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STUDY OF THE CHEMICAL COMPOSITION OF RAW ALCOHOL OBTAINED FROM THE TUBER OF DAHLIA

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Abstract. The raw material for alcohol production is a variety of plant materials, which contain sufficient amounts of digestible sugars or other carbohydrates that can be saccharified. Dahlias are tuberous plants of the Asteraceae family with a quick and powerful growth and a long vegetation period. The study of the chemical composition of dahlia tubers is of undoubted interest in terms of practical health care. Dahlia tubers are the main raw material for obtaining inulin, which has a wide range of pharmacological action. The vegetative (aboveground) part of dahlia has been an object of research. The purpose of this study has been to study the chemical composition of raw alcohol, obtained from the dahlia tubers. For this purpose, the chemical composition of the tuber of dahlia plants belonging to the Compositae family has been studied. It has been found that the tubers of dahlia contain a large amount of biologically active substances: protein, coumarin, polyphenol, pectin and inulin. Dry alcoholic yeast (TC BY 100104781.010-2005 dried alcoholic yeast Saccharomyces cerevisiae produced in Belarus) has been used as yeast. The fermentation process has taken place at the room temperature for 2-3 weeks. After 2 weeks it has been filtered, the quantity of wort has been measured and distilled. The chemical composition of the raw alcohol, obtained from dahlia tubers has been identified on an Agilent 7890A/5975C chromato-mass spectrometer.

Key words: dahlia tuber, raw alcohol, biologically active substances, chromatography-mass spectrometer.

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1. Introduction

In recent years there has been noted an increased interest in the problem of the introduction of plants, containing valuable biologically active substances (essential oils, polysaccharides, amino acids, vitamins, etc.), necessary for the human body [1]. The genus Dahlia Cav. belongs to the Asteraceae family, and includes about 19 classes (cultivars). More than 10,000 varieties of dahlia are cultivated worldwide as ornamental plants. At present, dahlia tubers are processed as a promising inulin-containing raw material in the United States and in European countries to produce inulin, which has a wide range of pharmacological action. The study of the chemical composition of dahlia tubers is of undoubted interest in terms of practical health care [2].

The Genus Dahlia is native of Mesoamerica, principally in the high plains of Mexico, some species can be also found in Guatemala, Honduras, Nicaragua, El Salvador & Costa Rica (probably introduced by the Toltecs or their ancestors) as well as parts of the South America, where it was introduced, and at present there are 35 recognised species in existence. Botanically, the Genus Dahlia belongs to the family Compositae (Asteraceae), tribe Heliantheae, and was given the Genus name “GEORGINA” in error in 1803, a name by which it is still known in many eastern parts of Europe [3].

The authors in this work [4] studied phenolic compounds of dahlia simple tubers by paper and thin-layer chromatography, chromato spectrophotometric method, high performance liquid chromatography method, using the standard samples of the substances. As a result of the studies, 31 substances of phenolic nature have been found, which are mainly represented by coumarins, phenolcarbonic acids and tannins.

In the production of rectified edible ethyl alcohol, there is a growing interest in the continuous improvement of the alcohol production technology. The process of technology modernization can take place in different directions. This can occur, for example, by improving the hardware part of the production, minimizing losses, searching for new strains of bacteria with a high coefficient of efficacy [5,6].

Using advanced technology, it is now possible to develop alternative fuels, which are renewable, combustible, and more reliable than the traditional fuels. Ethanol is a renewable alcohol fuel, which is mainly produced from the agricultural products. In most cases, it is made from starch, derived from rye,

sorghum, corn and wheat. Ethanol can be made from the industrial waste from the food and beverage production. Cellulose, which is found in wood, straw, rice hulls and millet, can be used for its production. Thus, it can be argued that the production of ethanol can significantly raise the level of agriculture, economy, and improve the environment [7]. The process of producing ethanol is based on the enzymatic hydrolysis of starch into sugars and their conversion into ethanol by yeast digestion. There are several process variations: dry milling or wet milling, batch or continuous fermentation, etc. The industry uses acid hydrolysis technology to produce ethanol from cellulose. An alternative to the acid hydrolysis of cellulose with a high potential of saccharide formation at the lower production costs is enzymatic hydrolysis [8].

2. Experimental part

The vegetative (above-ground) part of dahlia, sampled in October 2020, was the object of the study.

There are two ways to produce alcohol: biochemical and chemical or synthetic ones. The biochemical method is fermentation with sugar, the synthetic method is the interaction of ethylene with water in the presence of a catalyst.

We used a biochemical method to produce ethyl alcohol.

The technology for producing ethyl alcohol includes the following stages: 1) boiling the grain with water 2) cooling of the boiled mass and saccharification of starch with enzymes 3) the fermentation of sugars by yeast in biosport 4) distilling alcohol and its rectification [9].

The raw materials are washed and crushed. Besides 1:2, 1:3, 1:4 water is poured, then (TC BY 100104781.010-2005 produced in Belarus, dried alcoholic yeast wort Saccharomyces cerevistal) is filled with pre-prepared yeast, mixed and put on for 2-4 weeks at the room temperature. After two or four weeks, they filtered it out. After weighing the amount of wort, distilled it. The resulting wort was poured into a heat-resistant flask, and an electric stove was used to heat it. The temperature of the first distilled alcohol is 89^0C. Because the concentration of the first distilled alcohol is low. To increase the concentration, alcohol was re-distilled. The distilled alcohol contains impurities. To determine their quantity and purify them from the alcohol-containing impurities, it is necessary to adsorb and distill them with activated carbon and calcium oxide [10-12].

The composition of ethyl alcohol, obtained by fermentation of dahlia wort, was determined on Agilent 7890A/5975C chromato-mass spectrometer.

3. Results and Discussion

The content of anthocyanins, flavanoids, polyphenols, coumarins, carotene in plants was determined by photocalorimetric method on photocalorimeter “KFK-2” and “KFK-3”. The mass fraction of protein was determined by the Kjeldahl method, cellulose - by the Kürschner's and Hafer's method in modification of A. I. Ermakov. Crude oil content was determined by the gravimetric method, using a Soxhlet extractor laboratory apparatus.

The results of the study are shown in Table 1.

Table 1 - Chemical composition of the vegetative part of dahlia

1	Name of the indicator	Humidity, %	Ash content,%	Anthocyanins, %	Flavonoids, %	Proteins,%	Cellulose, %	Fatty oils , %	Coumarins,%	Carotins, mcg/100g	Polyphenols,%	Inulin,%	Pectin substances,%
2	Contents	7.00	3.20	0.06	0.11	3.36	5.87	0.94	1.25	11.55	8.75	35.00	5.34

As is seen from the Table, the dahlia tubers contain large amounts of inulin, carotenes and pectin substances.

The content of raw alcohol, obtained by the direct distillation of the filtered mash, fermented from dahlia tubers, is presented in Table 2.

Table 2 – The chemical composition of raw alcohol, obtained from the dahlia tubers after the first distillation

Name of the components	Retention times,tR min	Content,%
Carbon dioxide	1.411	1.06
Ethanol	1.577	69.94
Ethanol	24.00	1.66
Acetic acid	3.317	2.10
2,3-Butanediol	5.435	1.09
Ethylene oxide	9.317	0.25
Acetaldehyde	14.457	0.19
Carbon dioxide	21.289	0.25

This Table shows the retention time, **t**R min and the content of the components in the composition of the raw alcohol. After the first distillation the initial content of the raw alcohol in it was about-71%. Of the impurities in large quantities contained: carboxylic acid, aldehydes.

The content of the raw alcohol, obtained by the adsorption with activated carbon for 30 minutes is shown in Table 3.

Table 3 – The chemical composition of the raw alcohol, obtained from the dahlia tubers after the Active carbon adsorption

Name of components	Retention times,tR min	Content,%
Carbon dioxide	1.417	0.15
Acetaldehyde	1.500	0.23
Ethanol	1.684	74.26
Ethanol	1.756	16.04
Ethanol	1.916	0.05
Isopropyl Alcohol	1.809	0.90
1-Propanol	2.011	0.34
1-Propanol, 2-methyl-	2.444	1.31

This Table shows the retention time, TR min and the content of components in the raw alcohol obtained after the adsorptions of Active carbon. After adsorptions of the first distilled crude alcohol Active carbon the initial content of ethyl alcohol in it was -90.3%. Of the impurities in large are quantities contained: aldehydes, alcohols.

Table 4 – The chemical composition of the raw alcohol, obtained from the dahlia tubers after calcium oxide adsorption

Name of components	Retention times,tR min	Content,%
Carbon dioxide	0.931	0.04
Propane	1.429	0.08
Ethanol	1.619	98.18
1-Propanol	1.916	0.05
1-Propanol, 2-methyl-	2.361	0.43
1-Butanol, 3-methyl-	3.857	0.48
Acetaldehyde	13.151	0.03

After purification of raw alcohol by calcium oxide the initial content of ethyl alcohol in it was about 98.18%. Of the impurities in large quantities are contained: aldehydes, alcohols.

The main goal of our work is to obtain pure ethyl alcohol. This work is currently in progress.

4.Conclusion

The chemical composition of the raw alcohol, obtained from the dahlia tubers was identified on an Agilent 7890A/5975C chromato-mass spectrometer. After the first distillation the composition of the raw alcohol-71%, and impurities are-29%. After the adsorption by the activated carbon, the content of the raw alcohol is 90,3% and impurities are 9,7%. At the further treatment of this alcohol with calcium oxide the content of the raw alcohol is 98,18% and impurity is 1,82%.

Thus, based on the above, the technology of obtaining the raw alcohol from the dahlia tubers is effective. As this raw material is characterized by significant content of the easily fermentable substances with a high alcohol yield.

Conflicts of Interest: The authors declare no conflict of interest.

ГЕОРГИН (DAHLIA) ЖЕМІСІНЕН АЛЫНҒАН ШИКІ СПИРТТІҢ ХИМИЯЛЫҚ ҚҰРАМЫН ЗЕРТТЕУ

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Түйіндеме. Спирт өндірісінде шикізат ретінде құрамында спирттік ашуға қатысатын қанттар немесе басқа қанттауға болатын көмірсулар бар әр түрлі өсімдіктер қолданылады. Георгин (Dahlia) Asteraceae тұқымдасына жататын тамыртүйнекті көпжылдық өсімдік. Георгин (Dahlia) жемісінің химиялық құрамын зерттеуге практикалық мақсатта да, сонымен қатар денсаулық сақтау саласында да қызығушылық артуда. Себебі георгин (Dahlia) жемісі фармакологиялық қасиетке ие инулиннің табиғи қайнар көзі болып табылады.
Бұл жұмыста зерттеу нысаны ретінде георгин жемісі алынды. Жұмыстың мақсаты георгин өсімдігі (Dahlia) жемісінен алынған шикі спирттің химиялық құрамын зерттеу болды. Осы мақсатта георгин өсімдігі (Dahlia) жемісінің химиялық құрамы анықталып, зерттеу нәтижесінде георгин (Dahlia) жемісінің құрамында биологиялық белсенді заттар: белок, кумарин, полифенол, пектинді заттар және инулин көп мөлшерде кездесетіні анықталды.
Георгин өсімдігі (Dahlia) жемісінен шикі спирт алу үшін ашытқы ретінде Saccharomyces cerevistal (ТУ BY 100104781.010-2005) қолданылды. Ашыту процесі 2-3 апта бөлме температурасында жүргізілді. Ашу процесі аяқталған соң сүзіліп, сусло айдалды.
Георгин өсімдігі (Dahlia) жемісінен алынған шикі спирттің құрамы Agilent 7890A/5975C хромато-масс-спектрометрінде дәлелденді.

Түйін сөздер: георгин жемісі, шикі спирт, биологиялық белсенді заттар, хромато-масс спектрометр.

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ИЗУЧЕНИЕ ХИМИЧЕСКОГО СОСТАВА СПИРТ-СЫРЦА ПОЛУЧЕННОГО ИЗ КЛУБНЯ ГЕОРГИНА (DAHLIA)

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Резюме. Сырьем для производства спирта служат разнообразные растительные материалы, содержащие в достаточном количестве сбраживаемые сахара или другие углеводы, которые можно осахарить. Георгин клубневые растения из семейства Asteraceae с быстрым и мощным ростом и продолжительным периодом вегетации. Изучение химического состава клубней георгин представляет несомненный интерес с точки зрения практического здравоохранения. Клубни георгины являются основным сырьем для получения инулина, обладающего широким спектром фармакологического действия. Объектом исследования служила вегетативная (надземная) часть георгина. Целью данного исследования была изучение химического состава спирт-сырца полученного из клубней георгина. С этой целью изучен химический состав клубня растений георгина, относящегося к семейству сложноцветных. В результате исследования установлено, что

клубни георгина содержат большое количество биологически активных веществ: белка, кумарина, полифенола, пектиновых веществ и инулина. В качестве дрожжей использовали сухие спиртовые дрожжи (TY BY 100104781.010-2005 дрожжи сушеные «Спиртовые» Saccharomyces cerevisiae производства Беларуси). Процесс брожения проводился при комнатной температуре 2-3 недели. Через 2 недели отфильтровали, измеряли количество сусло и перегоняли. Химический состав спирт-сырца полученного из клубней георгина был идентифицирован на хромато-масс-спектрометре Agilent 7890A/5975C.

Ключевые слова: клубня георгина, спирт-сырец , биологически активные вещества, хромато-масс спектрометр.

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