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DEVISING A RECIPE FOR A FUNCTIONAL MILK DRINK BASED ON MORINGA POWDER

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The object of this study is a technique for producing functional instant drinks based on powdered milk and a mixture of plant raw materials. Moringa powder was used as the main functional plant component, which contains biologically active components but has the least desirable sensory properties. It was proposed to hide the herbal taste and smell of moringa with mint and citrus powders. The results of the organoleptic evaluation of the experimental samples showed that the introduction of mint and lime powders into the recipe made it possible to obtain a sweet and sour drink (sample 1) with a pleasant aroma. This combination of flavors gives an additional refreshing effect. Due to the high content of dietary fiber (28 g/100 g), the appearance of the drink was rated at 6.1 ± 0.05 points out of seven. The energy value of this drink was 285.2 ± 0.05 kcal. It contained 17.8 ± 0.05 g/100 g of proteins, which provides 13–15% of the daily physiological needs of the body. Sample 2 with orange powder, which had a sweet and sour taste, was liked by consumers only for its smell. However, it contains 0.5% more proteins and 4.3% carbohydrates. Due to the high content of carbohydrates (36.2 g/100 g), its energy value is 304.4 ± 0.05 kcal. The drink with orange powder contains the largest amount of vitamin C (73.8 mg/100 g), which is 82–98% of the recommended daily intake. The content of vitamin C in the drink based on lime powder is 69.4 mg/100 g. Thus, the addition of mint and citrus powder made it possible to obtain drinks with acceptable sensory parameters, hiding the shortcomings caused by the use of moringa. Unlike similar products, their composition includes only natural ingredients. The results could become the basis for the industrial production of instant drinks.

Keywords: functional drinks, powdered milk, vegetable powders, vitamin C, energy value, citrus fruits

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1. Introduction

Functional foods are considered to be those products that, in addition to satisfying hunger and providing nutrients, create a positive physiological effect in the body.

The development of new functional drinks is a popular trend in the food industry, driven by the growing demand for healthier products. Due to the high concentrations of biologically active compounds, the market for functional drinks based on plant raw materials is one of the fastest growing. The main consumer motive for purchasing functional products is the promotion of a healthy lifestyle. This is due to the fact that their regular consumption can alleviate chronic diseases, improve overall well-being by increasing energy and strengthening the immune system.

Despite all the advantages of drinks, the use of high temperatures in the process of their manufacture tends to reduce their biological value since vitamins and phenolic compounds that are part of the raw materials from which functional drinks are made are thermolabile compounds. Therefore, the most acceptable and common form, due to its ease of preparation, storage stability, and balanced composition, is powder.

Functional beverages must fulfill two main functions: first, to have a balanced composition, and second, to provide acceptable sensory properties, such as good taste and texture. The category of functional beverages includes dairy drinks, sports and performance drinks, energy drinks, ready-to-drink teas, koumiss, "smart" drinks, fortified fruit drinks, plant-based milks, and fortified water [1]. It is also possible to combine several types of raw materials in one beverage, which could improve its functional properties. However, such a combination poses difficulties in maintaining the physical stability of the finished beverage, which leads to a deterioration in sensory perception. This problem is especially relevant when using herbaceous plants for the production of functional beverages since they contain a large amount of insoluble fiber.

The processing of herbal plants into functional beverages requires not only knowledge of the content of biologically active compounds but also their influence on the physicochemical properties of the finished product. Thus, research on the development of functional beverages based on a dry milk base and a mixture of plant raw materials is relevant.

2. Literature review and problem statement

In [2] it is shown that one of the most common exported food products is powdered milk. The results of the studies show that powdered milk is used not only for recombination or recovery for food purposes. It is also a raw material for the production of functional products due to its high biological value. Powdered milk contains a number of nutrients, including proteins, milk fat, a number of vitamins, and calcium [3]. However, not all powdered dairy products are interchangeable sources of high-quality protein. Depending on the technique of manufacturing a powdered dairy product, its amino acid composition changes. This variability determines the suitability for the direction of application. In particular, powdered dairy products with branched-chain amino acids (dry whole and dry skimmed milk) are suitable for the production of sports nutrition products [4]. Products with a low content of minerals (dry whey) – for infant formulas, in order to prevent excessive load on the kidneys with dissolved substances [5]. Low-lactose dairy powders (fermented dry drinks) are acceptable for lactose intolerant consumers. Therefore, when designing a formula for products based on dry dairy powders, it is necessary to consider who their potential consumers will be.

Some studies have been conducted on the bioavailability of biologically active substances in beverage systems based on cow's and plant milk [6]. The effectiveness of using plant raw materials containing a large amount of proteins [7] and vegetable powders as sources of carotenoids [8] in the production of functional dairy drinks has been studied. However, these drinks have a limited shelf life. Therefore, the production of instant drinks in the form of dry mixes is more appropriate.

The consumption of herbal beverages is also increasing. Herbal beverages contain a large amount of carotenoids, phenolic acids, flavonoids, coumarins, alkaloids, polyacetylenes, saponins, and terpenoids. These ingredients have been shown to have high antioxidant, antibacterial, antiviral, anti-inflammatory, antiallergic, antithrombotic, antimutagenic, anticarcinogenic, and anti-aging effects [1]. Over the past decade, food researchers have shown increasing interest in *Moringa oleifera* for the development of functional foods [9]. Numerous scientific studies have been conducted to confirm the positive effects of moringa on product enrichment and improvement of technological properties during production. The benefits of moringa for human health have been proven [10]. It has been shown that a drink made from moringa powder demonstrated the highest concentration of phenolic and flavonoid compounds, as well as a powerful antioxidant capacity [11]. However, such drinks have the least desirable sensory properties. Green color, herbal taste, bitterness, and the presence of sediment are considered unfavorable sensory characteristics.

Thus, the issues related to improving the sensory characteristics of moringa powder-based beverages and increasing their shelf life remain unresolved. An option to overcome these difficulties may be to devise a functional beverage based on dry plant components and dry milk raw materials. The organoleptic quality indicators of moringa-based beverages can be improved by using plant powders with good taste and aroma. This is the approach used in [12]. The herbal taste of a centella drink was masked by Hasi tangerine peel powder. However, the sensory acceptability, physicochemical properties, and antioxidant potential of the powder significantly deteriorated at higher temperatures (45 °C). Such a beverage was unstable during storage.

All this gives reason to argue that it is advisable to conduct a study aimed at devising a recipe for a soluble combined functional drink based on powdered milk, moringa powder, and citrus powder.

3. The aim and objectives of the study

The aim of our study is to devise a recipe for a combined functional drink based on powdered milk and a mixture of plant raw materials with acceptable consumer properties. Results to obtained could allow us to substantiate the feasibility of using moringa powder as a raw material in the production of instant drinks.

To achieve the goal, the following tasks were set:

– to analyze the organoleptic quality indicators of functional drinks based on powdered milk and a mixture of plant raw materials;

– to investigate the physicochemical indicators and energy value of functional drinks based on powdered milk and a mixture of plant raw materials;

– to determine the content of vitamin C in functional drinks based on powdered milk and a mixture of plant raw materials.

4. The study materials and methods

4. 1. The object and hypothesis of the study

The object of our study is a technique for manufacturing functional instant drinks based on powdered milk and a mixture of plant raw materials. The subject of the study is the organoleptic, physicochemical quality indicators of the drinks, as well as the content of vitamin C in them.

The hypothesis of our study assumes that a functional instant drink can be created based on moringa powder, which has a high biological value. Considering that moringa has unacceptable sensory properties for consumption, it is proposed to introduce citrus and mint powders into the recipe. It is assumed that this could improve the organoleptic quality indicators of moringa-based drinks. A balanced combination of dairy raw materials and plant powders would make it possible to obtain a product with high functional properties.

4. 2. Materials

A recipe for two experimental samples of instant drinks was developed (Table 1). The following recipe components were used: powdered milk with a fat content of 25% by SPD

Salyuk A.V. (Ukraine), moringa powder by Holistic Solutions s.r.o (Czech Republic), sublimated lime powder by TM Vestra Healthy (Ukraine), sublimated mint powder by TM Vestra Healthy (Ukraine), sublimated orange powder without peel by TM Vestra Healthy (Ukraine).

Table 1

Formulation of experimental beverage samples

Recipe ingredients, g	Sample 1	Sample 2	Functional action
Milk powder 25% fat	25	25	Source of fat, calcium
Moringa powder	25	25	Source of protein, fiber
Mint powder	25	25	Source of fiber, protein, improved organoleptic properties
Lime powder	25	–	Source of carbohydrates, vitamin C, improved organoleptic properties
Orange powder	–	25	
Total	100	100	–

The recipe components were thoroughly mixed. To prepare the drink, 100 g of the mixture was dissolved in 200 ml of boiling water, stirred until a homogeneous consistency was obtained. The temperature of the drink during tasting was 70–75°C.

As an analog, the energy drink for sports nutrition XS Pre-Workout Drink with lemon and lime flavor from TM Amway (USA) was used. The composition of the analog includes (according to the manufacturer): maltodextrin, citric acid, creatine monohydrate (9.8%), dextrose, fructose, L-leucine (7%), L-valine (3.7%), L-isoleucine (3.7%), salt, calcium carbonate, flavoring, trisodium citrate, palm oil, dye (E141), sweetener (sucralose), L-ascorbic acid, DL-alpha-tocopherol, nicotinamide, zinc oxide, calcium D-pantothenate, thiamine hydrochloride, riboflavin, pyridoxine hydrochloride, folic acid, cyanocobalamin.

4. 3. Investigating the organoleptic quality indicators of beverages based on powdered milk and a mixture of plant raw materials

Sensory evaluation was carried out by 10 untrained consumers. The evaluation criteria are given in Table 2.

Table 2

Criteria for organoleptic evaluation of beverage samples

Point	Estimate
0–1	Dislike very much
2	Dislike neutrally
3	Dislike somewhat
4	Like neutrally
5	Like moderately
6	Good, like somewhat
7	Very good, like

The descriptors of organoleptic evaluation were smell, color, taste (presence of bitterness, astringency), appearance, and consistency.

4. 4. Investigating the physicochemical parameters and energy value of beverages based on powdered milk and a mixture of vegetable raw materials

The mass fraction of proteins was determined according to the standard methodology using combustion according to the Dumas principle (ISO 14891:2002).

The mass fraction of fats was determined by the nuclear magnetic resonance method (1H NMR). The mass fraction of dry substances was determined by the drying method, carbohydrates – as the difference between the content of dry substances and the remaining components.

The determination of dietary fiber was carried out using the enzymatic commercial kit Megazym (USA).

The energy value of beverages was calculated from the following formula

$$K = k_p \cdot (M_p + M_c) + k_f \cdot M_f, \quad (1)$$

where K – energy value, kcal; M_p – mass fraction of proteins, g/100 g; M_c – mass fraction of carbohydrates, g/100 g; M_f – mass fraction of fats, g/100 g; k_p – coefficient of energy value of 1 g of protein or 1 g of carbohydrates ($k_p = 4$), kcal/g; k_f – coefficient of energy value of 1 g of fat ($k_f = 9$), kcal/g.

To establish the nutritional value, a conversion was carried out (1 kcal = 4.184 kJ).

4. 5. Methodology for studying the content of vitamin C in drinks based on powdered milk and a mixture of plant raw materials

The content of vitamin C in drinks was determined by high-performance liquid chromatography (Agilent Technologies 1200, detector with UV-Vis Abs, $\lambda = 240$ and 300 nm). A C18 column (Zorbax SB-C18 4.6 × 150 mm, 5 µm) was used.

4. 6. Statistical analysis

Analysis of variance (ANOVA) with Fisher's least significant difference criterion was performed using the Statistics 13.1 software (USA). The lowest statistical significance was set at the level of $p < 0.05$.

5. Results of investigating the quality and nutritional value of functional drinks based on powdered milk and a mixture of plant raw materials

5. 1. Results of investigating the organoleptic indicators of functional drinks based on powdered milk and a mixture of plant raw materials

The results of the organoleptic assessment of the quality of drinks are given in Table 3.

Table 3

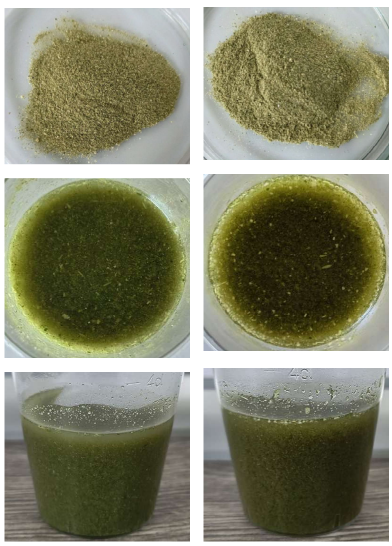
Organoleptic indicators of beverage quality. Uncertainty, U ($k = 2$, $P = 0.95$)

Name	Appearance	Consistency	Smell	Taste	Color
Analog	7.0 ± 0.05	7.0 ± 0.05	6.5 ± 0.05	6.8 ± 0.05	6.8 ± 0.05
Sample 1	6.1 ± 0.05	5.8 ± 0.05	6.8 ± 0.05	6.2 ± 0.05	6.1 ± 0.05
Sample 2	5.9 ± 0.05	5.6 ± 0.05	6.3 ± 0.05	5.9 ± 0.05	5.8 ± 0.05

The introduction of citrus and mint powders into the beverage formulation made it possible to improve their taste and smell. Most tasters noted that the smell of sample 1 (Fig. 1, *a*) was good (6.8 ± 0.05 points), better than the analog (6.5 ± 0.05 points). The aroma of mint and lime was felt, without a grassy smell. The taste of the drink was sweet and sour (6.2 ± 0.05 points), without bitterness and astringency.

In terms of appearance, sample 1 was approved with a rating of "good". It was noted that the color of the drink was acceptable, but the consistency was somewhat unpleasant since it contained a large amount of insoluble substances. Considering that the cause of sediment formation is the high fiber content, the tasters did not significantly reduce the ratings for appearance (6.1 ± 0.05 points).

Sample 2 (Fig. 1, *b*) was liked by consumers only by its smell as it had a mint aroma with a hint of orange. The sweet-sour taste of the drink was somewhat liked (6.9 ± 0.05 points). The tasters moderately liked the consistency (5.6 ± 0.05 points) and appearance (5.9 ± 0.05 points) of the drink due to the presence of sediment.



a *b*

Fig. 1. Drinks with moringa powder: *a* – sample 1; *b* – sample 2

It is worth noting that despite the imperfect appearance, none of the presented drinks were rated less than 5 points for any of the indicators. Although the industrial sample (analog) had an attractive appearance and consistency, it was noted that its taste and smell were not characteristic of natural products. A significant content of synthetic flavoring additives was felt.

5. 2. Results of investigating the physicochemical parameters and energy value of the developed functional drinks

To determine the energy value of the compound drink, an analysis of nutritional properties was conducted. The results are given in Table 4.

All recipe components of the experimental samples are natural, which positively affects their nutritional and energy value. The energy value of a drink based on powdered milk, moringa powder, lime, and mint (sample 1) is 285.2 ± 0.05 kcal. Due to the use of moringa, the mass fraction of proteins in drinks increases significantly. Sample 1 contains 17.8 ± 0.05 g/100 g of proteins, which provides 3–15% of the daily physiological needs of the body. Also, this sample contains 28 g/100 g of dietary fiber, which provides 100% of the daily needs of the body.

Sample 2, made on the basis of orange powder, contains 0.5% more proteins and 4.3% carbohydrates than sample 1. The mass fraction of fats in the moringa-based samples, due to the significant share (25%) of powdered milk in the recipe, is 9.6 ± 0.05 g/100 g.

It is worth noting that the analog contains only 0.4 ± 0.05 g/100 g of fats. Also, this sample contains the largest amount of carbohydrates (55.0 ± 0.05 g/100 g), which mainly form their energy value. The caloric content or energy value of the analog drink was only 935.5 kJ or 223.6 kcal. This drink was made with the addition of artificial flavors and sweeteners, stabilizers, and preservatives.

5. 3. Results of determining the C vitamin content in functional drinks based on powdered milk and a mixture of plant raw materials

It was found that samples made on a natural basis contain more vitamin C (Fig. 2).

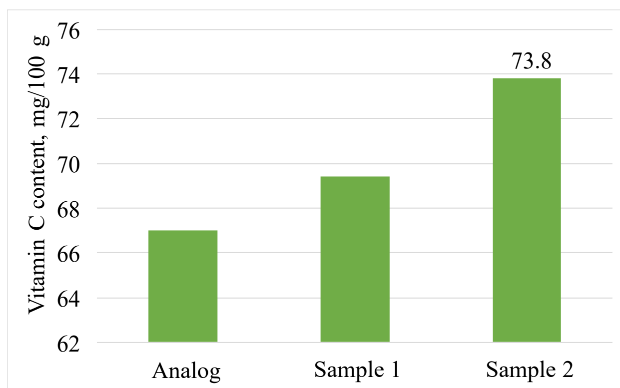


Fig. 2. Vitamin C content, mg/100 g

The daily norm of vitamin C for adults from 19 years of age is 75–90 mg. Thus, sample 1, which contains 69.4 mg/100 g of vitamin C, provides the daily requirement of the body by 77–93%.

Table 4

Physicochemical parameters and nutritional value of beverages. Uncertainty, *U* (*k* = 2, *P* = 0.95)

Name of indicators	Analog	Sample 1	Sample 2	Recommended daily intake, g
Mass fraction of proteins, g/100 g	–	17.8 ± 0.05	18.3 ± 0.05	118–132
% of daily intake	0	13–15	14–16	
Mass fraction of fats, g/100 g	0.4 ± 0.05	9.6 ± 0.05	9.6 ± 0.05	53–59
% of daily intake	0.7–0.8	16–18	16–18	
Mass fraction of carbohydrates, g/100 g	55.0 ± 0.05	31.9 ± 0.05	36.2 ± 0.05	182–202
% of daily intake	27–30	16–18	18–20	
Energy value, kcal	223.6 ± 0.05	285.2 ± 0.05	304.4 ± 0.05	1800–2800
kJ	935.5 ± 0.05	1193.3 ± 0.05	1273.6 ± 0.05	531–11715
% daily requirement	8–12	10–16	11–17	
Dietary fiber content, g/100 g	–	28.0	25.8	25–28
% of daily intake	–	100	100	

The drink with orange powder (sample 2) contains the largest amount of vitamin C (73.8 mg/100 g), which is 82–98% of the recommended daily intake.

Humans are unable to synthesize vitamin C endogenously, so it is an essential component of the diet. Vitamin C is also an important physiological antioxidant that regenerates other antioxidants in the body, including alpha-tocopherol. Therefore, high levels of vitamin C in beverages provide them with additional functional properties.

6. Discussion of results related to investigating the functional drinks based on powdered milk and a mixture of plant raw materials

The results given in Table 3 confirmed the hypothesis put forward. After a preliminary sensory evaluation, as demonstrated in Table 3, it turned out that the introduction of 25% of mint powder and 25% of lime powder into the formulation is more acceptable than another combination (orange and mint powder). It is noted that sample 1 (Fig. 1, *a*) had a better, compared to the analog and sample 2, smell (6.8 ± 0.05 points) and aroma of mint and lime. The taste of the drink was sweet and sour (6.2 ± 0.05 points), without bitterness and astringency. In sample 2, the sweet and sour taste of orange and the smell of mint dominated. The participants of the tasting noticed that adding mint gives the drinks a more pleasant and refreshing feeling. These results are consistent with previous studies [12]. However, this study showed that such a composition of raw materials does not make it possible to provide an excellent appearance of the drinks (Fig. 1, *a*, *b*). The tasters moderately liked the consistency of sample 1 (5.8 ± 0.05 points) and sample 2 (5.6 ± 0.05 points) due to the presence of sediment.

Potential consumers who had the opportunity to compare the organoleptic indicators of the experimental samples and the analog with a high content of food additives demonstrated a better perception of the drink based on natural raw materials. This indicates that consumers can develop a preference for drinks based on moringa powder. The high content of functional elements (dietary fiber, vitamin C) in the composition of the drink was acceptable for people who adhere to a healthier lifestyle.

The values of physicochemical indicators obtained during the analysis of drinks are given in Table 4, indicating an increase in their functional properties (samples 1, 2). The presence of moringa powder in the recipe allows to ensure a high protein content (12–16% of the daily requirement of the body). The high content of milk powder in the recipe (25%) contributes to an increase in the fat content, which in drinks with moringa is 9.6 ± 0.05 g/100 g. Due to the high carbohydrate content (31.9–36.2 g/100 g), which is typical for plant raw materials, the energy value of sample 1 was 285.2 ± 0.05, and sample 2 – 304.4 ± 0.05 kcal.

The functionality of the developed drinks (samples 1, 2) is confirmed by the high content of dietary fiber in their composition, which provides 100% of the daily requirement of the body. Most studies show that consumers prefer functional drinks that allow for weight control [13]. Consumption of products rich in fiber has a beneficial effect on health and body weight [14].

It was found that the samples made on a natural basis contain more vitamin C (Fig. 2). Considering that the daily intake of vitamin C for adults is 75–90 mg, drinks with moringa powder are functional. Sample 1, which contains 69.4 mg/100 g of vitamin C, provides the daily requirement of the body by 77–93%, and the drink with orange powder (sample 2) contains the largest amount of vitamin C (73.8 mg/100 g), which is 82–98% of the recommended norm. Vitamin C has low toxicity and does not cause serious side effects when consuming products containing it in large quantities.

Considering all our results, the formulation of sample 1, which contains moringa powder, milk powder, mint powder, and lime powder, is more acceptable.

The practical significance of this study is that the results could become the basis for the industrial production of functional instant drinks. It is worth noting that these drinks could become an important part of the diet of people during their stay in shelters and bomb shelters.

The limitations of our study include the fact that an industrial sample of drinks was used for comparison, which was radically different in composition from the experimental samples. In addition, when using powders from other manufacturers, data on the chemical composition of drinks may differ.

The disadvantage of the proposed recipe is too high a content of insoluble substances in the composition of drinks, which negatively affects their consistency.

Therefore, there is a need for further research aimed at improving the consistency of drinks with moringa.

7. Conclusions

1. Analysis of organoleptic quality indicators of functional drinks revealed that introducing citrus powders and mint powder into the recipe makes it possible to hide the sensory shortcomings of moringa. The recipe of sample 1 is the most attractive for consumers since the drink has good organoleptic indicators and functional properties.

2. Physicochemical analysis revealed that due to moringa powder, the drinks contain a sufficient amount of proteins (17–18 g/100 g). Milk powder saturates the drinks with healthy fats (9.6 g/100 g), mint powder enriches the drinks with dietary fiber (25–28 g/100 g), and citrus powders with vitamin C.

3. Introduction of lime powder into the recipe contributed to an increase in the content of vitamin C, which provides the daily requirement of the body by 77–93%. When consuming a drink with orange powder, the body's daily need for vitamin C is met by 82–98%.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study, as well as the results reported in this paper.

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Data availability

All data are available, either in numerical or graphical form, in the main text of the manuscript.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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