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APPLICATION OF THE PRINCIPLE OF NONRESONANT EFFECT OF THE INFLUENCE OF THE MICROWAVE FIELD IN THE TECHNOLOGY OF JUICE BLENDING

ЗАСТОСУВАННЯ ПРИНЦИПУ НЕРЕЗОНАНСНОГО ЕФЕКТУ ВПЛИВУ МІКРОХВИЛЬОВОГО ПОЛЯ В ТЕХНОЛОГІЇ КУПАЖУВАННЯ СОКІВ

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Abstract. *Technologies strive for improvement and this process is almost endless. In the technology of juice blending, not only the most optimal selection of components for blending remains relevant, but also the technological features of heat treatment processes.*

In this work, we have substantiated the improvement of the technological problem of pasteurization of blended juices by treating with ultra-high-frequency energy of a microwave field of nonresonant action [1-5].

For the preparation of juices, fruit and berry materials grown by FRUCTONA-VN LLC, Vinnitsia, were used. The technology of blending apple juice of the "Champion" variety with the remontant strawberry variety "Temptation" in a ratio (%) of 80:20 was chosen. The choice was made due to their high organoleptic and physicochemical characteristics.

Key words: *blending, juices, ultra-high frequency field, resonant effect.*

Анотація. *Технології прагнуть до вдосконалення і цей процес практично нескінченний. У технології купажування соків актуальним залишається не тільки найбільш оптимальний підбір компонентів для купажування, а й технологічні особливості процесів теплової обробки.*

В даній роботі обґрунтовано удосконалення технологічної задачі пастеризації купажованих соків шляхом обробки надвисокочастотною енергією НВЧ поля нерезонансної дії.

Для приготування соків використовували плодово-ягідну сировину, вирощену ТОВ "ФРУКТОНА-ВН", м. Вінниця. Було обрано технологію купажування яблучного соку сорту Чемпіон з ремонтантним сортом полуниці Спокуса у співвідношенні (%) 80:20. Вибір обумовлений їх високими органолептичними та фізико-хімічними показниками.

Ключові слова: *купажування, соки, поле надвисоких частот, резонансний ефект.*

Introduction.

Champion apple juice contains 0,5% protein, 0,1% fat, and 10,3% carbohydrates (including starch, mono- and disaccharides) in terms of nutritional value. In addition, organic acids, tannins, phytosterols, polyphenols, essential oils, useful trace elements - iron, potassium, zinc, vitamins C, A, E, and K. Many minerals, trace elements, as

well as many enzymes - potassium, sodium, phosphorus, zinc, manganese, flavonoids, phytoncides, carotenoids, etc. In addition, malic acid, starch and proteins, glucose and fructose. And, of course, a number of vitamins, the main ones being E, A and C - natural antioxidants, a group of vitamins B, as well as H and PP. The total content of complex sugars: fructose, glucose and sucrose is about 6%.

Chemical composition of the remontant strawberry variety "Temptation". In addition to proteins, fats, carbohydrates, fiber and organic acids, strawberries and strawberry juice contain vitamins: A, Z, E, H, many B vitamins; macronutrients: potassium, calcium, magnesium, sodium, sulfur, phosphorus, chlorine; trace elements: iron, manganese, copper, fluorine, chromium, zinc, iodine, boron, selenium, nickel, vanadium, cobalt, molybdenum.

Only black currant berries contain more vitamin C than strawberries. For example, it is enough to eat 5 small strawberries to get the same amount of vitamin C as an entire orange.

Strawberry juice has more folic acid (vitamin B₉) than raspberry and grape juice, and the iodine contained in berries can make up for its lack in regular food.

Of course, such a rich and useful composition allows strawberries and their juice to be used as a preventive and therapeutic agent in many cases.

The effect of strawberry juice on the body. Strawberry juice has a beneficial effect on the entire digestive system, improves appetite and cleanses the entire body, as it has a mild diaphoretic and diuretic effect.

The antioxidant effect of strawberries is also pronounced, thanks to a significant amount of vitamins and flavonoids, so its consumption prolongs youth.

Strawberry phenolic substances - polyphenols, flavonoids - actively protect the structure of our cells from destruction, preventing the development of inflammation, cardiovascular diseases, age-related brain diseases, oncology, arthritis and other health problems. The antioxidant activity of these substances is 4-5 times higher than that of the well-known antioxidants - vitamins E and C. The content of amino acids is also important. Of the 20 natural amino acids, eight are essential. These are lysine, methionine, tryptophan, phenylalanine, leucine, isoleucine, threonine, and valine. Now they also include histidine and arginine, which are not synthesized in the child's body.

Research results.

Inactivation of microflora is one of the main challenges facing the production process of any food product. It is also problematic to preserve the native nutrients of the components of the fruit and berry blend during inactivation.

The main bacteria in juice production that require inactivation are acetic acid bacteria. In nature, they are found on flowers, fruits, honey bees, grape wines, cheese, beer, kefir, brewer's yeast, vinegar, sour fruit juices, sugar cane juice, kombucha, plant tannins, and soil.

Some members of the genus *Acetobacter* can cause pink rot of pineapples, apples, and pears. One species (*A. diazotrophicus*) is a microaerophilic nitrogen-fixing microorganism present on the roots and stems of sugar cane.

Methods that contribute to the inactivation of microflora are called preservation methods in the processing of fruits and vegetables and are classified into:

- physical methods - low temperatures, high temperatures, sterilizing filters, ultraviolet radiation, ultra-high and ultra-high frequencies, X-rays (gamma rays), ionizing radiation, ultrasonic waves;
- chemical methods - sulfuric acid (sulfitation), sorbic acid, benzoic acid, antibiotics, carbon dioxide, ozone;
- physical and chemical methods - drying, sugar, salt;
- biochemical methods - fermentation, pickling, soaking;
- Combined methods - cold smoking, hot smoking, electrostatic smoking, smokeless smoking, combination of several methods.

Physical methods are based on the use of high and low temperatures, sterilizing filters, ionizing radiation, ultra-high frequency (UHF) and ultra-high frequency (UHF) currents, ultraviolet and ionizing radiation. When low temperatures are used, fruits and vegetables are cooled or frozen; when high temperatures are used, they are sterilized (above 100°C), pasteurized (below 100°C), or aseptic canning is used; when ionizing radiation is used, they are processed in inert gases or in a vacuum.

High temperatures are used to reduce the amount of microflora and inactivate oxidizing enzymes in food. Pasteurization is carried out at a temperature below 100°C to inactivate enzymes and partially destroy microflora (vegetative forms of microorganisms). There are two forms of pasteurization - short-term (85-90°C for 0.5-1 min.) and long-term (about 65°C for 24-30 min.). Sometimes, to extend the shelf life, multiple pasteurization is carried out - tindalization (repeated heat treatment of the product at intervals). Sterilization is the heating of food products at a temperature above 100°C in order to completely destroy the microflora, which allows to increase the shelf life of canned food at normal temperatures by several years. Sterilization somewhat reduces the taste and nutritional value of products due to the hydrolysis of proteins, fats, carbohydrates, destruction of vitamins, phenolic compounds, anthocyanins, some amino acids (lysine, histidine and arginine), etc. Aseptic canning is a more advanced method. It involves sterilizing liquid and pureed

food products by short-term high-temperature heating, cooling, packing them in sterile containers and sealing them under aseptic conditions. Low-temperature canning involves cooling and freezing. Cooling is the processing and storage of food products at temperatures from 0°C to 4°C, which are close to the cryoscopic temperature (freezing point of cell sap), depending on the composition and concentration of dry matter. The duration of food storage in the chilled state depends on the type of product (fruits and vegetables - 6-10 days. Freezing is a processing that results in the complete crystallization of the liquid phase and the formation of ice in the product. Freezing is carried out to a temperature in the product of -18, -20, -25°C. The most widely used method is rapid shock freezing of products in an intense stream of cold air in fluidization fast freezers (more often used for freezing small berries). Fluidization (pseudo-liquefaction) is the blowing of air from the bottom up at a certain speed through a layer of product. In this case, the dense layer of product becomes a suspension, the product particles are intensively mixed, resembling a boiling liquid, so sometimes such a layer is called «boiling». Canning using sterilizing filters helps to produce sterile food products with maximum preservation of vitamins, color, taste and aroma. The essence of the method is to pass the product through filters with a mesh size of 0.1 to 3 microns, which have pores so small that they retain microorganisms. This is how clear juices, grape wines, beer, etc. are freed from microorganisms. Canning with ionizing radiation gives a positive result without raising the temperature.

Preservation by ionizing radiation (60-400 nm wavelength) is sometimes called cold sterilization or cold pasteurization. X-rays, γ -rays, and a stream of accelerated electrons are used for food processing. The mechanism of action of ionizing radiation is based on the ionization of molecules and atoms of 24 microorganisms, which results in a decrease in their normal biological functions and their death. Preservation by ultra-high (UHF) and ultra-high (UHF) frequency currents (oscillations over 20 kHz) is based on the enhanced movement of charged particles under the influence of ultra-high and ultra-high frequencies, which leads to an increase in the temperature of the product to 100°C and above. Food products sealed in hermetically sealed containers and placed in the zone of action of ultrahigh frequency waves are heated to boiling in just 30-50 seconds. Chemicals used for food preservation should be harmless and not change the taste or color of the product. For canning, chemicals such as ethyl alcohol, acetic, sulfuric, benzoic, sorbic acids and their salts, some antibiotics, etc. are used. When canning with sulfuric acid (sulfitation), sodium bisulfate (NaHSO_3), potassium bisulfate (Na_2HSO_3), and a 5-6% solution (H_2SO_4) are used; acetic acid (marinating) - acetic acid 3-6%, vinegar essence 70-80%; benzoic

acid - sodium benzoic acid $C_6H_5CO_2Na$, benzoic acid C_6H_5COOH ; antibiotics - biomyacin, nystatin, nisin.

The peculiarities of the heat treatment process accompanying the pasteurization and sterilization of products are undesirable reactions from polyphenols and anthocyanins contained in the fruit and berry raw materials. It is also known that vitamins, amino acids and carbohydrates are destroyed.

Compared to the classical heating, the use of microwave ultra-high frequency exposure is a more modern and economical process that is more sensitive to the chemical composition of raw materials during processing. This technology is widely used in food processing and agriculture.

The advantage of microwave heating compared to traditional methods of food processing is [1, 2]:

- 1) high process speed (e.g., drying time is reduced by 10 ... 30 times);
- 2) short time to reach the mode (not exceeding 1 ... 2 min.);
- 3) heat distribution over the entire volume of the material, regardless of its thermal conductivity;
- 4) selectivity of the process: wet particles of the material warm up faster than dry ones, which is not typical for convection heating;
- 5) possibility of full automation of the process with characteristic inertia of heating;
- 6) high efficiency of the process;
- 7) no need to use coolants, significant reduction of heat losses to the environment and reduction of its pollution;
- 8) reduction of production areas by 3...5 times;
- 9) high bactericidal effect of microwave energy;
- 10) high nutritional value of products, preservation of vitamins;
- 11) reduction of service personnel by 10...50%;
- 12) possibility of obtaining finished products with new properties.

But a significant drawback is the formation of so-called "standing waves" in the microwave chamber. They cause localized overheating zones in places of their maximum. And there are also underheating zones in the places of the waves' minima. Of course, this affects the chemical composition of the product and insufficiently inactivates the microflora.

Conclusions.

Therefore, to carry out the heat treatment process by microwave exposure, the principles of nonresonant action of the microwave field were used in the study. The improvement of this type of microwave apparatus is that the converter, i.e. the

absorber, of ballast field energy into thermal energy, which, along with the field concentrator in the product volume, is necessary to obtain a "traveling" wave in the chamber, has a high level (10 dB/mm) of the field transmission coefficient into the energy absorber. At the same time, there is no local overheating or underheating of the product. The technical realization of the non-resonant chamber was achieved by concentrating the field energy in the product volume, converting the ballast field energy into thermal energy and utilizing it. Selective heating of products in a non-resonant working chamber makes it possible to reduce the temperature required for guaranteed inactivation of microflora by 25...30 °C. This contributes to the preservation of product components due to the absence of overheating and reduced energy consumption. In addition, it ensures: the exclusion of harmful radiation from the working chamber; prevents generator overheating and eliminates the dependence of the chamber's energy efficiency on the level of its product load [3].

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