 10, this indicator practically

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did not change. Therefore, the optimal ratio of chia seeds to water for preparing a working suspension for making smoothies was chosen as 1 : 10. In studies, in order to increase the biological value of the finished product, water was replaced with kombucha.

According to microbiological indicators of chia seeds, the number of mesophilic aerobic and facultative anaerobic microorganisms did not exceed the maximum permissible values. Pathogenic microorganisms, including *Salmonella, E. coli* and *S. aureus*, were not detected, ensuring the raw material's microbiological safety and, consequently, the finished drink.

Fresh, blanched and baked pumpkin was used in the smoothie preparation. The physical and chemical indicators of the studied samples are given in Table. 5.

Table 5

Physical and chemical characteristics of pumpkin

Indicator	Pumpkin sample		
	Fresh (1)	Blanched (2)	Baked (3)
Mass fraction of dry matter, %	6.5	7.9	8.2
Mass fraction of pectic substances, %	0.44	0.44	0.56
Mass concentration, mg/100g			
L-ascorbic acid	7.5	5.03	2.67
Carotenoids	4.52	5.75	5.34
β- carotene	4.15	4.41	3.85

The mass fraction of dry matter, pectin substances, carotenoids, and β-carotene content did not change significantly in drinks using fresh, blanched and baked pumpkin. A decrease in the content of L-ascorbic acid was observed. However, according to organoleptic perception, baked pumpkin (sample 3) was perceived as the most acceptable.

The selection of ingredients for the experimental samples of the smoothie was carried out, taking into account the consumption of taste descriptors. Turmeric has high antioxidant properties and was added to the recipe to give the product the high taste and aroma properties.

Fig. 4 shows the ratio of the smoothie components on the base of the fermented kombucha drink with bacterial cellulose using chia seeds, turmeric and various pumpkin samples.

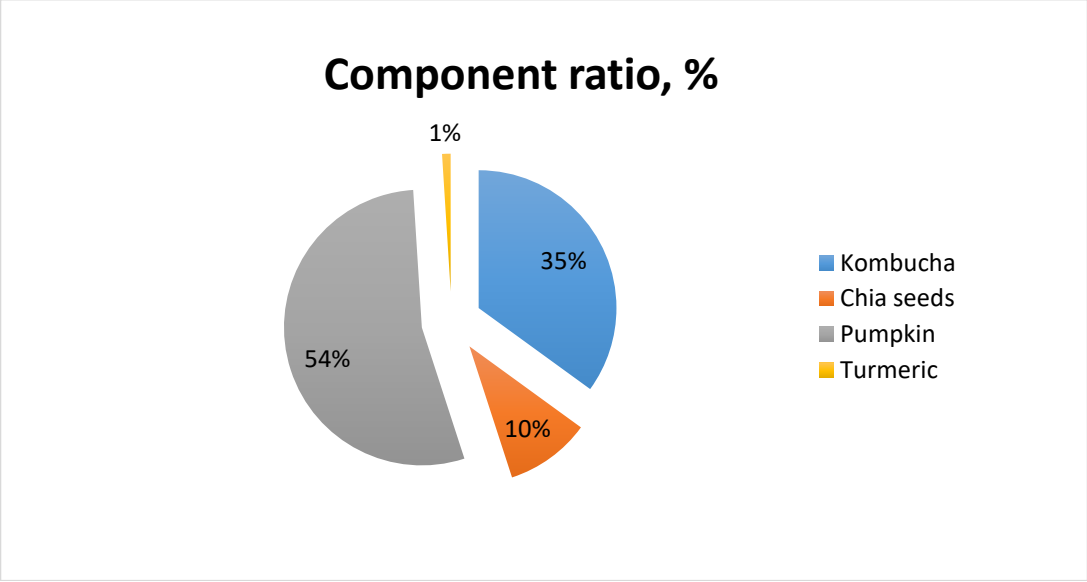

Fig. 4. Optimal ratio of smoothie ingredients

Fig. 5 shows the organoleptic profile of the smoothie using the specified ingredients in the optimal organoleptic ratios using fresh (sample 1), blanched (sample 2) and baked (sample 3) pumpkin.

Fig. 5. Organoleptic profile of the smoothie

It was found that sample 2 had the best performance in terms of appearance, aroma and consistency.

Therefore, according to organoleptic indicators and the content of biologically active substances in smoothie technologies, fermented kombucha drink, chia seeds, turmeric, and baked pumpkin are recommended as bases.

Conclusions

1. Morphological characteristics of *Medusomyces gisevii* culture for obtaining smoothies are presented.

2. Using chia seeds in smoothie technologies is recommended to expand the range of finished products with a high content of biologically active substances.

3. Baked pumpkin is recommended to expand the range of smoothies with original taste and aroma properties.

4. A recipe for a non-alcoholic smoothie drink with a health-promoting effect using fermented kombucha, chia seeds, pumpkin and turmeric is developed.

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