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Rice screenings as effective ingredients in beauty products

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Abstract. Secondary rice products represent a source of effective ingredients for the cosmetics industry. Environmentally friendly and biodegradable products are among the promising trends of the present time. They do not pollute the environment and create a closed cycle in raw material production. Rice screenings and germs are a source of valuable bioactive substances. The products are currently being recycled, due to the lack of economically viable technology for recycling secondary rice products. The paper presents the technology for the processing of secondary rice products by solvent extraction with hexane and carbon dioxide. The extraction was carried out on a laboratory unit, after which the component composition of the extracts was determined by thin-layer chromatography. The main components of CO_2 extract are phospholipids, sterols, fatty acids, triacylglycerols, tocopherols, carotenoids, and waxes. Processing of the extraction oil and CO_2 extract will make it possible to isolate the waxes. Rice waxes are currently the quality plant-based analogue of synthetic texturizers. A plant-based wax that can be effectively used in both decorative and skincare formulations, as it has a range of skin-soothing substances and can absorb UV-A and UV-B rays. Rice screenings could become an alternative to silica in alginate wrap preparations of the SPA industry. Rice recycling technology will produce valuable raw materials for cosmetic products: vegetable waxes, rice bran oil, and rice flour. These products are effective raw components for the cosmetics industry and their use will reduce the cost of the finished cosmetic product and expand the base of domestic raw materials.

1 Introduction

The current beauty products market and its development trends determine the need to find safe and effective solutions to model cosmetic products, including face and body skin care products. It is advisable for developers and manufacturers to consider natural sources of renewable vegetable raw materials, given the growth trends of the natural "green" cosmetics market.

One of the promising areas for scientific research is an agricultural crop, rice and secondary products of its processing, the annual harvest of which in Russia is more than one million tons. At the same time, key recycled products used in the cosmetics industry are

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imported. The introduction of advanced technologies and equipment for deep processing of vegetable sources at the domestic enterprises will allow creating a competitive foreign raw material for the cosmetics industry. The aim of the work is to develop the technology of processing secondary products of rice for expanding the base of raw materials of cosmetic raw materials.

At the processing enterprises of the country the basic way of manufacture of rice groats is cleaning of grain mass from extraneous impurities, peeling of grain, division of products of peeling (peeled, not peeled rice and husk) and the subsequent grinding of peeled rice. During the processing of rice into groats, a number of secondary products are formed: flours after various grinding systems, crushed rice, unripe and stubby grains, and the germ fraction. The total yield of these products after processing is up to 20 % of the initial volume of rice grain [1].

Rice screenings and germ fraction are the main source of vegetable oil and is a valuable raw material for extraction of lipid fraction rich in wax-like compounds and fat-soluble vitamins E and carotenoids. A flow chart of the lipid composition of rice extracts is shown in Figure 1.

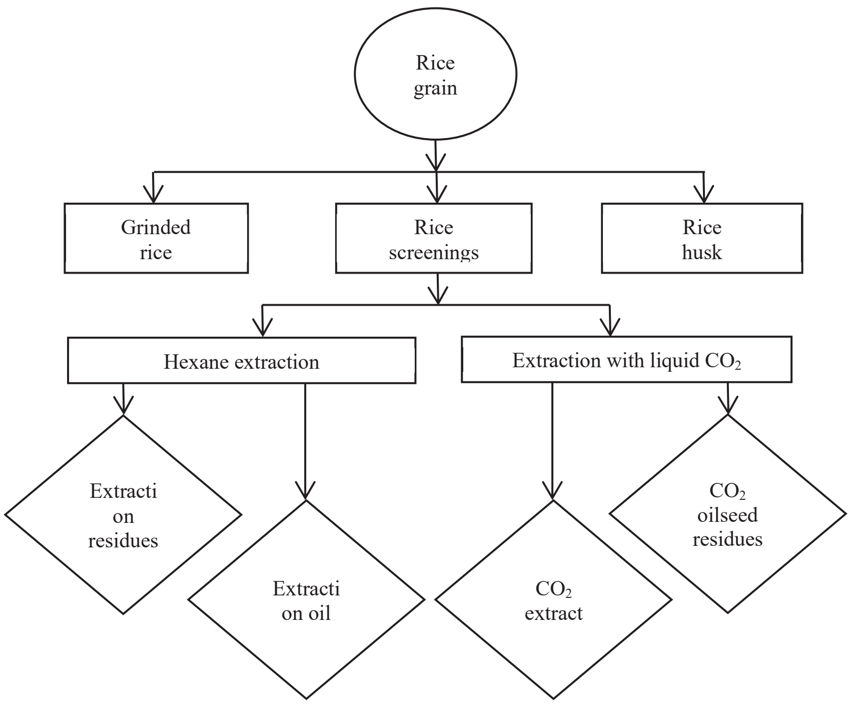

Fig. 1. Flowchart of a lipid composition study of extracts.

2 Materials and Methods

The main proposed technological operation for the processing of rice screenings is extraction with different solvents (hexane and carbon dioxide). In order to investigate the extracted substances from rice screenings by extraction, the units shown in Figures 2 and 3 [2] were applied.

3 Laboratory method for the extraction of extractive substances with hydrocarbon solvent

The mass fraction of the sum of extractive substances by extraction with low boiling solvent was carried out in the glass Soxhlet apparatus shown in Figure 2. Hexane with boiling point 68.0-69.0 ºC was used as solvent.

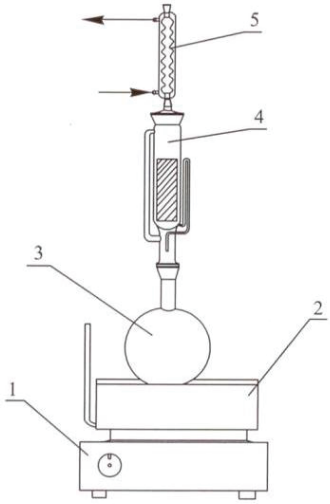

Fig. 2. Installation for exhaustive extraction with low-boiling hydrocarbon solvent.

Laboratory method of extraction with liquid carbon dioxide

CO_2 extraction was carried out in a laboratory apparatus shown in Figure 3 [3]. The unit consists of a Soxhlet apparatus (item 7) with a receiving flask (item 8) placed in a thick-walled metal casing (item 2). The body is closed with a screw cap (item 3) containing a safety valve (item 4) designed for internal pressure of 7 MPa, pressure gauge (item 5) and a surface condenser (item 6) representing a glycerine bath with a coil tube lowered into it for supply of cooling agent at a temperature of t = 0÷ -10 ºC.

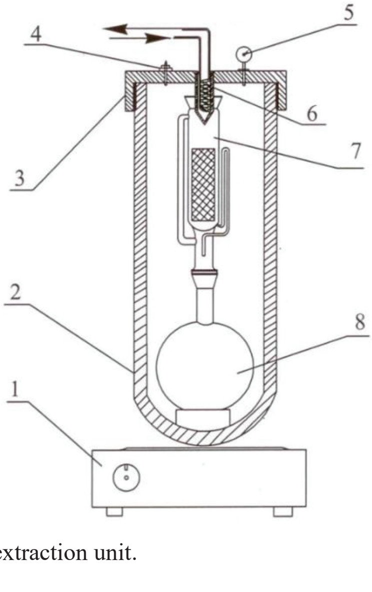

Fig. 3. Liquid carbon dioxide extraction unit.

The Soxhlet apparatus with the loaded raw material is placed in an enclosure, and carbon dioxide in crystalline form is poured into the enclosure on the basis of the following liquid 500 cm^3. A vacuum pump evacuates air from the housing through the opening of the safety valve. A coil with cooling agent is lowered into the glycerine bath and glycerine is poured into the bath.

The prepared extraction unit is placed on the heating element (item 1) and gradually heated to t = +40 ° C. This converts the crystalline carbon dioxide into a gaseous state, and its vapour rises upward. Contacting the surface of the condenser, it condenses and enters the Soxhlet extraction chamber in a liquid state. When filled to the upper overflow tube of the siphon, miscella overflows into the extraction flask (item 8), and then, in a cycle, heating at the bottom, goes up to the condenser. Process temperature + 20-22 °C, the system pressure is 5.8 MPa and the duration of the extraction process is 180 minutes. At the end of the process, the carbon dioxide is discharged through the safety valve, the lid is unscrewed, and the extractor is removed. The obtained CO_2 extract is subjected to analysis.

4 Results

The component composition of the extracts was determined by thin-layer chromatography. The technique is as follows. About 0.1 g (exact sample weight) of the extract is placed in a glass beaker, 10 cm^3 of diethyl ether is added and stirred with a glass rod until the sample is completely dissolved. The mixture is then dried with anhydrous sodium sulphate until all traces of moisture have disappeared, so that the solution is completely transparent. At the same time, high efficiency Sorbfil plates are prepared by heating them in the desiccator for 30 minutes at 130 °C and indicating the starting line at a distance of 1 cm from the beginning of the plate. A dehydrated solution of the extract sample in ether is then applied with a capillary to the start line of the prepared plate, which is then placed in a chromatographic chamber. The chromatography is performed in vapours of solvent mixture hexane: diethyl ether: acetic acid (80: 20: 1), using a developer reagent H_2SO_4 (2 % solution). The plate is then placed in a desiccator for a few minutes so that all the chromatogram spots are completely visible. The quantification of individual groups of test substances is done by scanning densitometry using a computer program for evaluating and calculating the chromatogram parameters of SorbfilTLCVideo-densitomer. The chromatograms are then analysed for their group composition.

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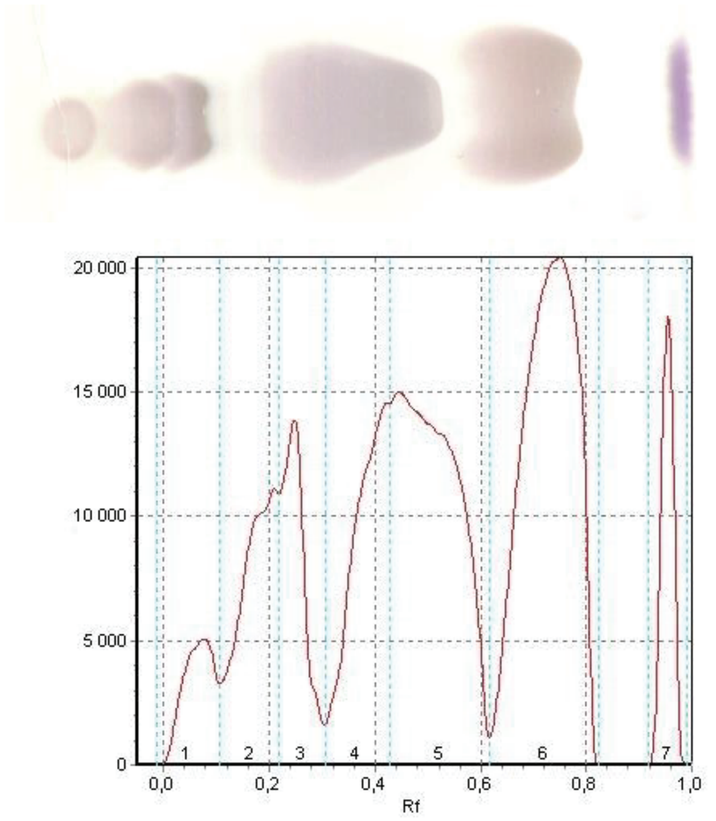

Fig. 4. Chromatogram of hexane extract of rice screenings.

The obtained samples of rice screenings extracts were analysed using a chromatographic profile. The results are shown in Figure 4 and 5.

Table 1. Chromatographic analysis of the lipid complex of the hexane extract of rice screenings.

Peak	Rf	S	%S	H	%H	Description
1	0.08	219302	4.3	5072	5.2	Phospholipids
2	0.21	539250	10.5	11113	11.3	Diglycerides
3	0.25	427658	8.4	13866	14.1	Monoglycerides
4	0.42	662380	12.9	14579	14.9	Free fatty acids
5	0.44	1349341	26.4	14999	15.3	
6	0.75	1600864	31.3	20446	20.8	Triacylglycerols
7	0.96	316204	6.2	18025	18.4	Waxes
Total		5114999		98100		

The results show that extraction with hexane allows the extraction of more extractive substances than carbon dioxide, while the qualitative composition of these extracts will differ.

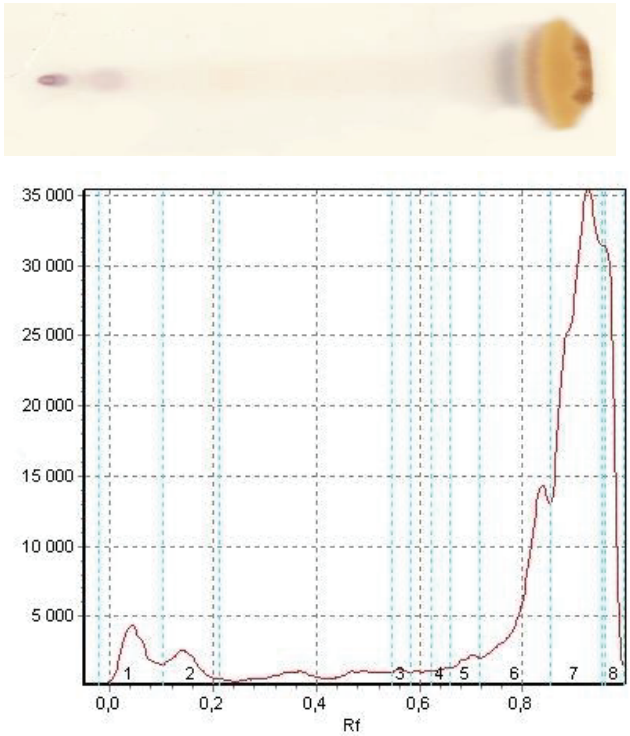

Fig. 5. Chromatogram of CO_2 rice screenings extract.

Table 2. Chromatographic analysis of lipid complex of CO_2 extract of rice screenings.

Peak	Rf	S	%S	H	%H	Description
1	0.04	103156	5.3	4386	4.7	Phospholipids
2	0.14	70476	3.6	2591	2.8	Sterols
3	0.56	16948	0.9	1248	1.3	Fatty acids
4	0.66	17137	0.9	1339	1.4	
5	0.70	43226	2.2	2271	2.4	Triacylglycerols
6	0.84	348791	17.9	14363	15.4	Tocopherols
7	0.93	1091997	56.2	35436	38.1	Carotenoids
8	0.96	251794	13.0	31374	33.7	Waxes
Total		1943525		93008		

The removal of the solvent from the miscellaneous is accompanied by changes in the composition of the lipid complex of the extracts. The extraction oil obtained by hexane removal is represented by the lipid fractions: phospholipids, mono- and diglycerols, fatty acids, triacylglycerols and waxes. The rice bran CO_2 extract will consist of: phospholipids, sterols, fatty acids, triacylglycerols, fat-soluble vitamins (tocopherols and carotenoids) and waxes.

Further processing of extraction oil and CO_2 extract will allow the isolation of waxes, which are currently the plant analogue of synthetic structure-forming agents [4-7].

5 Discussion

Plant waxes act as bioactive substances in cosmetic formulations. In addition, plant waxes are used as rheology modifier, co-moisturizer and stabilizer.

The closest analogue of plant waxes on the global cosmetic market is the imported rice bran wax Kahlwax 2218 (INCI: Oryza Sativa Cera). It is a light wax containing mainly esters of fatty acids C16-C24 and alcohols C26-C32 with melting point of 78-82ºC. Due to its high crystallization ability, it forms soft matte oleogels with a pleasant texture suitable for lipsticks, mascara, hair styling products.

The proposed processing technology of rice flour and rice germ fractions will produce high-quality plant wax, which can be effectively used in the formulations of both decorative and skin care cosmetics. Earlier studies of rice bran oil [8-10] suggest a high content of bioactive substances. Rice bran oil contains unsaturated fatty acids - mainly linoleic and oleic acids, vitamins (A, E), lecithin, antioxidant complex: $^{\gamma}$-orisanol, squalene and ferulic acid. Ferulic acid is synthesised from ferulic acid ester, which is a creamy white powder almost odourless. In cosmetic products, it exhibits antimicrobial properties, soothes the skin, absorbs UV-A and UV-B rays, so it is more commonly used in sunscreen and anti-inflammatory cosmetics [11].

In general, rice oil in cosmetics promotes skin firmness and elasticity and activates regeneration processes.

Skimmed rice screenings can also act as a filler for powdered cosmetic products, as an alternative to silica in products for alginate wraps SPA-industry [12-14].

6 Conclusions

The proposed technology of recycling of secondary resources of rice will allow to obtain valuable raw materials for cosmetic products: vegetable waxes, rice bran oil and rice flour. These products are effective analogues of imported raw materials, and their application will reduce the cost of the finished cosmetic product and expand the domestic raw material base.

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