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OF THE REPUBLIC OF KAZAKHSTAN

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T. Tazhibaev, R. Arziyeva, B. Turegeldiyev, G. Ahmetkanova

Kazakh national agrarian university, Almaty, Kazakhstan

MILLING OF VEGETABLES ON A CAVITATIONAL DISPERSANT

Abstract. Analyzed and generalized results of the study of the possibilities of using cavitation plants for dispersing vegetables in the production of puree products. It is established that the homogenization of vegetables, together with the skin and seeds, further enriches the finished product with biologically active and mineral substances.
Keywords: homogenization, dispersion, cavitation, milling of vegetables, puree, puree products from vegetables.

Introduction. The vegetables and fruits are among the most important food products. In the human diet, their share should account for about 30-35% of the total consumption of basic products. Therefore, the production and processing of vegetable crops and potatoes are one of the main branches of the food complex.

The production of vegetables, melons, and potatoes in Kazakhstan in recent years provides a human need above the national consumption rate. The situation is worse with canned fruits and vegetables. Their production per capita is 100 or more times lower than the calculated consumption rates. For processing, there is no more than one percent of fruits and vegetables produced.

The fruit and vegetable products belong to the perishable group, so the lack of sales guarantees sharply increases the possible risks of producers. Today, sales difficulties are one of the main factors hampering the development of fruit and vegetable growing in Kazakhstan. The development of processing has the prospect of growth, which in turn creates the prospect of increasing the domestic market for fresh vegetables and fruits and can give greater stability and assurance to the sale of vegetables and fruits.

One of the main ways of processing can be the production of vegetable puree products, which are both the end product for consumption, and intermediate raw materials for further processing.

The advantage of such products is the convenience of their transportation, relatively long shelf life and sufficient ease of use for further processing. The vegetable purees in terms of nutritional value are almost as good as fresh products, and by digestibility even surpass them. The production of puree from vegetables is difficult in terms of technology and energy-consuming. It is necessary to search for new ways of processing fruits and vegetables that are embedded in the existing technological chain

Recently, the production of native, ecologically safe food products, such as biological products is becoming important. Hence, Kazakhstan currently occupies a unique position in connection with the almost complete absence of production of genetically modified plant raw materials and the availability of favorable land resources for the production of bio products.

On the other hand, ecologically safe technologies are needed for processing bio-products.

One of such approaches to innovative and environmentally safe processing are technologies based on hydromechanical effects on raw materials with elements of cavitation manifestations and nanotechnologies [1].

In the new products, the content of vitamins, cellulose and other biologically active substances increases. The puree products from vegetables as a raw material just meet all these requirements. They can also be used for the production of products with "status" dietary and curative and preventive. The puree-like products can be used for quick cooking in the home and in public catering. One of the promising areas for the use of puree products from vegetables is the development of an assortment of products for children and school meals, the development of instant formulas.

Therefore, the creation of new-generation vegetable and fruit purees in order to improve consumer properties, improve the biological and nutritional value of products and develop rational process regimes are an important direction in the field of technology improvement [2].

In its majority, the preparation of puree mass is carried out by the "wiping" method. With this method, there is a large waste and the need for cleaning the sieves. Hence, to improve the consistency and resistance to delamination, the product is homogenized. With homogenization, the size of the pulp particles decreases to 50 μm or less, this contributes to the preservation of the pulp in a suspended state. Plunger homogenizers are mainly used for homogenization.

Materials and methods. Based on the analysis of research results, the most popular types of vegetable and fruit crops suitable for hydromechanical grinding were selected.

The following criteria were taken for objective selection:

– high nutritional, nutritional and dietary value;
– convenience for cavitation grinding;
– technological simplicity of use in homogenization;
– high demand for processed products;
– universality of the use of homogenates obtained;
– sufficient production volumes;
– possibilities of non-waste grinding along with peel and seeds.

As a result, for further study and development of the technology of cavitation dispersion, tomatoes and carrots were selected.

Information on the technological properties of these vegetable crops indicates that they are valuable food products since they contain almost the entire complex of biologically active substances and other essential nutrients. Hence, the task is to develop technological solutions for the more use of useful properties of raw materials, developing new resource-saving technologies, using secondary raw materials. The main task is the most complete and non-waste processing of raw materials with the maximum possible preservation in its unchanged form of constituent components: vitamins, macro and micro elements, pectins, coloring and other biologically active substances.

The fruits of all these crops were analyzed for chemical and mechanical composition.

The content of vitamins C, E, B3, B6, B9, beta-carotene was determined; the content of mineral substances (calcium, magnesium, iron, copper) and dry substances separately in pulp, peel, and seeds. The correlation in the berries of pulp, peel, and seeds is analyzed.

The correlation in the fruits of the studied cultures of pulp, peel, and seeds was carried out under laboratory conditions by division into component components and weighing on the MWP-150 N electronic scales.

The determination of vitamins was carried out on an "Agilent-1200" chromatograph with a spectrophotometric and fluorometric detector in accordance with the requirements of normative documents (GOST 8756.22-80; GOST 7047-55, p.VIII; P 4.1.1672-2003, p.I., p. 2).

The method for the determination of folic acid is based on the extraction of the folic acid added to the product with 0.001M NaOH solution, followed by the analysis of an aliquot of an alkaline solution on a liquid chromatograph from Hewelett Packard in a gradient elution mode on a reverse phase column (C18) using a spectrophotometric or diode matrix Detector.

Determination of mineral substances was carried out in accordance with the requirements of normative documents (P 4.1.1672-2003, p. II, p.3; P 4.1.1672-2003, p.II, p.3; GOST 26928-86; GOST R 51301-99;). By the following methods:

– Ca, Mg - titrimetric method;
– Fe - spectrophotometric method. Spectrophotometer "Jenwey" production of Japan;
– Zn - voltammetry method. "ABA-3" - the analyzer voltamperometry production of Russia.

The dry substances were determined by drying to constant weight. The drying cabinet BINDER, production of Germany was used with FED Series. The electronic balance MWP-150 N was used (the smallest weighing limit is 0.01 g, the price of the verification division is 0.005 g, the discreteness of the count is 0.005 g).

Results and discussion. The vegetables, as a processing object, are characterized by a large amount of water and a low content of solids. Hence, the use of rinds and seeds having a higher solids content may be of great importance.

At the Kazakh national agrarian university, a plant is being established that grinds vegetables, fruits, berries together with seeds, skin, and pulp, and the degree of grinding achievable is unattainable when using existing grinders. The rotary pulsation cavitator simultaneously with grinding heats the ground mass to a pasteurization temperature of 60-70 °C. It has been established that a decrease in the temperature of processing vegetables from 90 to 60 ... 70 ° C makes it possible to maintain biologically active substances more fully. It is possible to process vegetable raw materials with maximum preservation of aroma, appearance and biochemical composition, with enrichment of the product with vitamins and other useful substances from the skin and seeds of the fetus. The fresh vegetables and fruits together with seeds, leaves, skin and pedicles are completely dispersed in a cavitation apparatus.

The technological scheme of processing is simplified by combining the stages of blanching, rubbing, homogenization, pasteurization in one stage under conditions of the hydro-mechanical processing.

We have started the development of technology for processing vegetables and fruits to produce a wide range of eco-friendly products: purees, juices, pastes, confitures, and etc., based on hydro-mechanical processing of feedstock. This processing of fruit and vegetable products can be carried out on rotor-pulsating plants using the principle of cavitation. The application of the cavitation effect makes it possible to obtain a homogenized product of a high degree of dispersion with simultaneous or subsequent heat treatment.

Cavitation devices harmoniously fit into the technological process of processing fruits and vegetables in puree production, without changing the basic laws of the process in conjunction with the physico-chemical and structural-mechanical characteristics of the raw materials being investigated [3].

The use of a variety of physical effects allows significantly accelerating biochemical reactions and obtaining results unattainable with the use of traditional technologies [4]. The vegetable raw material is a heterogeneous mass, which contains pieces of flesh pulp, skin particles, seeds, seed nests, pedicels, having a different size, shape, moisture content and correspondingly different colloidal-physical properties

The development of non-waste technologies is an important factor when processing plant raw materials. At present, the almost universal use of traditional, sometimes obsolete technologies, leads to the accumulation of a large mass of underutilized wastes from the processing of various biocompatible materials. At the same time, a study by experts of the chemical composition of waste confirms the fact that practically all wastes are valuable secondary raw materials.

In conditions of industrial processing of tomatoes, the seeds and peel of fruits constitute a significant share of losses. In practice, the potential and natural resource of waste from peels and seeds is used irrationally and not completely, as their chemical composition is poorly understood. The prospect of using peels and seeds in the food industry determines the availability of raw materials, but to solve the issue of its nutritional importance, extensive studies of its chemical composition are required.

In this regard, a comparative study of the chemical composition of seeds, rind, and flesh of berries for the purpose of using this bio concrete in food production is relevant [5].

Since in the cavitation dispersant is planned to grind the fruits together with seeds and skin, it is important to know the ratio of these components in the cultures studied. These data will be important in the theoretical calculations of the processes occurring during rotary pulsation grinding of each culture.

The analysis data for determining the content of pulp, rind, and seeds in fruits are given in Table 1.

As can be seen from the table, the content of seeds and peel in tomato depends on the size of the fruit. In 1,5-2,0 times more than in fruits of medium size. In large fruits, this ratio is likely to be even greater.

Table 1 – Ratio of pulp, rind and seeds in fruits

Crop	Concentration in fruits, %		
	rind	Seed	pulp
Tomatoes with medium-fruited	2,75	1,01	95,9
Tomatoes with small-fruited	3,08	0,72	94,5
Carrot	27,1(refuse)	–	72,9 (juice)

Accordingly, the pulp in the fruit is less, and therefore at the frequency of processing, when the seeds and peel go into waste, the losses are greater. Consequently, with cavitation grinding of tomatoes, 4-5 percent of the raw material losses are saved.

Since there are no seeds and rinds in the carrots, we determined the amount of squeeze when pressing the carrots onto the juice. As you can see from the table when pressing carrots to 27 percent of raw materials can go into losses. With cavitation grinding, these losses are excluded. From them, a homogenate with a high content of useful fiber and biologically active substances can be obtained.

The content of solids in different parts of the fetus (Table 2) also turned out to be different. The highest content of solids up to 25% was observed in seeds of tomatoes.

The content of solids ranged from 4% in the flesh of tomato to 25% in seeds. This means that when the fruit is dispersed along with the seeds and the skin, the resulting homogenate will contain more solids and including useful biologically active substances than traditional technologies where only pulp or juice is useful.

Table 2 – The dry matter content of different parts of the fruit

Crop	Dry matter content, %		
	rind	Seed	pulp
Tomato	18,3	25,0	4,0
Carrot	–	–	19,7

Tomatoes are especially important in the canning industry. T widespread use of tomato fruit in human nutrition is due to their high nutritional, flavor and dietary properties associated with the chemical composition.

The nutritional value of tomatoes is due to the content in them of a large number of substances that are very important for the human body: sugars, vitamins, organic acids, amino acids, proteins, enzymes, mineral salts, cellulose, pectins, fats, phytoncides and other useful biologically active substances. The fruits have a delicate fiber, which accounts for only 0.5-0.9%, which increases their useful properties. The composition of tomatoes also includes pectin substances (0.1-0.3%), hemicellulose (0.1-0.2%), dietary fiber (0.4-0.8%), starch. Tomatoes are the most valuable biochemical product. Tomatoes contain proteins, enzymes, amino acids, mono and oligosaccharides (fructose, raffinose, sucrose), as well as polysaccharides (fiber and pectin substances). Of other substances is a high content of carotenoids, vitamins (B1, B2, B3, B5, folic and ascorbic acids), organic acids (citric, malic, oxalic, succinic, tartaric), high-molecular fatty and phenolic carboxylic acids. In fruits, in addition, anthocyanins, sterols, triterpene saponins, abscisic acid are found. The fruits are very saturated with iron salts, trace elements, such as zinc, copper, fluorine, and iodine. They also contain potassium, calcium, magnesium, phosphorus and other minerals. According to the content of iron and magnesium, tomatoes occupy one of the first places among vegetable plants [6].

Tomatoes, along with carrots, are an important supplier of carotenoids, which form vitamin A in the human body.

Tomatoes are rich in lycopene, a powerful antioxidant. Heat-treated tomatoes are more useful than raw tomatoes, a number of lycopene increases in them.

Seeds of tomatoes have 17-29% of the oil. The composition of fatty acids, tomato seed oil refers to full-fledged food. For example, semi-drying oil is extracted from seeds and they are filled with salads in Italy. When the tomato juice is squeezed out, fats usually go to the cake, which goes to waste. Oil from tomato seeds contains a high proportion of unsaturated fatty acids, especially linoleic acid. Tomato oil is a high-calorie product, a source of valuable physiologically active substances: fat-soluble vitamins, phytosterols, and etc.. With internal application, tomato seed oil prevents aging processes in the body, improves immunity, helps to remove heavy metals, normalizes cholesterol and fat metabolism, promotes protein uptake, Elasticity, and permeability of blood vessels, prevents the development of atherosclerosis. Lycopene, contained in tomato seed oil, has antitumor action, is effective in cardiovascular diseases and atherosclerosis, and has antioxidant properties [7].

The results of analysis of the chemical composition of seeds, rind, and flesh of tomato fruit are presented in Table 3.

Table 3 – Chemical composition of tomato fruit

№	Indicators	Content, mg/100g		
		seed	rind	pulp
Vitamins				
1	Vitamin E	Not found	0,2074	0,6432
2	Beta-carotene	0,88	4,0	0,45
3	Vitamin B_3	0,027	0,297	0,207
4	Vitamin B_6	0,005	0,056	0,039
5	Vitamin B_9	0,55	6,6	4,29
6	Vitamin C	1,25	14,321	9,757
Minerals				
7	Calcium	57	18	40
8	Magnesium	13	4,8	11,0
9	Iron	3,33	1,07	2,24
10	Zinc	0,111	0,077	0,078

As can be seen from the table, the content of beta-carotene in tomato seeds (0.88 mg / 100 g) is high, but in the peel, it is even higher (4.0), which is almost 10 times higher than in pulp (0.45). There is also a high content of vitamins B9, E, C, B3 in the skin and in the flesh of tomatoes, and the vitamins B9, B3 and C in the skin are much higher.

In tomato seeds, the mineral content was significantly higher than in other parts. It should be noted the high level of iron in all parts of tomato fruits, and especially in seeds (3.33 mg/100 g).

It can be concluded that the homogenization of tomatoes together with the skin and seeds will help enrich the final product with vitamins and minerals.

Carrots are very affordable, inexpensive vegetable. Carrots are one of the main vegetable crops not only in Kazakhstan but also in almost all countries of the world. Carrots used in the vitamin industry to produce carotene. Carrots are a valuable dietary product.

Carrots are a multivitamin. In the roots of carrots contain water-soluble vitamins C, B1, B2, B6 and fat-soluble - E, D, K, essential oils, flavonoids. Carrots also contain a small amount of iodine. Root carrots are rich in carotenoids (α-, β-, γ-carotene, phytophene, phytoene, etc.). Carotene, contained in carrots, under the influence of the liver enzyme, is converted into vitamin A.

Roots are rich in mineral salts of sodium, calcium, potassium, magnesium, iron, phosphorus, iodine [6,7].

The results of the analysis of the chemical composition of carrots are presented in Table 4.

Table 4 – Chemical composition of carrots

Indicators	Content, mg/100g
Vitamins	
Vitamin E	0,5781
Beta-carotene	8,37
Vitamin B_3	1,231
Vitamin B_6	0,124
Vitamin B_9	11,0
Vitamin C	4,733
Minerals	
Calcium	63
Magnesium	21
Iron	0,57
Zinc	0,059

The content of minerals in carrots at the level of data presented in the literature.

As can be seen from the table, carrots are characterized by a high content of beta-carotene, vitamins B9, B3, C, E. Carrots are used in significant amounts in the production of baby food. This circumstance puts forward particularly stringent requirements for the preservation of vitamins during processing for puree products. The proposed plants for rotary pulsation crushing fruit and vegetable raw materials can help in solving these problems.

Conclusion. The grinding of vegetables together with the skin and seeds during the production of puree products allows enriching the production with vitamins, mineral and other useful substances.

The use of cavitation plants for the dispersion of vegetables in the production of purees can reduce waste, improve the quality and nutritional value of the final product.

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Т. С. Тәжібаев, Р. Ю. Арзиева, Б. А. Турегельдиев, Г. А. Ахметканова

Қазақ ұлттық аграрлық университеті, Алматы, Қазақстан

КАВИТАЦИЯЛЫҚ ДИСПЕРГАТОРДА КОКӨНІСТЕРДІ МАЙДАЛАУ

Аннотация. Пюретәрізді өнімдер дайындау технологиясында кокөністерді майдалу үшін кавитациялық қондырғыларды пайдалану мүмкіншіліктерін зерттеу бойынша нәтижелері талдандып тұжырымдалды. Кокөністерді тұқым және қабығымен бірге гомогенизациялау, дайын өнімді биологиялық белсенді және минералдық заттармен одан әрі байытатындығы анықталды.

Түйін сөздер: гомогенизациялау, диспергирлеу, кавитация, жидектерді майдалу, пюре, кокөністерден дайындалған пюретәрізді өнімдер.

Т. С. Тажибаев, Р. Ю. Арзиева, Б. А. Турегельдиев, Г. А. Ахметканова

Казахский национальный аграрный университет, Алматы, Казахстан

ИЗМЕЛЬЧЕНИЕ ОВОЩЕЙ НА КАВИТАЦИОННОМ ДИСПЕРГАТОРЕ

Аннотация. Проанализированы и обобщены результаты исследований по изучению возможности использования кавитационных установок для диспергирования овощей при производстве пюреобразных продуктов. Установлено, что гомогенизация овощей вместе с кожурой и семенами дополнительно обогащает готовый продукт биологически активными и минеральными веществами.

Ключевые слова: гомогенизация, диспергирование, кавитация, измельчение овощей, пюре, пюреобразные продукты из овощей.

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