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The Use of Artichoke to Obtain a Concentrated Extract

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Running title: **Concentrate Production From Artichoke**

Abstract
In the scientific research paper presents the results of the preliminary processing of artichoke chips by steam blanch and hot water and installed reduced loss of dry substances in the processing of a pair of 17%. For concentrate extraction processes used artichoke inulin clean it in different ways, and evaporation from the extract to obtain the concentrated extraction containing 30 % of dry substances. To carry out the extraction and concentration of the extract used modern laboratory equipment. This concentrate can be used in the food industry for the production of biologically active food additives. The process of concentrating the juice of Jerusalem artichoke and defined quality indicators of the finished product, confirming its high quality by quantity derived inulin and low cost compared to other sugar substitutable products.

Practical applications
This concentrated extract can be used in the food industry for soluble powder drying method to replace sugar fructose contained in inulin. This substance is also suitable for the production of biologically active food additives used in the confectionery and bakery industries, in the manufacture of food canning as a substitute for sugar canned fruit.

Key words: artichoke , chips , extract , extraction , inulin, concentrate

Introduction

Artichoke has the ability to accumulate high content of inulin. At the same time the tubers and the overground mass of artichoke do not accumulate heavy metals (lead, mercury, arsenic, etc.) and radionuclides. The unique biochemical composition of artichoke allows us to recommend it and use it as raw material for the creation and production of functional products. The enrichment of products by the functional ingredients in order to strengthen the health of population is now a common practice in the world [1, 2].

The greatest interest to the system of functional nutrition shows the products which are made from the directly fresh artichoke, obtained by special technologies for maximum preservation of useful properties and qualities of artichoke [3].

Here we can apply the products which include powder of tuber of artichoke. The rich composition of bioactive substances of artichoke gives us the reason to recommend this perspective plant in dietary, food industry and as feedstock (starting material) for the creation of high food additives [4, 5].

The particular value is devoted to the extract of artichoke for diabetics, as it has inulin containing bioactive components of nutrition and an artificial substitute for sugar, reducing the need of insulin medicines and stabilizing the level of sugar in human blood.

Great attention is paid to the development of technology of artichoke powder [6]. Tuber powder of artichoke is a good biological additive in many products. Besides, adding it to the bakery, meat and dairy products, the first and second courses significantly increases the nutritional and biological value of these products and reduces their glycemic index and caloricity.

The products containing artichoke are very valuable to dietic and prophylactic nutrition for adults. These products not only effectively satisfy the physiological needs of the human body for nutrients and energy, but also perform prophylactic tasks.

In Ukraine the market of extracts based on plant materials is complicated and various. It includes extracts from fruits and vegetables, grain extracts from medical raw material [6]. The basic processes of obtaining concentrated extracts are: obtaining extract, its purification and concentration.

The purpose of the research

The above mentioned gives us the reason to consider one of the most important tasks for the food industry and science by strengthening the health of population, the developing and realization in practice the system of correction of nutrition structure due to the creation and widely spread usage of functional dietary products based on artichoke.

Materials and methods

The main raw material for the concentrate was artichoke. The determination of content of soluble dry substances was performed by the method of refractometry and the determination of inulin was performed by the method which was based on the properties of inulin to hydrolysable in the presence of hydrochloric acid or oxalic acid to form fructose and also the ability of inulin to dissolve well in hot water and not to dissolve in alcohol.

The results of the research

It was necessary to choose a variety of artichoke before the research that would satisfy the conditions. Such varieties such as Znachidka (Discovery), Kyivskyi Bilyi and Chervonyi (Kyiv White and Red) do not require much care for growing conditions, have rather smooth shapes, so this ease the operation of the preliminary preparation of raw materials, which is widely spread in the region of Kiev. All the three varieties have the same appearance and taste. However, the roundly shaped varieties of artichoke Kyivskyi are larger in diameter but as for their chemical composition they contain the highest content of dry substances - 25,7 % against 21,3 and 18,8 %, the same we can see in such varieties as Znachidka (Finding) and Chervonyi (Red), and the great quantity of the main component - inulin (11,8 %).

Artichoke was cut into different slices. The following four options of raw material were: cubes, chips, plates, wedges (Fig. 1).

The main factors affecting the extraction process are: the hydromodule, the temperature of the extragent, the degree of grinding of raw materials and the duration of the process.

Water was chosen as the extragent, as most of the components of artichoke are water-soluble combinations. To determine the necessary hydromodule the following researches were conducted at different ratio of raw material and

extragent. The fastest transition of extractives substances was done in the hydromodule at 1, but the ratio of liquid and solid phases 1:1 there was no total immersion and also a high probability that not all water-soluble substances could go to extract completely. In the hydromodule 3 it was pointless to conduct extraction as the extract will contain smaller amount of dry substances and its concentration will spend more energy, and this will make the product more expensive. That is why the hydromodule 2 was selected, which has provided a complete covering of raw material by water and the maximum transition of extractives into the extragent.

The research of optimal mode of the process of extraction was performed by the laboratory equipment under vacuum IKA EUROSTAR 200P4 control, shown in Fig. 2, which has allowed to lower the temperature of extraction to 60 - 70 ° C. This leads to intensification of the process without oxygen and also at lower temperatures, which in its turn maximizes the preservation of important extractive substances.

Fig. 3 shows the diagram changes in solids content in temperature and the form of grinding artichoke. The researches had been conducted for 50 min. at 40 ° C.

Fig. 3 shows that during the grinding of the raw materials into chips by size 3 x 0,4 x 0,1 cm extraction is performed faster. The temperature of extragent affects the rate of conversion of extractive substances into extract. The temperature of extragent was changed from 30° to 80 ° C. Time to reach the equilibrium of the solids at different temperatures is presented in Table 1.

The results have showed that the higher the temperature of the extragent, the faster the transition of extractive substances is performed from chips into extract. At high temperatures of extraction the very extract obtains dark colour. At low temperatures of extraction the process takes a long time, which is unsuitable from the economical point of view.

Several ways of pretreatment of artichoke chips were conducted there, the main purpose of which was to prevent the chips from darkening, as well as the inactivation of enzymes. For this reason the blanching of the minced raw materials in water and steam was applied.

During the additional pretreatment of the raw materials, such as by blanching in water and steam, the chip does not lose its colour and it is in both cases almost identical, so the researches were carried out to determine the loss of the solid materials depending on the carried treatment of the raw materials.

The results are shown in Fig. 4, which it is clear that during the process of blanching of artichoke chips by steam there were less losses of the solid materials than during the blanching of chips in water. In percentage terms, this value has 17 units.

The purification of extract was performed to release it from the suspended colloidal particles which prevent the extraction of pure inulin. In this case, ethanol was used. The results of the research are presented in Table 2.

The gained extract with purified alcohol was filtered, and then it was concentrated on the equipment for the concentration IKA RV10 control, which is shown in Fig. 5.

The extract of artichoke with the content of solid materials 8 % was concentrated to the content of solid material 30 %. The concentration was performed at different ranges of temperatures from 50 to 100 ° C at intervals of 10 ° C.

Organoleptic and physical and chemical properties of the ready-made extract from artichoke are given in Table 3.

Discussion

As the artichoke chip without the pretreatment begins to get dark, which is not desirable, so it is better to conduct blanching before the extraction of the raw materials. After the preliminary blanching the chip is light yellow, which allows us to get the clear extract. The process of blanching of chips in water brings great losses of the solid materials, so it is more appropriate to use the method of pretreatment blanching by steam for 10 minutes.

The following optimal parameters for the concentration of the extract were: pressure 0,030 MPa and temperature 70 °C. The time of concentration at this temperature was 50 minutes to achieve 30% the content of solid materials. This concentration was chosen substantially for further drying of the concentrated extract. The previous researches gave the opportunity to establish that under the conditions of the reducing of concentration of the product, the productivity of the dryer decreases because of the limit of productivity of evaporated moisture, but in cases of the increase

of the initial concentration of the sticking of the product was observed on the walls of the dryer chamber in the disk.

Conclusions

It is experimentally proved that the best way of pretreatment of artichoke chips is by steam blanching. The following optimal parameters of the process of extraction by steam were determined for artichoke chips: hydromodule 2, the temperature of the process - 60...70 ° C, the duration of the process - 40 ...50 min. The process of concentrating of artichoke juice was researched and the qualitative indicators of the ready-made (finished) product were shown, which confirm its high quality thanks to quantity of the gained inulin and also low expenses in comparison with other artificial substitutes for sugar.

Such concentrated extract can be used in the food industry to use sugar instead of fructose and also for the production of biologically active food additives.

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Cubes 4x0,8x0,8 cm | Thick plates 0,2 cm | Chips 3x0,4x0,1 cm | Cubes 1x1x1 cm

Figure 1. Variants of chopping artichoke tubers.

Figure 2. Vacuum equipment for extracting IKA EUROSTAR 200P4 control.

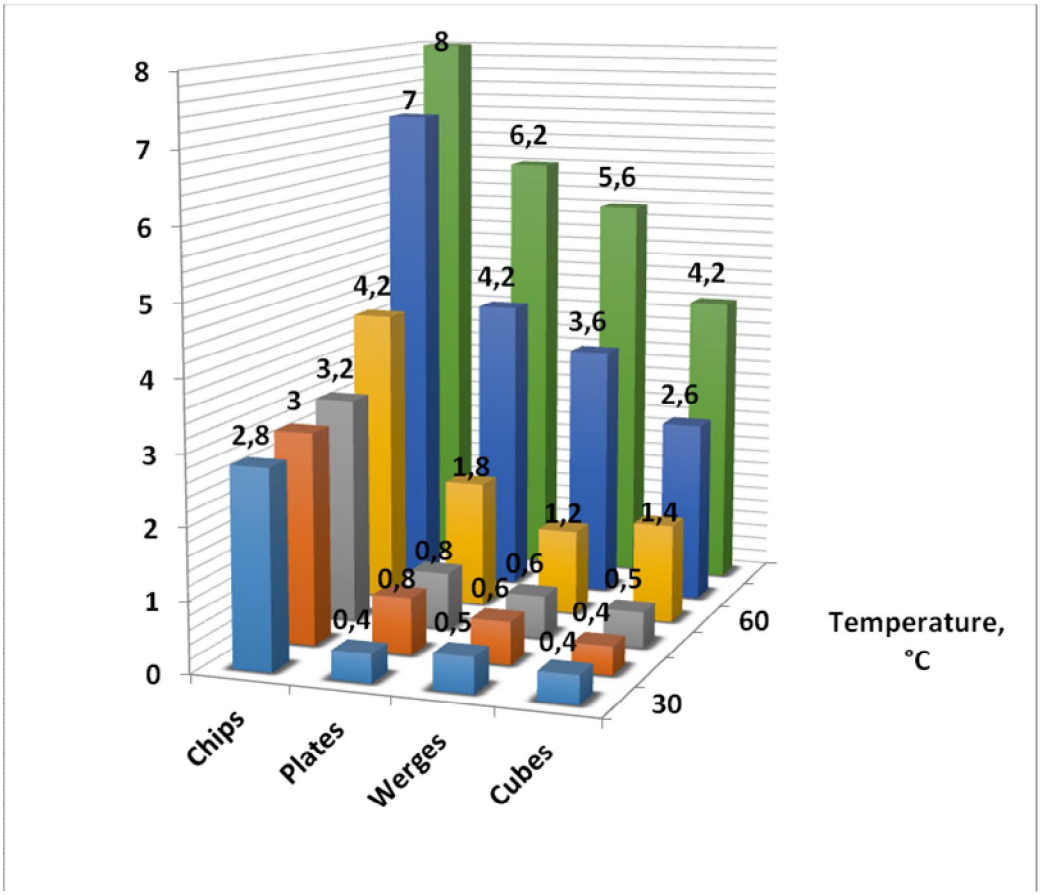

Figure 3. Dynamics of extraction of solids, depending on temperature and the form of raw materials.

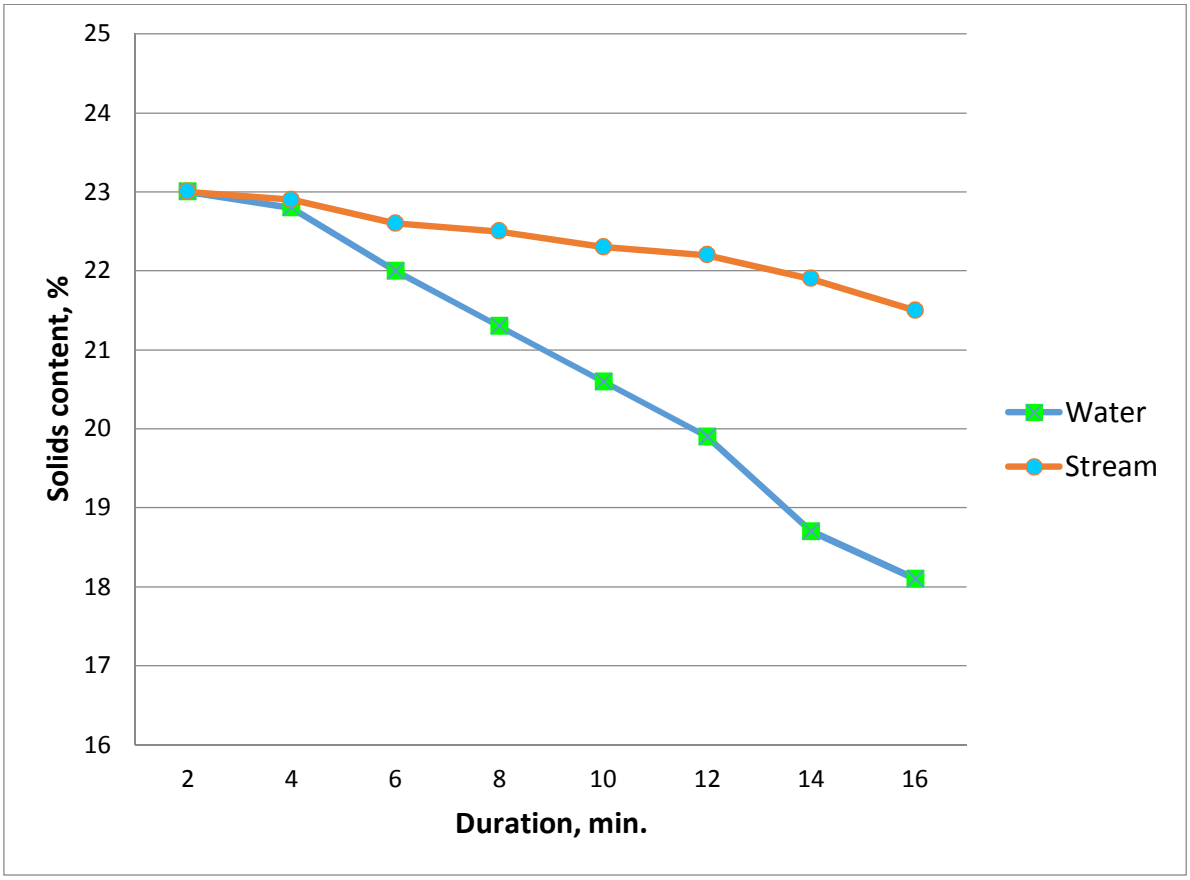

Figure 4. Loss of the solid materials in artichoke chips during the process of blanching.

Figure 5. Equipment for the concentration IKA RV 10 control.

Table 1. The dependence of the duration of the extraction temperature

Temperature extractant, °C	Time to reach equilibrium solids, min.	Note
30	95	The process is long, color light yellow
40	81	The process long, color yellow-green
50	69	The process of long, light brown color, optimum temperature for microorganisms
60	51	Color brownish-green, the optimum temperature for microorganisms
70	30	Brown color with a greenish tint
80	10	Dark brown, dry matter loss

Table 2. Content inulin depending on how clean

Method of purification of extract	Number of inulin in a concentrated extract of artichoke*, mg
Purification with alcohol	225
No purification	309
A mixture of purified alcohol extract and non purified	246

*Number of inulin is shown in the concentrated extract of artichoke with the content of solid material of 30 %.

Table 3. Organoleptic and physique and chemical properties of concentrated extract of artichoke

Indicator	Result	The method of determining
Appearance	Hardly a thick liquid without sediment and turbidity	According to ISO 46.086 - 2004
Color	Light brown	
Scent	Inherent artichoke, without foreign smell	
Taste	Sweet, typical artichoke, without outside taste	
Solids content	30 %	
Content inulin	38,7 %	