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COMPLEX PROCESSING OF *STEVIA REBAUDIANA BERTRONI*

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The production of stevia is one of the cost-efficient industries of the world, regardless of processing only dry leaves into substances of different degree of sweetness. **Aim.** The aim is to create the technology of complex processing of the aboveground part of stevia. **Methods.** Modern methods and technologies of determining quality indices for the concentrate were used. **Results.** The experimental and theoretical studies were used to suggest the technological scheme of complex processing of the aboveground part of dried stevia. **Conclusions.** The suggested technology allows ensuring complete processing of the aboveground part of stevia to obtain substances of different degrees of sweetness as well as additional amounts of florazole, a complex of aminoacids, feed additive and pellets.

Keywords: aboveground part, quality, complex processing technology, natural sugar substitute.

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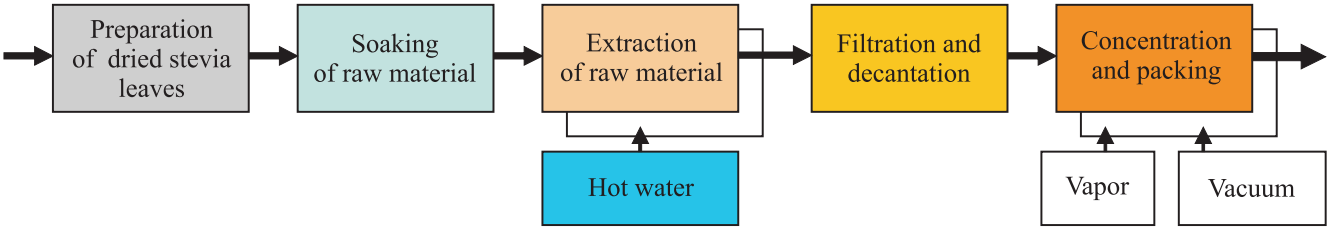
INTRODUCTION

Due to low energy value and the abilities for environment protection, every year there is an increase in the demand for dried stevia leaves and products of their processing which promotes the development of scientific provisions for the production in the directions of selection, technologies of cultivation, primary and secondary processing of stevia leaves. According to OTCQB: STEV [1], in 2010, worldwide sales of stevia extract reached the highest levels – 3,500 tons (875 thousand tons of WSE) with an overall market value of $285 million. 76 lines, producing sweeteners based on dried stevia leaves, were launched in the USA [2]. According to the estimates of FDA experts (2008), the volumes of their sales in the USA exceeded the volumes of sales of aspartame and saccharin considerably. In 2014, the demand for products of dried leaves processing was 4.67 thousand tons with the estimated value of USD 336 million. This resulted in tripling the production of dried leaves and a drop in a price for crude sugar down to 16–17 cents per pound. According to the forecasts, in 2017 the production of dried stevia leaves processing products will amount to 7.15 thousand tons for the total amount of USD 578 million. Regardless of the increasing demand and its strategic significance, the main problem is the absence of stevia as highly quality raw material.

At the same time, the production of stevia is underdeveloped in Ukraine. According to our estimates [3], the ratio coefficient (one of the main indices of food safety, indicating the level of product fulfillment) for dried stevia leaves is 0.67 for Ukraine. The main reason for the absence of industrial fields of stevia in Ukraine is the deficiency of current technologies of cultivating and preserving, which are to be finalized in the part of increasing the productivity of stevia and obtaining "organic dried leaves" of guaranteed quality.

The analysis of recent studies and publications. Dried stevia leaves are processed worldwide only to obtain the extract or substances of diterpenic glycosides of different degree of sweetness. In particular, there are known studies of Japanese [4], American [5–7] and Portuguese [8] scientists, A. E. Abou-Arab [9], V. A. Zubtsov and other scientists [10] of the Institute of Bioenergetic Crops and Sugar Beet, NAAS, the scientists of the Research Institute of Chemistry and Technology of Medical Preparations (Kharkiv), V. P. Chorna and I. V. Nikiforuk [11], the scientists of Taurida National V. I. Vernadsky University in cooperation



Technology of obtaining the concentrate from dried stevia leaves

with the private enterprise Stevia [12], G. K. Podporinova [13, 14], *etc*.

Regardless of considerable scientific potential in the world concerning the development of stevia production, stevia is a poorly studied plant both from the agronomic standpoint and by quality indices. It decreases cost efficiency of the production, and the absence of technological specificities of complex processing of the aboveground part leads to the loss of a number of products of stevia production.

METHODS OF STUDIES

The improvement of technological schemes of processing the aboveground part of dried stevia and the analysis of dried leaves and the obtained concentrate by quality indices was conducted in specialized laboratories of the Institute of Engineering Thermophysics, NAS of Ukraine, the National University of Food Technologies, the National University of Life and Environmental Sciences of Ukraine, the Institute of Food Supplies, NAAS. The practicing of technological ways of obtaining the extract was done on the basis of Apikosmetik LLC.

The content of compounds of diterpenic glycosides was determined by potentiometry according to TS U 15.8-31591453-002:2005 [15]. Crude protein was determined according to DSTU 7169:2010 [16] and flavonoids were defined by the improved method [17]. The determination of crude fiber was done according to GOST 13496.2-91 "Feeds, combined feeds, raw materials for combined feeds. Method of determining crude protein (Feeds, combined feeds, raw materials for combined feeds. Method of determining crude fiber)" [18]. The determination of ash was done according to GOST 26226-95 "Feeds, combined feds, raw materials for combined feeds. Methods of determining crude ash (Feeds, combined feeds, raw materials for combined feeds. Methods of determining crude ash)" and according to GOST 22027.02-74 "Medicinal vegetative raw materials. Methods of determining humidity, content of ash, extractive and tanning materials, ether oils" [19].

RESULTS OF INVESTIGATIONS

The experimental and theoretical studies were used to suggest the technological scheme of complex processing of the aboveground part of dried stevia. After separating leaves from stems, the dried aboveground part is sent for further processing. Full dried 5–8 mm leaves of stevia are used for immediate consumption in the form of tea and packed in 30–50 g carton boxes with a paper insert. Other leaves are sent for processing to obtain:

• powder (not over 0.2 mm degree of dispersion), which is packed into a container with the volume of 30–50 g, or may be capsuled in the amounts, not exceeding 5 g, to preserve normative values of daily consumption of diterpenic glycoside compounds, or may be mixed with powders of other medicinal plants according to current regulatory and technical provisions;

• ground fraction (1–3 mm) of dried leaves for further application in the production of the concentrate or diterpenic glycoside compounds;

• extraction cake, packed into the containers of stainless steel with the addition of a preservative, and transported to the pharmaceutical plant to obtain specific compounds (rutin, aminoacids, flavonoids, *etc.*), medicinal antibacterial bandages or culture medium for yeast cultivation;

• feed meal, aminoacids, and flurozole from the extraction cake.

Flurozole is a powder-like product of the mixture of flavonoids (quercetin, rutin, isoquercetin, and hyperoside) with clearly expressed P-vitamin activity, hypolipidimic and antisclerotic effect which may be used for prevention and treatment of diseases, notable for increased permeability of blood vessels (hypertension, rheumatism, endocarditis, radiation disease, *etc.*). The volume of flurozole consumption worldwide is enormous.

The main product of the industry is the concentrate, the technological process of obtaining which is as follows (Fig.): preparation of raw material, extraction,

isolation of the extract and its concentration, packing and preserving.

Dried stevia leaves, which should meet the requirements, set by regulatory and technical provisions in terms of quality indices, are received for processing [20]. The selection of optimal conditions for extraction ensures the quality of the ready product. It is during the extraction that taste properties of the product are formed: presence of bitter aftertaste, sweetness intensity, *etc*. Concentrating the extract using drinking water without prior preparation of the latter will result in increased content of salts of metals which will aggravate its taste qualities. Thus, the level of technological water mineralization should not exceed the minimal level of the content of salts of metals – 100 mg/l. In addition, salts of metals have a considerable impact on the formation of taste qualities of water, which is relevant in the production of the concentrate from medicinal raw material.

The experimental and industrial data of Apikosmetik LLC were used to develop the balance of concentrate production, presented in Table 1.

Due to low content of protein and fat, the concentrate may be preserved for up to 2 years. Dried leaves contain 49.67 % of other substances, and the concentrate – 45.8 %. Other substances are presented with the following compounds: chlorophylls, macro- and microelements, *etc*. The concentrate has the density of 1.18 g/ml which is 35 con. units of sweetness. It is also relevant to have the production of the concentrate powder, obtained from dried stevia leaves, which promotes prolonging the shelf-life and facilitating its use in the production of food products.

In terms of quality indices, the obtained extract may also be used to produce some substances of diterpenic compounds of different purity or their mixture (saccharol). For this purpose, the extract is additionally purified from flavonoids, aminoacids, fat, chlorophylls, macro- and microelements using ion-exchange resins.

After the ion-exchange, the extract is of light yellow color and sent to cartridge filters for active carbon process. After that, the purified extract is boiled and gradually cooled in the mixers. The cooling of highly biterpenic-glycoside mass is accompanied with the maturity of crys-

Table 1. The balance of substances while obtaining the concentrate from dried stevia leaves

Index	Leaves	Concentrate	extraction cake	precipitate
Moisture content, %	7.1	38	66	57
Diterpenic glycoside compounds, %	10.82	10.5	0.23	0.11
Flavonoids, %	6.43	5.41	0.65	0.37
Protein, %	7.99	0.12	6.51	1.36
Fiber, %	5.03	–	4.27	0.76
Ash, % (550 °C)	8.21	0.10	7.9	0.21
Fat, %	4.75	0.08	4.5	0.19
Other substances	49.67	45.8	9.94	40.0
Total	100	100	100	100

Table 2. Complex processing of the aboveground part of stevia

No.	Raw materials	Amount of raw material, kg	Products	Volume of products, kg
1	Dried leaves	650	concentrate	169.7
			powder from concentrate	26.0
			DGC	6.8
			mixture of aminoacids	10.2
			flurozole	3.5
			feed additive	538.7
2	Dried stalk	350	pellets	350.0

tals of stevioside or rebaudioside A. The separators are used to separate crystals, which are completely dried and packed into polyethylene or paper bags according to current regulatory and technical documents. Intercrystalline precipitate is used in the technological process to improve the formation of crystals of diterpenic glycosides and in the production of confectionery to produce fudges.

A stalk is not used in the processing enterprises, though its share in the production is 35–45 % from the total aboveground mass. It was estimated by us [3] that the dried stalk of stevia may provide the increase in the yield of fuel at the enterprises, producing pellets, up to 0.98 tons of conventional fuel per hectare.

Based on the results of studies, we have suggested the technology of complex processing of 1 ton of dried aboveground part of stevia (Table 2) which allows increasing the income of production due to obtaining additional products: pellets, mixtures of aminoacids, flurozole, and a feed additive.

TS *10.62.13-90.00.2:2014 "Concentrate of stevia leaves"* was developed to improve the technology of producing the concentrate from dried stevia leaves, which was coordinated with the Food Department of the Ministry of Agrarian Policy and Food of Ukraine.

CONCLUSIONS

The technology of complex processing of stevia was presented, which provides for waste-free production of the aboveground part of stevia in the agroindustrial complex; the balance of substances of the obtained products was estimated for the processing of dried leaves into the concentrate. It was demonstrated that complex processing of the aboveground part of stevia is efficient for agroindustrial complex of Ukraine and provides for the production of the natural sugar substitute (concentrate of 1697.2 kg or CBG 68 kg), aminoacids (10.22 kg), flurozole (3.5 kg), feed additive (538.7 kg) and pellets (350 kg).

Комплексна переробка стевії медової

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Стевієвиробництво є однією з рентабельних галузей у світі, незважаючи на переробку лише листків сушених на речовини різного ступеня солодкості. **Мета.** Метою є створення технології комплексної переробки надземної частини стевії. **Методи**. Використано сучасні методи та методики з встановлення показників якості концентрату. **Результати.** На основі проведених експериментальних і теоретичних досліджень запропоновано технологічну схему комплексної переробки надземної частини стевії сушеної. **Висновки.** Запропонована технологія дозволяє забезпечити повну переробку надземної частини стевії з отриманням, крім речовин різного ступеня солодкості, додатково флоразолу, комплексу амінокислот, кормової добавки і пелетів.

Ключові слова: надземна частина, якість, технологія комплексної переробки, натуральний замінник цукру.

Комплексная переработка стевии медовой

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Стевиепроизводство является одной из рентабельных отраслей в мире, несмотря на переработку только листьев сушеных на вещества разной степени сладости. **Цель**. Целью является создание технологии комплексной переработки надземной части стевии. **Методы**. Использованы современные методы и методики по установлению показателей качества концентрата. **Результаты.** На основе проведенных экспериментальных и теоретических исследований предложена технологическая схема комплексной переработки надземной части стевии сушеной. **Выводы**. Предложенная технология позволяет обеспечить полную переработку надземной части стевии с получением, кроме веществ разной степени сладости, дополнительно флоразола, комплекса аминокислот, кормовой добавки и пеллет.

Ключевые слова: надземная часть, качество, технология комплексной переработки, натуральный заменитель сахара.

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