Rationale and methods of the use of *Artemisia absinthium* L., *Ledum palustre* L. and *Tanacetum vulgare* L. for food purposes

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**Abstract.** The paper presents the results of a comprehensive study that substantiates the nutritional use of non-traditional plant materials – *Artemisia absinthium* L., *Ledum palustre* L. shoots and *Tanacetum vulgare* L. Their chemical composition was studied, including a detailed analysis of the composition of essential oils. The possibilities of extracting a complex of biologically active substances into aqueous extracts from dry oil cakes remaining after the extraction of essential oils are shown. Qualitative parameters and safety indicators of dry herbal substances, oil cakes and essential oils, prepared desserts are determined, regulatory documentation for each type of raw and finished products is developed. The relevance of the study is determined by the determining state documents in the field of territorial development, import substitution, ensuring the safety and health of the nation.

1. Introduction

Harvesting and processing wild plants, the creation of enterprises for the processing raw materials and the production of food additives are recognized as an element of priority areas for the development of territories in within the import substitution, the development of agricultural potential and cooperative production [1]. The target state of the problem under consideration is also determined by a number of other documents in the field of ensuring the safety and health of citizens of the country adopted at the state level [2-4]. Processing local medicinal plant raw materials is recognized as one of the promising areas of production of products of increased nutritional value, which is very important - from areas remote from industrial centers.

In this regard, the study presented had the goal of analyzing the possibilities of using a fairly common plant material that is not prone to degeneration, resistant to negative environmental factors (climatic, soil parameters) for enriching the beneficial substances contained in food products. The usefulness of the introduced substances or plant parts is determined by the presence of functional properties for the human body and is provided by its composition. Plants that were non-traditional for food, but used for pharmaceutical purposes for a long time, were selected as such raw materials - *Artemisia absinthium* L., *Ledum palustre* L. shoots and *Tanacetum vulgare* L. Their nutritional prospects are due to both the presence of a biologically active principle and the widespread prevalence of raw materials in any remote area, unpretentiousness, renewable resources, which will not create a shortage of raw materials if it is used on a large scale. The restraint of the use of these plants for food purposes is mainly due to the high physiological activity of some substances in their composition, for
which these plants are used for pharmaceutical purposes. The way out of this contradiction seems is presented as the use of raw materials for the extraction of specific substances from it, including their oil cakes or other forms of raw materials remaining after the extraction of the drug substance.

In connection with the goal, the article presents studies of the chemical composition of the studied plants collected in ecologically safe areas. The chemical composition was determined based on the subsequent use of components or parts of plants remaining after separation of part of the composition. The way of intended food use - gelled desserts using secondary products of processing medicinal herbs [5; 6].

2. Materials and methods

The objects of the study were wild herbs - Artemisia absinthium L., Ledum palustre L. and Tanacetum vulgare L., intermediate processing products (essential oils and oil cakes), finished food products (jelly).

The general research scheme included the stages:
1. analysis of the chemical composition of the selected raw materials, including the biologically active principle, and determination of the possibility of their use for the dessert base of the enriched composition;
2. defining the qualitative characteristics of plant materials source and indicators of its safety;
3. studies of intermediate products of processing raw materials (essential oil and dry oil cake);
4. defining the nomenclature of indicators for the development of regulatory documents (Technical conditions) for the prepared oil cakes;
5. formulation of culinary ratios and the technological process for the manufacture of gelled desserts;
6. defining the range of quality indicators of finished desserts;
7. defining the qualitative characteristics of the finished product and studying their dynamics during storage;
8. developing of regulatory documents for new types of products based on non-traditional plant materials and the economic feasibility of their production [6].

This paper briefly presents the results of the first four stages, which determine the possibilities and directions for the further use of non-traditional raw materials based on wild herbs.

The collection of medicinal plant materials was gathered in the Sayan district of the Krasnoyarsk Region at different vegetative periods in different plants: Artemisia absinthium L. and Tanacetum vulgare L. were gathered in the flowering phase (Artemisia absinthium L. and Tanacetum vulgare L.); Ledum palustre L. was gathered at the fruit ripening phase (shoots). Remoteness from industrial centers was a determining factor in choosing a gathering place to eliminate the risks of the impact of negative environmental conditions. During the gathering period, the optimal conditions for the possible supply of such raw materials from the indicated place of growth on an ongoing basis, taking into account seasonality, both in terms of natural resources and the availability of transport routes, were also determined [6; 7].

Harvested raw materials were dried in the shade with natural air exchange in a layer of 10-15 cm to eliminate the risk of loss of essential oils. The ambient temperature during the drying period was in the range of 25-30 °C. The duration of the process was determined by the conditions of the raw materials, characterized by brittleness when bending parts of plants with a characteristic crunch.

As research methods, standardized methods were used according to the conditions for the collection and processing the procured raw materials, according to the main indicators of the quality and safety of raw materials and finished products [8-12]. The qualitative composition of the essential oil was determined by chromatography-mass spectroscopy on a gas chromatograph with a quadrupole mass spectrum (HP MSD 5971) as a detector. A complete list is given in [6; 7]. The significance of differences in the results was determined using Student's t-test [6].
3. Results and discussion

The effectiveness and relevance of the results of scientific and technical research and the development of new technological solutions associated with the use of new types of raw materials is determined by the vector aimed at creating a new product with improved consumer properties. The solution to this question is a complex task, affecting many aspects, among which are the functional properties of the created product, its social significance, economic feasibility, compliance with technological, quality and product safety requirements. This determines the sequence of steps for solving the tasks set in the study [13-15].

An assessment of the quality characteristics determined after organoleptic and physicochemical methods carried out after gathering and drying the plant material, showed full compliance with the regularity established by the applicable standards. The analysis evaluated the appearance, taste, smell, moisture content, degree of fineness, pest infection, and the presence of organic or mineral impurities. The comparison was carried out with the relevant State standards and the State Pharmacopoeia.

During the analysis, no signs of violations were revealed, which may indicate compliance with the procurement technology at all preliminary stages of work.

When defining the safety parameters of the prepared raw materials to confirm the feasibility of choosing a gathering point in terms of ecological cleanliness of the area, the content of toxic substances was determined; this showed that the obtained values do not exceed the established acceptable levels. Thus, it can be said about the ecological purity of the raw materials of the selected area for procurement in the framework of the study.

Given the proposed integrated approach to the processing of unconventional raw materials, one of the defining tasks was to study the chemical composition, in particular, the yield of extractives.

An analysis of the results obtained by UV spectroscopy indicates the presence in the extracts of significant quantities of a number of substances. Common to all three plant species were tannins, simple phenols, and flavonoids. Hydroxybenzoic acids and aurones were common for Artemisia absinthium L. and Tanacetum vulgare L.; anthocyanins – for Ledum palustre L.; for each of the herbs: xanthones (for Artemisia absinthium L.); hydroxyl-cinnamic acids (for Tanacetum vulgare L.); coumarins, leukoanthocyanins, catechins, chlorophyll (for Ledum palustre L. shoots).

Due to such a wide range of extractives, these plants can not only be traditionally used in the pharmacy, but also suitable for the perfume and cosmetics industry as a source of essential oil raw materials.

For food purposes, only extracts with non-toxic contents may be used. To obtain such extracts, the method of infusion of plant materials is used, followed by hot (70-80°C) exposure in an aqueous extract. The method makes it possible to extract proteins, carbohydrates, vitamins, mineral and tannins in this way.

Essential oils were isolated by hydrodistillation. Essential oils accounted for an average of 2% (by weight of air-dried raw materials) for Artemisia absinthium L. and Ledum palustre L., up to 0.8% for Tanacetum vulgare L. The distinguishing characteristics of the selected essential oils are not only certain aromatic characteristics, but also color (blue-green in Artemisia absinthium L. oil; saturated yellow in Ledum palustre L. oil, dark yellow in Tanacetum vulgare L.), density (0.949; 0.933; 0.894 g/cm³, respectively); refractive index (1.5021; 1.4813; 1.4727, respectively). This allows one to attribute all parameters to the identifying ones for the purpose of further confirmation of compliance. The presence of characteristic aromas indicates the scope of the selected essential oils: in the confectionery and distillery for flavoring drinks; in the perfumery and cosmetics industry.

The composition of the obtained essential oils by chromatography-mass spectrometry was identified:

- in Artemisia absinthium L. oil - 21 components with a concentration range of 0.10-7.43%, including β-myrcene (7.41%), 1.8-cineole (7.42%) and germacrene-D (7.39%), α-bisabolol (3.68%).
in Ledum palustre L. oil - 34 components, including terpenyl acetate (41.05%), R-cimol (17.11%), le dol (7.40%), α-terpinene (9.77%) and germacrene (2.11%).

37 components in Tanacetum vulgare L. oil: camphor (43.68%), borneol (14.31%), terpineol (8.80%), borne acetate (6.14%), camphene (2.65%).

The oil cake remaining after the extraction of essential oils is a source of a wide range of extractives, the extraction of which is possible using water as an extraction agent. In terms of absolutely dry raw materials, water extracts contain from 7.9% sugars for Ledum palustre L. oil cake, up to 9.4 and 9.6% in Artemisia absinthium L. and Tanacetum vulgare L. oil cakes, respectively. The share of tannins is 2.2; 1.7 and 3.5%, respectively. All types of raw materials were rich in the presence of ascorbic acid (197.0-215.0 mg/100 g) and vitamin PP (0.16-0.43 mg/100 g). Thus, this makes it possible to use the aqueous extracts of oil cakes for the formulations of gelled desserts.

The establishment of the obtained dry oil cakes for 12 months’ storage with monitoring of quality and safety parameters showed their high shelf life.

For the further use of oil cake in the food industry, a nomenclature of quality indicators was defined, and technical specifications for all three types of oil cakes were developed [6; 7].

At the formulation development stage, a preliminary analysis of different combinations of fruit and berry raw materials, sugar and aqueous extracts of oil cakes with different concentrations was carried out. According to the results of the tasting assessment, the optimum ratio of extracts with water was selected as the ratio of "raw materials: water" as 1:30. In this case, the taste of the basic syrup obtained according to the recipe is characterized as “pleasant sweet, spicy, with the characteristic tones of the plant material used” [6; 7].

The developed recipes and technological sequences for the production of gelled desserts made it possible to develop appropriate technological instructions and regulatory documents for the finished product.

When storing the finished product within the established 24 hours for jelly, the negative effect of water extracts obtained on the basis of meal from wild herbs on the qualitative characteristics was not revealed. In terms of safety, all finished products met the established requirements.

The calculation of economic efficiency showed that the introduction of aqueous extracts based on the oil cake of wild herbs does not give a noticeable increase in prices against the background of an increase in nutritional value due to the enrichment of the product with a complex of useful substances.

4. Conclusions
The principal possibility and expediency of using Artemisia absinthium L., Ledum palustre L. shoots and Tanacetum vulgare L. flowers gathered in the Krasnoyarsk Region for food purposes is shown to be possible and expedient.

Gathered and dried vegetable raw materials, secondary products from it (essential oils, oil cake), ready-made gelled desserts during the study received an analysis on the composition, quality, safety and shelf life; defining the nomenclatures of quality and safety indicators, storage conditions and periods; development of normative documentation and technological instructions.

The formulation and technological parameters of the production of gelled desserts using plant oil cake are theoretically substantiated and optimized. Their comprehensive commodity assessment is given; consumer properties in the process of production and storage are studied.

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References
[1] 2019 The concept of development of border territories of the subjects of the Russian Federation, which are part of the far Eastern Federal district and the Baikal region Available at:
http://docs.cntd.ru/document/420313859

[2] 2019 The concept of long-term socio-economic development of the Russian Federation for the period up to 2020 Available at: http://docs.cntd.ru/document/902130343

[3] 2019 Presidential decree "On the national security strategy of the Russian Federation" Available at: http://docs.cntd.ru/document/420327289

[4] 2019 Fundamentals of the state policy of the Russian Federation in the field of healthy nutrition of the population for the period up to 2020 Available at: http://docs.cntd.ru/document/902242308

[5] Veretnova O Yu, Polyakov N A and Efremov A A 2007 Nature of extractive substances of marsh beetle growing in the Krasnoyarsk Territory Chemistry of plant raw materials 2 67-72

[6] Veretnova O Yu 2009 Development and commodity evaluation of gelled desserts on the basis of wormwood meal, marsh vermilion and tansy of the Krasnoyarsk territory (Krasnoyarsk) p 148

[7] Menyailo L N Baturina I A et al. 2015 Scientific bases of formation of the range of food products with the set properties Technologies of production and processing of plant raw materials (Krasnoyarsk: SFU) p 212

[8] Ermakov A I et al. 1987 Methods of biochemical research (Leningrad Kolos) p 430

[9] Leschuk R I, Vaishlya O B and Wojciechowska S A 2002 Workshop on biochemistry (Tomsk) p 192

[10] Pleshkov B P 1985 Workshop on plant biochemistry (Moscow: Agropromizdat) p 255

[11] Beswick G and Johnson R M 1970 Chemist Analyst (Talanta) 17 709

[12] Zaitsev G N 1991 Mathematical statistics of biological data (Moscow: Nauka) p 184

[13] Demakova E A et al 2019 System approach to the creation of Siberian brands on the example of adaptogenic drinks from local plant materials IOP Conf. Ser.: Earth Environ. Sci. 315 022070

[14] Gulenkova G S Demakova E A et al. 2017 Systematic approach to managing the assortment and quality of products (Krasnoyarsk: SFU) p 236

[15] Cooper R G 2011 Winning at New Products: Creating Value Through Innovation (New York: Basic Books)