The study of fractional composition of pectin substances in vegetables and technical means of its obtaining

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Abstract. The article discusses the feasibility of automation of technological process of liquid pectin obtaining for the production of functional beverages to ensure a given quality and required physiological properties. There were presented the comparative differences between traditional operator consoles and workstations. There was justified the expediency of control and regulation of main technological parameters of the process of pectin extraction. There was described the algorithm of evaluating the results of real-time monitoring of the process.

Pectin substances in plant raw materials are in soluble and insoluble (protopectin) form and are closely related to other polysaccharide components of plant cells. The fractional composition of pectin substances causes a difference in the structure and texture of plant tissue. For example, protopectin, localized in the cell wall and intercellular parts, performs structural functions along with cellulose and hemicellulose. Soluble pectin is found mainly in vacuoles [1].

Tomatoes, cucumbers, bell peppers, beet pulp of the Uspensky sugar plant (Fig. 1) were chosen as objects of the research [2].

At the process of hydrolysis-extraction of pectin substances from beet pulp, 1.5% hydrochloric acid is used as a hydrolyzing agent. The hydromodule of q= 1:10. The mass of sample taken for the process of hydrolysis-extraction (m_{hinge}) = 60 g. The water volume of water taken for the study (V_{H2O}) = 600 ml. The duration of hydrolysis - extraction process was 3 hours at 80°C.

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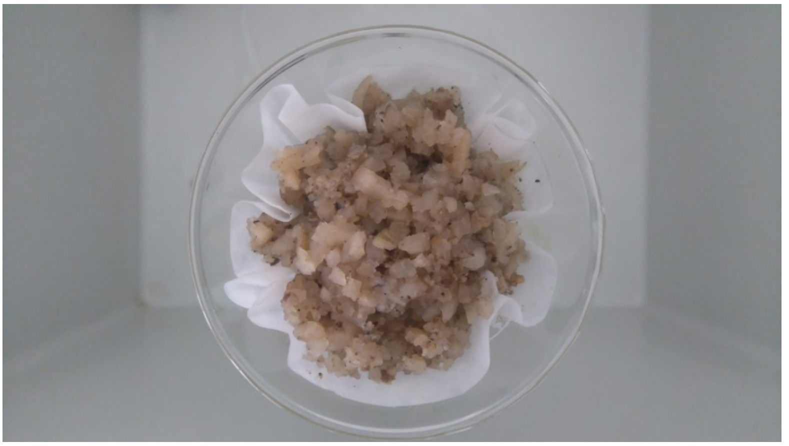

Fig. 1. Beet pulp.

Then there was obtained the beet pectin extract in volume of 440 ml with pH= 0,8 and content CB = 5,1 %. Further, this extract was precipitated with alcohol. The mass of pectin substances after deposition of the extract was 2.52 g (Fig. 2).

Fig. 2. Beet pectin.

The content of pectin substances in sugar beet was determined by calcium-pectate method. The method involves drying a pleated paper filter to constant weight, the preparation of standardized solutions of protopectin and hydrate pectin, sampling [3]. Fractions of pectin substances in the sample solutions with NaOH for 8-10 hours neutralize and soap acidic solution. After that, the precipitated pectin was filtered and precipitated. Then the precipitates on the filters are washed with cold distilled water. Filters with precipitation are dried to a constant mass and calculate the mass fraction of fractions of pectin substances according to certain formulas [4].

The results of the calcium-pectate method of pectin substances from beet pulp are shown in Figure 3.

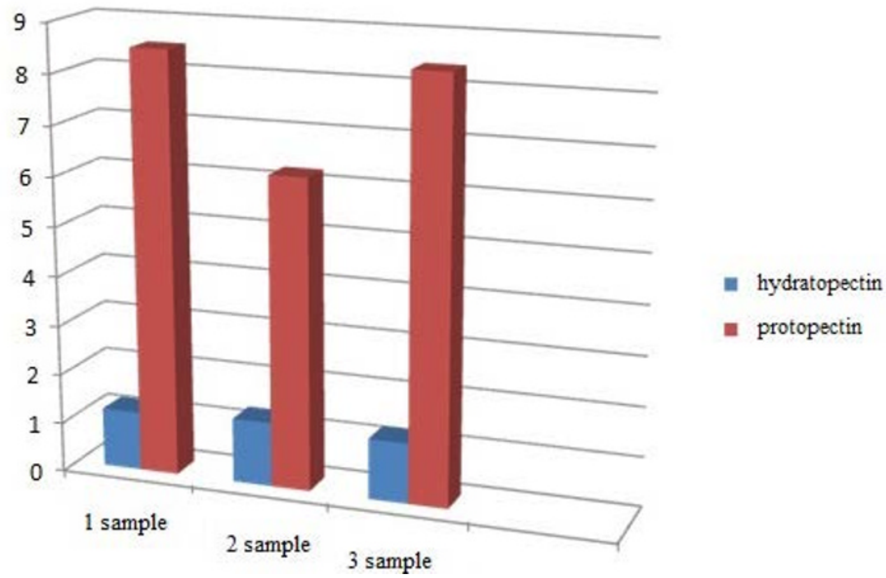

Fig. 3. Content of proto- and hydrate pectin.

Formula 1 is used to calculate the number of hydrate and protopectin

$$X = \frac{(m_{\phi+n} - m_{\phi}) \times 0,9235 V_{flasks} \times 100}{V_{exstr} \times m_{hinge}} \quad (1)$$

where X – content of available fraction of pectin in researched material, % from raw mass;

$m_{ф+n}$ – mass of a box with filter and dried to constant mass of precipitation, g;

$m_{ф}$ - mass of a box with dried filter to filtration, g;

V_{flasks} – volume of measuring jar with “standardized” solution, ml;

0,9235 – coefficient of recalculation to pectin acid;

100 - coefficient of recalculation in %;

m_{hinge} – mass of researched sample, g;

V_{exstr} – volume of “standardized” solution which is necessary to conduct the experiment.

Calculation of the number of hydrate – and protopectin in beet pulp:

GP (1) = 0.0257*0,9235*250*100/50*10 = 1,19 %

GP (2) = 0,0282*0,9235*250*100/50*10 = 1,3%

GP (3) = 0,0263*0,9235*250*100/50*10 = 1,22%

PP (1) = 0,0924*0,9235*500*100/50*10 = 8,53 %

PP (2) = 0,0678*0,9235*500*100/50×10 = 6,26 %

PP (3) = 0,0909*0,9235*500*100/50×10 = 8,4 %

Content of the number of hydrate – and protopectin in tomatoes, cucumbers, bell peppers was determined by the volume method. The results of the researches are presented in Figure 4 [5].

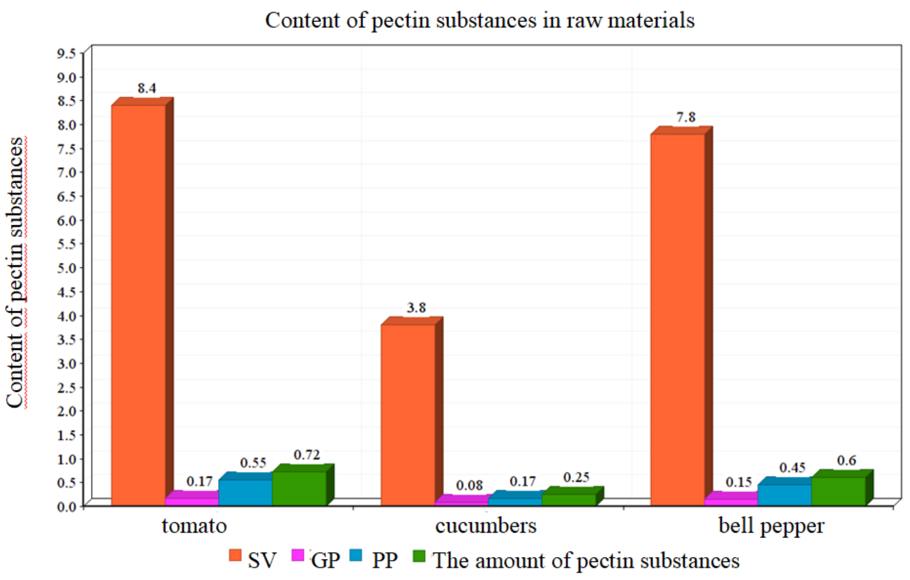

Fig. 4. Content of pectin substances.

According to the graphic data, the most pectin substances are found in tomatoes (0.72 %), and the least in cucumbers (0.25 %). The amount of dry matter is also the most in tomatoes (8.4 %), almost the same in bell pepper (7.8%) and the least in cucumbers (3.8%).

Study of analytical characteristics of pectin substances of selected vegetable raw materials.

As already noted, the belonging of pectin substances to polysaccharides determines their basic physical and chemical properties.

Thus, ionized carboxyl groups give the molecules of pectin substances the character of polyelectrolytes-polyacids and corresponding electrical, configurational and hydrodynamic properties. Carboxyl and hydroxyl groups determine the water-holding capacity of pectin substances. The presence of side chains in the macromolecule of rhamnogalacturonan and esterification of carboxyl groups with methanol contribute to the weakening of acidic properties of pectin. Properties of pectin extracted from plant tissues largely depends on the source of pectin, extraction method (hydrolysis), hydrolyzing agent, and processing of obtained pectin following the hydrolysis.

Complex-forming properties of pectin substances depend on the content of free carboxyl groups, i.e. the degree of esterification of carboxyl groups with methanol [6].

The method of conductometric titration was used to determine the analytical characteristics of pectin substances of selected research objects. Conductometric methods of analysis are based on the measurement of the electrical conductivity of solutions under study, and therefore, this property of electrolyte solutions is of paramount importance in conductometry [7].

The following results were received on the basis of the carried out researches of analytical characteristics of received beet pectin by the conductometric method:

- content of free carboxyl groups - 5,85%
- esterified carboxyl groups (Кэ) - 9,45%
- degree of esterification of carboxyl groups (Ст.Е) – 61,76%
- share of net polygalacturonase acid (Пч) – 62,8%

During the study of vegetable juices included in the drink there were obtained the following results presented in Figure 5.

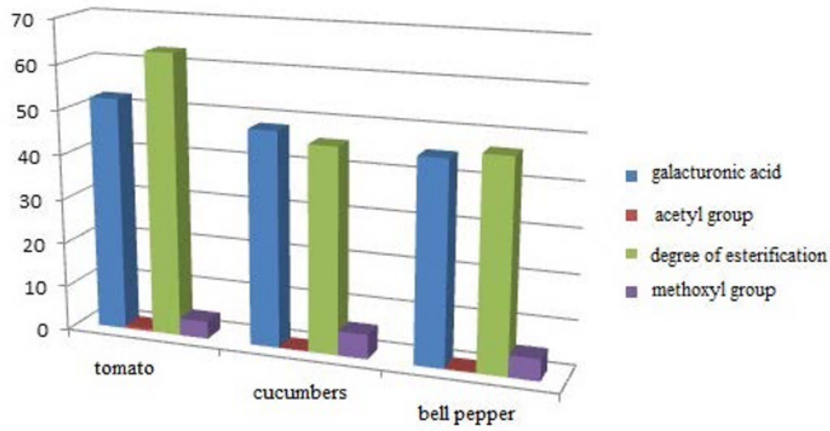

Fig. 5. Results of raw material research.

From the graphs it can be concluded that most of galacturonic acid (52.4%) and acetyl groups (0.64%) are contained in tomatoes, in which the highest degree of etherification (Cт.E 63.2 per cent) and the smallest content metaxylene groups (3.9 percent). In cucumbers and Bulgarian peppers the content of galacturonic acid is 48.1% and 45.2% respectively, the content of acetyl groups in cucumbers 0,2%, in Bulgarian pepper of 0.3, the degree of esterification is equal to 45.8% in cucumbers and 46.8% in Bulgarian pepper. The number of metaxylene groups are most in cucumbers - 5.5%, in Bulgarian pepper - 4.9%. Pectin contained in all components of the drink is highly esterified, which enhances the taste of the drink, allows you to get a homogeneous product, preventing the pulp subsidence, supports natural flavor, provides taste perception of juice.

References

1. Sobol I.V. Peculiarities of analytical characteristics of extracted pectin from sunflower /I.V. Sobol, L.V. Donchenko, L.Y. Rodionova, A.G. Koshchaev, A.V.Stepovoy // Asian Journal of Pharmaceutics, 2017. T. 11, № 1. – P. 97-100.
2. Ogneva O.A. Pectin-containing beverage with probiotic substances / O.A. Ogneva, L.V. Donchenko // Multidisciplinary network electronic scientific journal of Kuban State Agrarian University, 2015, № 107. – P. 333-341.
3. Degtyarev L.S. Properties and structure of galacturonic acid in pectin production technology. Proceedings of higher educational institutions. / L.S. Degtyarev, M.P. Kupchik, L.V. Donchenko, O.V.Bogdanova // Food Technology, 2002, № 4. – P. 15-17.
4. Il'ina I.A. Peculiarities of technology of highly prolonged pectines obtaining / I.A. Il'ina, L.V. Donchenko, Z.G. Zemskova // Herald of the Russian Agricultural Academy, 2003, № 3. – P. 8-10.
5. Azimova S.T. Towards food security through application of new scientific findings / S.T. Azimova, M.Z. Kizatova, S.O. Akhmetova, L.V. Donchenko, A.M.Admayeva // Journal of Security and Sustainability Issues, 2017. V. 6, № 4. – P. 719-728.
6. Belousova A. I. Innovation solutions in development of biocomponent beverage technology for specialized nutrition [Text] / A.I. Belousova, L.V. Donchenko // In the book: Food technologies: researches, innovations: materials of the 1st national scientific-research conference, Kerch, 2018: RGMTU, IMBI, AzSRIF, 2018. P. 6-8.
7. Donchenko L.V. Pectin: main properties, production and application / L.V. Donchenko, G.G. Firsov. M.: DeLi print, 2007. – 276 p.