Evaluation of using herbal extracts in enriched beverages’ production

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Abstract. This study evaluates the possibility of developing a juice-containing beverage enriched with biologically active substances that allows solving the problems of insomnia. As a functional additive, herbal extracts prepared from herbal collection №2 and №3 of the company “Fitosedan” were used. Samples of juice-containing products based on orange juice and cranberry juice were prepared with a concentration of herbal extracts from 10 to 50% with the discreteness of adding 5% in each flavour range. Calculations were made for the compound of active substances in the functional drink at different concentrations of the added extract. It is shown that the daily rate of active substances in the broth is achieved at 62.5% compound of herbal extract in the prepared drink. Organoleptic evaluation of consumer properties of experimental samples was carried out. The results were assessed by the presence of bitterness and medicinal taste. Studies have shown that when the concentration of the functional ingredient is from 50% to 40% (with cranberry juice) and 35% (with orange juice), the taste is evaluated as bitter; with decreased concentration of functional additives and herbal collection from 25% to 15%, a decrease of the intensity of the bitterness is observed, and when the compound of functional ingredient is 10%, the bitter taste is not felt at all. When determining consumer preferences, the respondents gave the most positive ratings to samples of the drink with orange juice with a collection concentration of 20, 15 and 10% and cranberry juice with a collection concentration of 15 and 10%.

1. Introduction
One of the most relevant global problems nowadays is sleep disturbance, which leads to a decrease in the emotional sphere of life and, as a result, a decrease in human attention and efficiency. Medical statistics show that about 45% of adults suffer from various sleep disorders, and from 10 to 23% need medical care [1-4]. The all-world health organization suggests that by 2020, diseases of the nervous system and various mental disorders be included in the top five diseases that lead to disability. In the world, 16% of the population needs psychiatric care, while in Russia, their number exceeds 24% [5].

As noted by doctors, some causes of insomnia are:
The unfavourable environment in which a person goes to bed (noise, heat, cold, light, hard or soft bed);  
- The change of the lifestyle and place of life (travelling, moving to a new apartment);  
- Stressful situations at home and work;  
- Diseases that lead to pain, difficulty breathing, or frequent urination;  
- Anxiety;  
- Depression [1-4].

For combat insomnia, sedatives are used. They are meant to reduce emotional stress and allow relaxing the nervous system from various stresses. In this regard, the use of certain sedatives has become very relevant, since the modern pace of life does not allow a person relaxing on their own and overcome the growing stress completely. Sedatives can be of plant and chemical origin [6]. Sedatives moderately inhibit the work of the cerebral cortex, increasing the processes of inhibition in it. However, some medications are dispensed without a prescription, and if used correctly, do not cause harm. These include herbal sedative medications – herbal supplements that have a calming effect, which is recommended for the treatment of insomnia. It is mint, motherwort, Valerian, hawthorn, Melissa, St. John's wort, dill seeds. These plants help to get rid of anxiety, irritability, and make sleep more peaceful [1]. Currently, the possibility of using various ingredients with a high compound of biologically active substances (BAS) that can be used as a functional ingredient for a drink, is being considered.

The development of functional food products as an alternative to medicines is becoming increasingly popular. Soft drinks and juices enriched with micro-nutrients-vitamins, minerals, pre- and prebiotics, plant extracts, preparations based on phenolic compounds are among the most dynamically developing products in the segment of the Russian beverage market [4-9].

Fruit juices are considered to be one of the healthiest drinks, but people who care about their health want more. Marketing research has shown that consumers prefer new combinations of vegetables, fruits, and medicinal plants with additional beneficial properties [10].

One of the functional ingredients that allow creating drinks with a preventive focus on the treatment of insomnia is collections based on herbal extracts. Herbal extracts have an unpleasant, specific bitter taste. Adding broths from herbal extracts in various concentrations and using products with a high compound of sucrose, salt and/or lemon citric acid can mask the unpleasant taste of the functional additive.

The purpose of the current study was to investigate the possibility of creating functional beverages using functional food ingredients (collections of herbal extracts) based on juice products, as well as to determine the thresholds of taste and olfactory sensitivity and consumer preferences.

2. Research materials and methods
Orange juice and cranberry juice were used as the basis for functional drinks. The choice is justified by the chemical composition of the product, specifically the high compound of sugars, ascorbic acid, which allows masking the bitter taste of the functional drink, which is acquired by making broths of herbal extracts [9]. As a functional additive based on herbal extracts, medicinal herbal collections were used: Fitosedan herbal teas №2 and №3. The composition of a mixture of milled medicinal plant raw material (in the ratio, %):

- collection №2 – motherwort herbs 40, peppermint leaves and rhizomes with Valerian roots 15, liquorice roots 10, hop cones 20;
- collection №3 – rhizomes with Valerian roots 17, melon grass 8, thyme grass, oregano grass and motherwort grass 25.

Collections of herbal extracts were prepared according to the manufacturer's instructions: 200 ml of boiling water was added to 5 g of dry collection, the broth was closed with a lid and heated in a water bath for 15 minutes, then it was infused for 45 minutes, filtered and cooled to a temperature of +10°C. The resulting broth was brought to the initial volume (200 ml) and added to orange juice and cranberry juice with the calculation of the functional ingredient from 10 to 50% with the discreteness of 5%.
The resulting samples were packed in 250 ml bottles, depersonalized and encoded. The obtained experimental samples were assessed by organoleptic evaluation. 77 respondents aged 20 to 23 years participated in the research.

The results were taken into account in the tasting list for the following categories: descriptors for masking the medicinal smell (sweet smell; bitter smell; sour smell; fruit (berry) smell; medicinal herbs) and evaluation of consumer preferences (like it very much; like it; still; dislike it; very dislike it). The assessment was carried out according to the scoring system and % of respondents on a hedonic scale.

3. Results
Calculations were made for the compound of active substances in the functional drink at different concentrations of added broth (Table 1). The daily rate of active substances in the broth is achieved at 62.5% of the compound of herbal extract in the finished drink.

According to the technical regulations of the Customs Union "On food safety", the amount of the functional component must be at least 10%. In this regard, the concentrations of plant extracts were selected from 10% to 50% with the discreteness of 5% [11-12].

Table 1. Calculations of the compound of active substances in a functional drink

| Compound of the herbal collection | Consumption rate, g per day | Concentration of the active substance, % | 10  | 15  | 20  | 25  | 30  | 35  | 40  | 45  | 50  | 62.5 |
|-----------------------------------|-----------------------------|------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| Herbal extract «Collection №2»    |                             |                                          |     |     |     |     |     |     |     |     |     |      |
| motherwort grass                  | 1.25                        | 0.20                                     | 0.30| 0.40| 0.50| 0.60| 0.70| 0.80| 0.90| 1.00| 1.25 |
| mint leaves                       | 0.47                        | 0.07                                     | 0.11| 0.15| 0.18| 0.22| 0.26| 0.30| 0.33| 0.37| 0.46 |
| valerian root                     | 0.47                        | 0.07                                     | 0.11| 0.15| 0.18| 0.22| 0.26| 0.30| 0.33| 0.37| 0.46 |
| licorice root                     | 0.31                        | 0.05                                     | 0.07| 0.10| 0.12| 0.15| 0.17| 0.20| 0.22| 0.25| 0.31 |
| hop cones                         | 0.63                        | 0.10                                     | 0.15| 0.20| 0.25| 0.30| 0.35| 0.40| 0.45| 0.50| 0.62 |
| Herbal extract «Collection №3»    |                             |                                          |     |     |     |     |     |     |     |     |     |      |
| valerian root                     | 0.53                        | 0.08                                     | 0.12| 0.17| 0.21| 0.25| 0.29| 0.34| 0.38| 0.42| 0.52 |
| melilot grass                     | 0.25                        | 0.04                                     | 0.06| 0.08| 0.10| 0.12| 0.14| 0.16| 0.18| 0.20| 0.24 |
| thyme grass                       | 0.78                        | 0.12                                     | 0.18| 0.25| 0.31| 0.37| 0.43| 0.50| 0.56| 0.62| 0.77 |
| oregano grass                     | 0.78                        | 0.12                                     | 0.18| 0.25| 0.31| 0.37| 0.43| 0.50| 0.56| 0.62| 0.77 |
| motherwort grass                  | 0.78                        | 0.12                                     | 0.18| 0.25| 0.31| 0.37| 0.43| 0.50| 0.56| 0.62| 0.77 |

On the basis of the obtained data, the necessary volume of enriched juice-containing products is calculated for obtaining the daily rate of herbal extracts:
- At a concentration of 10-15% of active substances in 100 ml of the prepared drink, it is necessary to consume 500 ml;
- At a concentration of 25-30% of active substances in 100 ml of the prepared drink, it is necessary to use 200 ml;
- At a concentration of 63% of active substances in 100 ml of the prepared beverage, 100 ml must be consumed.

Preliminary studies have shown that the introduction of collection №3 in any concentrations is acceptable for organoleptic indicators. In this regard, further research was carried out using the collection №2. The results of the study are presented in Tables 2-4.

As can be seen from the data obtained, when the concentration of the functional ingredient is from 50% to 40% (with cranberry juice) and up to 35 % (orange juice), a bitter taste is felt. With a functional ingredient concentration of 30 and 35 %, a significant decrease in bitter taste was noted by 16 % when using orange juice and 14 % when using cranberry juice. With a decrease in the concentration of collection № 2 from 25% to 10%, there is an increase in masking the bitter taste. If the functional ingredient contains 10%, the bitter taste is not felt. After the unpleasant taste is no longer felt, the first taste was defined as sweet orange when using orange juice and sweet cranberry when using cranberry juice.
Table 2. Research of masking the bitter taste in experimental samples of orange juice and cranberry juice with the addition of herbal collection №2

| Orange juice | Cranberry juice |
|--------------|-----------------|
| № sample    | Amount of functional ingredient, % | % who did not feel the bitter taste of the total number of respondents | № sample | Amount of functional ingredient, % | % who did not feel the bitter taste of the total number of respondents |
| 165         | 50              | -                            | 201      | 50              | -                            |
| 276         | 45              | -                            | 216      | 45              | -                            |
| 119         | 40              | -                            | 017      | 40              | -                            |
| 964         | 35              | -                            | 321      | 35              | 14                           |
| 132         | 30              | 16                           | 252      | 30              | 20                           |
| 597         | 25              | 28                           | 016      | 25              | 40                           |
| 657         | 20              | 39                           | 564      | 20              | 63                           |
| 853         | 15              | 60                           | 978      | 15              | 78                           |
| 348         | 10              | 86                           | 338      | 10              | 89                           |

At the same time, the possibility of masking the medicinal smell with the beverages as mentioned earlier: orange juice and cranberry juice without involving food flavourings were investigated. A 10-point scale of aroma intensity was used for determining the unwanted medicinal smell in the samples. A reference point equal to “0” corresponding to the absence of this descriptor, and a reference point equal to “10” corresponding to the notable presence of this descriptor. In parallel with determining the intensity of the ”smell of medicinal herbs”, respondents were asked to evaluate the intensity of the” sweet smell”, “bitter smell”, “sour smell and ”fruit (berry) smell.”

Studies have been carried out to study the organoleptic evaluation of experimental samples based on medicinal smell masking descriptors. The results of the study are presented in Table 3. The measurement error was from 0.05 to 0.15 points.

Table 3. Research of experimental samples of orange juice and cranberry juice with the addition of collection by descriptors of masking the medicinal smell

| The amount of functional ingredient of the collection №2, % | Descriptor, points | Sweet odor | Bitter odor | Sour odor | Fruit (berry) odor | Medicinal herbs |
|-----------------------------------------------------------|--------------------|-----------|-------------|----------|--------------------|----------------|
| Orange juice                                              |                    |           |             |          |                    |                |
| 50             | 1.4                | 8.3       | 3.1         | 3.3      | 8.1                |                |
| 45             | 1.2                | 6.5       | 2.6         | 3.5      | 7.0                |                |
| 40             | 1.8                | 5.6       | 2.4         | 3.9      | 6.4                |                |
| 35             | 1.8                | 4.8       | 2.7         | 4.8      | 5.2                |                |
| 30             | 3.2                | 3.5       | 3.3         | 4.4      | 4.3                |                |
| 25             | 3.0                | 3.2       | 3.4         | 4.7      | 3.6                |                |
| 20             | 3.3                | 3.1       | 3.8         | 5.6      | 2.9                |                |
| 15             | 4.5                | 2.2       | 3.7         | 6.9      | 2.6                |                |
| 10             | 5.0                | 2.3       | 4.1         | 7.0      | 2.2                |                |
| Cranberry juice                                          |                    |           |             |          |                    |                |
| 50             | 1.0                | 7.6       | 1.0         | 3.5      | 7.9                |                |
| 45             | 1.0                | 6.6       | 0           | 4.7      | 6.9                |                |
| 40             | 1.0                | 5.5       | 1.0         | 4.7      | 6.8                |                |
| 35             | 2.3                | 6.2       | 1.0         | 4.8      | 6.4                |                |
| 30             | 2.7                | 6.0       | 0           | 5.0      | 5.9                |                |
| 25             | 3.0                | 5.2       | 0           | 5.3      | 5.8                |                |
| 20             | 2.7                | 5.5       | 0           | 5.3      | 5.5                |                |
| 15             | 3.5                | 4.5       | 1.0         | 6.2      | 4.4                |                |
| 10             | 4.6                | 4.0       | 0           | 7.0      | 3.4                |                |
As can be seen from the presented data, with a decrease in the concentration of the functional ingredient of collection №2, the odours of medicinal herbs and bitter odours decrease in the beverage samples. In contrast, the sweet and fruit (orange and cranberry) odours increase by more than two times. The sour flavour increases slightly in the case of orange juice, and when using cranberry juice, it is not determined. The most acceptable combination of flavours is achieved when the concentration of herbal collection №2 is no more than 20% using orange juice and no more than 15% with cranberry juice.

When the concentration of the collection is higher than 20 and 25%, the bitter odour and odour of medicinal herbs are not masked, which is undesirable when creating a functional drink. It is also important mentioning that the full masking of the "smell of medicinal herbs" was not achieved; its intensity was at the level of 1.1 points for orange juice and 2.0 when using cranberry juice.

In the study of consumer preferences, respondents were asked to fill out a questionnaire, distributing samples on a hedonic scale of "like – dislike": "like very much," "like," "all the same," "do not like," "dislike very much." The results of the study are presented in Table 4.

| The amount of the functional ingredient of collection No. 2 in the juice-containing beverage, % | Hedonic, % |
|-------------------------------------------------------------------------------------------------|-----------|
|                                                                                               | Like very much | Like | All the same | Do not like | Dislike very much |
| Orange juice                                                                                   |             |     |             |            |                 |
| 50                                                                                             | -          | -    | 7           | 29         | 64              |
| 45                                                                                             | -          | -    | 12          | 28         | 60              |
| 40                                                                                             | -          | -    | 14          | 43         | 43              |
| 35                                                                                             | -          | 4    | 39          | 36         | 21              |
| 30                                                                                             | -          | 21   | 32          | 36         | 11              |
| 25                                                                                             | 8          | 29   | 32          | 27         | 4               |
| 20                                                                                             | 14         | 31   | 35          | 20         | -               |
| 15                                                                                             | 20         | 41   | 29          | 10         | -               |
| 10                                                                                             | 29         | 52   | 14          | 5          | -               |
| Cranberry juice                                                                                |             |     |             |            |                 |
| 50                                                                                             | -          | -    | 21          | 32         | 47              |
| 45                                                                                             | -          | -    | 29          | 29         | 42              |
| 40                                                                                             | -          | 4    | 32          | 32         | 32              |
| 35                                                                                             | -          | 7    | 30          | 42         | 21              |
| 30                                                                                             | -          | 15   | 32          | 36         | 17              |
| 25                                                                                             | -          | 19   | 37          | 32         | 12              |
| 20                                                                                             | 8          | 21   | 36          | 32         | 3               |
| 15                                                                                             | 22         | 46   | 25          | 7          | -               |
| 10                                                                                             | 25         | 33   | 36          | 6          | -               |

As can be seen from the presented data, the respondents gave the highest preference to the samples of the drink with orange juice with the addition of herbal collection №2 in concentrations of 20, 15 and 10% and cranberry juice with concentrations of herbal collection of 15, 10%. In drinks which contained orange juice and cranberry juice with a higher concentration of the functional ingredient (50-30%), the bitter taste and medicinal odour prevailed over the taste qualities of the used juices.

4. General discussion

As a result of the conducted research, a prescription model of a juice-containing sedative drink was proposed. It is possible to use as a source of biologically active substances collections of medicinal herbs containing herbs of motherwort, melon, thyme and oregano, peppermint leaves, Valerian and liquorice roots, hop cones. Herbal infusions were added to juice products (orange juice and cranberry
juice) in concentrations from 10 to 50% with the discreteness of adding 5% in each flavour range. It was determined, that herbal infusions of collection №3 are acceptable for adding to juice products in any concentrations due to the lack of a bitter taste in the infusion. Drinks based on collection №2 had a bitter taste, which required masking this sensation. When developing a functional drink enriched with collection №2, orange juice with a concentration of the functional ingredient from 10 to 20% and cranberry juice from 10 to 15 % may be used. For fill the daily intake of BAS, it is necessary to consume 200 ml of the drink with a concentration of 25-30% of active substances in 100 ml of the prepared drink or 500 ml at a concentration of 10-15%. These functional drinks meet the requirements of consumers for organoleptic indicators.

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