COMPARATIVE ANALYSIS OF PULSED AND STEADY RADIATION INFLUENCE ON DYNAMIC OF EXTRACTIVES

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An electron accelerator has been applied to radiation technology for extraction of grape polyphenols after the grape being preliminary dried in vacuum. It is shown that the extraction process is more effective while the irradiation is applied in a pulsed mode rather than in a steady one.

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INTRODUCTION

Now, when treatment by synthetic medical products provokes growth of complications owing to their side effect, the preference is given to the specimens made of vegetative raw material [1, 2].

The analysis of the production technology of phytochemical medications shows that one of the basic stages – extraction, determines technical and economic efficiency of all manufacture. And, unfortunately, this technology remains most poorly completed as regard to intensification of process and completeness of extraction of biologically active substances. Advantage is given to radiation-chemical technology which is determined by ability of ionizing radiation to initiate chemical processes of substance.

EXPERIMENTAL SET-UP AND METHODS

The electron accelerators are applied most widely in radiation technology [3,4]. Their advantage is stipulated by possibility to create powerful directed beams of accelerated electrons, which allows performing effectively the bombarding radiation.

Efficiency of radiation-chemical transformations in vegetable objects depends first of all on ionizing radiation influences on separate components of objects (direct influence of irradiation). The decomposition of any substances is connected with active intermediates (ions, radicals) which are generated at radiolysis of different components.

Recently, the significant attention is given to the polyphenols contained in grape. Polyphenols are cyclic spirits where in benzene ring of hydroxyl groups are contained. Polyphenols of grape in the form of flavonoids, coming to organism of animals and humans with food, are controlling and normalize processes of metabolism at cell level.

The fundamental universal reason of cells damage in organism of humans and animals is structurally functional violations of biomembranes of cells as a result of reinforcement of intensity of free-radical oxidations and formations of highly-reactionary products, which are resulting in origination of various pathological conditions (stress, oncology, immune insufficiency, aging, etc.). It is determined that antioxidants obtained from grape extract, possess the most expressed properties of free radicals neutralization among bioflavonoids.

The purpose of this paper is to study the effect of radiation influence on the dynamics of extractives from grape raw material.

Fiber and kernels of different kinds of grape were used as object of study. They were preliminary dried in thermal-vacuum dryer.

The radiation bombarding of samples was carried out on the accelerator “KUT” (pulse duration – 2.6 microseconds, frequency – 200 Hz, energy – 12 MeV) and "ELIAS" apparatus (pulse duration – 440 microseconds, frequency – 2.25 KHz, energy – 2.5 MeV). Radiation doses made up 10, 20 and 40 kGr.

RESULTS AND DISCUSSION

Dependences of pH parameter from extraction time of the unirradiated and irradiated grape material are presented in Figs.1,2 and 3.

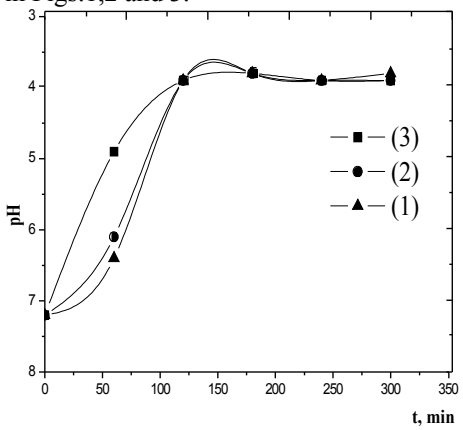

Fig.1. Extraction dynamics (pH-ions) of unirradiated and irradiated (10 kGr dose) of the grape fiber (M10): 1- control; 2 - steady irradiation; 3 - pulsed irradiation

The dynamics of hydrogen ions density during extraction of the researched substances was measured on pH-meter-340. The sample was 1 g of dry grape material. A sample was filled by 50 ml of distilled water and it was located in the thermostat for incubation at 37^0C. Magnetic rabble was used for mixing extractives. The time of pH measurements of the extracts has made 60, 120, 240 and 360 minutes.

It was studied the acidity dynamics of grape fiber and kernels extracts which has been dried at different temperatures 40°C, 50°C, 60°C and pressure of 8, 14 and 16 mm Hg *versus* radiation dose of 10, 20 and 40 kGr. These data reflect hydrogen ions density of cell contents. There is significant amount of different formations as ions, excited molecules, etc. at bombarding radiation influence onto grape samples. Complexity of structure of components of vegetative raw material creates numerous interactions with ionizing radiation,

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which probably leads to the formation of various products of radiolysis. It is known that the grape raw material contains significant amount of hydrocarbons (glucose, fructose, saccharose, mannose).

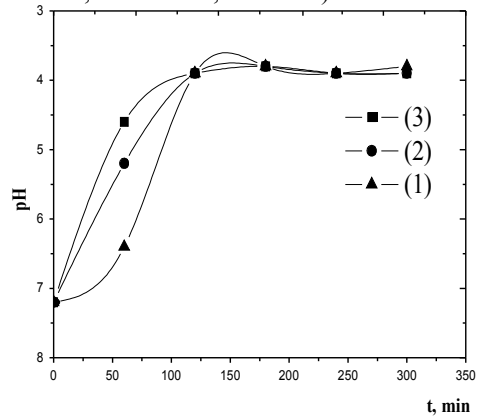

Fig.2. Extraction dynamics (pH-ions) of unirradiated and irradiated (20 kGr dose) of the grape fiber (M10): 1 - control; 2 - continuous irradiation; 3 - pulsed irradiation

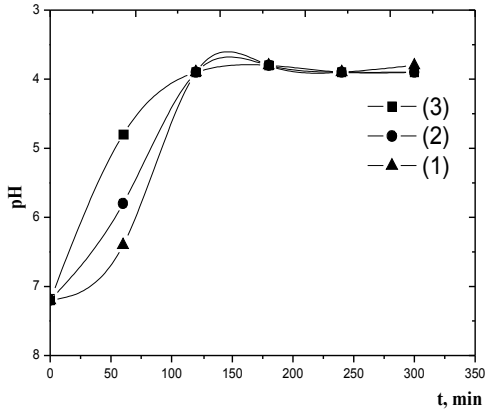

Fig. 3. Extraction dynamics (pH-ions) of unirradiated and irradiated (40 kGr dose) of the grape fiber (M10): 1 – control; 2 – steady irradiation; 3 – pulsed irradiation

At bombarding radiation application to these products by doses more than 60 kGr the disintegration of these products with formation of organic acids and formaldehydes is possible. At application of small radiation doses to these products the volatile acids are formed. The mechanism of increased acidity in the irradiated samples can be explained by molecular transport of energy obtained through H-links between hydroxyl groups and hydrocarbon molecules. Formation of acids at application of bombarding radiation to the samples containing hydrocarbons, apparently, is possible to explain also by presence of water which penetrates into crystal structure and modifies chain of hydrogen links with hydroxyl groups, violating thus transfer of energy between joints.

Raise of acidity after radiant processing of grape raw material is one of major factors of the interaction mechanism of ionizing irradiation with the extraction process. Increasing of hydrogen ions density leads to change of structure of cell shell, decrease of extracts viscosity, destruction of complex compounds, and also increase of penetrability of cell membrane structures, absorptivity, etc.

As it is known, the cell shell of grape fiber and kernels consists of the long cellulose molecules connected among themselves by polysaccharide bridges, formed by mixture of hydrocarbons. Long cellulose molecules keep their structure at the expense of different types of links. So, some links, which direction is oriented in parallel to the axis of vegetable fibers, are covalent, and other ones, directed perpendicularly to the axis, are weaker hydrogen links. It is breach of hydrogen links, which leads to acids formation.

Radiant processing of grape raw material downgrades acidity in grape fiber and kernels. Reduction of density of hydrogen ions leads to breach of cross-ties between molecules also. Other reasons of cross-ties breach can be act of free radicals, products of water radiolysis or other substances, which have arisen under act of radiant processing.

One can see from the obtained experimental data, that density of hydrogen ions in fiber and kernels, dried at different temperatures in vacuum dryer and irradiated by electrons with doses 10, 20 and 40 kGr depends on several factors: kind of grape, type of grape raw material (integral or grinded), temperature of vacuum drying and radiation dose.

CONCLUSIONS

Radiation processing of raw material intensifies the process of extraction. Intensity of extraction reduces within the dynamic of observation. The extraction process is more effective in the case of pulsed irradiation because this regime provides a higher ionization density.

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СРАВНИТЕЛЬНЫЙ АНАЛИЗ ИМПУЛЬСНОГО И НЕПРЕРЫВНОГО РАДИАЦИОННОГО ВОЗДЕЙСТВИЯ НА ДИНАМИКУ ИЗВЛЕЧЕНИЯ ЭКСТРАКТИВНЫХ ВЕЩЕСТВ

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Описано применение электронных ускорителей в радиационной технологии экстракции полифенолов винограда после вакуумной сушки. Показано, что процесс экстракции идет наиболее эффективно в образцах, облученных импульсным излучением по сравнению с контрольными образцами и образцами, облученными непрерывным излучением.

ПОРІВНЯЛЬНИЙ АНАЛІЗ ІМПУЛЬСНОГО І БЕЗПЕРЕРВНОГО РАДІАЦІЙНОГО ВПЛИВУ НА ДИНАМІКУ ВИТЯГУ ЕКСТРАКТИВНИХ РЕЧОВИН

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Описано застосування електронних прискорювачів в радіаційній технології екстракції поліфенолів винограду після вакуумного сушіння. Показано, що процес екстракції іде найбільше ефективно в зразках, опромінених імпульсним випромінюванням у порівнянні з контрольними зразками і зразками, опроміненими безперервним випромінюванням.