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Determination ways of dielectric conductivity in fruits and vegetables

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Abstract- This article describes the results of research conducted to determine the dielectric constant of fruits and vegetables. The complex dielectric constant is characterized, the experimental methodology and the equipment used are given. Also keywords, kand relevance of the topic,the calculation method and the results of the dielectric properties of whole and cut varieties of fruits (apricots, apples, plums) and vegetables (carrots, potatoes, beets and onions) of different sizes are given in the experimental process.

Keywords- Dielectrics, Dielectric Properties, Microwave Heating, Frequency Range, Microwave Field Input Depth, Resonance, Waveguide, Free And Slow Wave Method.

I. INTRODUCTION

Today, “Fruit and vegetable production is growing rapidly around the world. China, India and the United States are leading the way. Over the past 10 years, exports of fruits and vegetables have increased 10 times and exports 12 times in value terms. For this reason, scientific research is being developed in the field of processing all fruits and vegetables and obtaining semi-finished and finished food products from them.

It is known that fruits and vegetables rich in natural vitamins, micro and macro elements, including dried apples and plums, potatoes and carrots and theirProduction of processed products using modern technologies, including the maximum preservation of natural components, as well as improving the consumer quality of products, increasing their nutritional safety and biological value, the development of technologies for obtaining quality fruit and vegetable juices.

After gaining independence, our country has achieved certain results in the development of agriculture and the improvement of technological processes for the processing of agricultural raw materials and the creation of new ones.Action Strategy for further development of the Republic of Uzbekistan "Modernization of agriculture, consistent development of agricultural production, further strengthening of food security of the country, expansion of production of environmentally friendly products, deep processing of agricultural products" [2]. In this regard, research work aimed at extracting juice from fruits and vegetables rich in vitamins, carbohydrates and minerals with high content of natural components, drying and export-oriented packaging is of great importance.

In the processing of fruits and vegetables under the influence of electricity, it is important to know their electrophysical properties. It is necessary to know the mechanism of processes in electrophysical processing of fruits and vegetables (electroplasmolysis, electroflotation, heating in the electromagnetic field, etc.), in the design of electrical equipment, construction, determining the speed of their transport organs, to calculate the processing regimes of fruits and vegetables. One of the main electrophysical properties of products is their dielectric constant.

II. LITERATURE REVIEW

The following scholars have considered the determination ways of dielectric conductivity in fruits and vegetables in their research: Kurbanov Zh.M., Khodjaeva U.R. [3], Rogov I.A., Gorbatov A.V. [4], Brandt A.A. [5], Eli F. [6], Rogov I.A., Nekrutman S.V., Lysov G.G. [7], Kurbanov Zh.M., Ostapenkov A.M [8].

III. RESEARCH METHODOLOGY

In this research, we used of methods of logical analysis and synthesis, grouping, abstraction, induction and deduction.

IV. ANALYSIS AND RESULTS

At present, the dielectric constant of fruits and vegetables in the ultra-high frequency (UHF) range can be determined experimentally by various methods. The choice of these methods depends on the composition of the product, the temperature and in what frequency range to measure.

Due to the variety of functions, there is no universal methodology for measuring dielectric properties. Methods of measuring dielectric properties differ in the following main parameters. These include the frequency range in which they are measured; dielectric conductivity measurement limit and light absorption tangent angle; the accuracy of measuring these quantities; the amount of sample material used; experimental temperature range; even in the solid, liquid, and gaseous state of the products, the method's usability, the complexity of sample preparation, the cost of the instrument, the ease of experimentation, and the complexity of the calculation. Currently, Commonly accepted methods in the OYUC rangeiga: resonant, wave, transmitter, free wave method and slow wave based methods.

In the composition of modern meters, modifications of waveguide methods are common. Such versatility is due to the cross-section of its various waveguides, which are: right-angled or filled with a fully or partially tested product. A separate modification of this method depends on the nature of the propagation of electromagnetic waves (standing or running) in the waveguide at the same time. short-circuit method ”) and released (“ single-mode ”method) or their combination with an approved load or absolute absorption; inspected product,

It is known that the conductivity complex of a product is characterized by its dielectric constant, and the dielectric property of a dielectric (product) is characterized by its current conductivity.ε^*

In the dielectric (all fruits and vegetables are dielectric) The complex dielectric property in a complex text is characterized by a real vector and is characterized by polarization processes, and they are characterized by "mixed" currents and its "minimum" part conducting current [3]. $\varepsilon^*\varepsilon'$ In this the minimum part of the electromagnetic field (EMM) under the influence of the electric part represents the effect of the dielectric and is determined by. They can also be characterized by a tangent angle :. the larger the angle, the greater the energy expended on the dielectric effect (heating, breaking the cell, extracting the juice, etc.). (Fig.1.)$\varepsilon'' = \frac{\sigma}{\vartheta} tg\delta = \frac{\varepsilon''}{\varepsilon'} = \frac{\sigma}{\vartheta} \cdot \frac{1}{\varepsilon'} tg\delta$

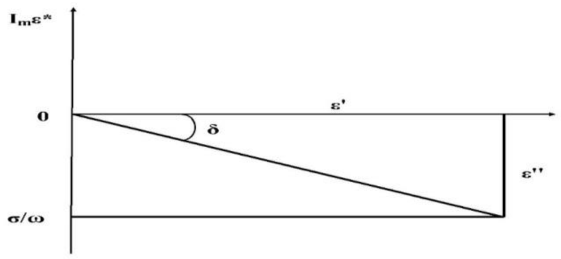

Fig. 1 Complex dielectric constant$tg\delta$ determine the angle

The complex dielectric constant depends on its component and the frequency, temperature and other physico-mechanical properties of the affected area.$\varepsilon' \varepsilon''$

We measured the dielectric constant of fruits and vegetables with a special device using the "short circuit" method. The block diagram of the device for determining the dielectric constant of fruits and vegetables is shown in Figure 2.

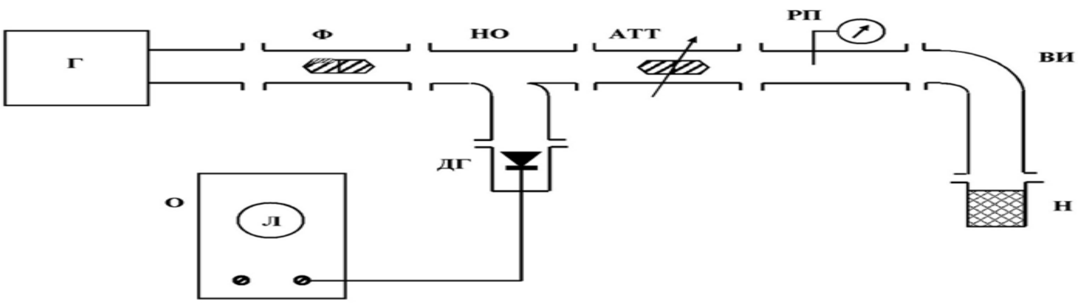

Fig. 2 Block diagram of the device for determining the dielectric constant of fruits and vegetables

G- Cell generator meter; F- ferrite valve; NO- directional adjuster; DG- detector head; O-ocyllograph; N- traceable dielectric waveguide source (load); ATT- variable attenuator; IL-measuring line; RP-recording device (microammeter M-95 or amplifier U2-4); VI-wave transmitter rotation.

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The dielectric constant measuring device works as follows. The device has a generator that is a source for measuring the signal of the player. For the stable operation of the generator, a ferrite valve is used to eliminate the effect of returning the electromagnetic waves from the load. The directional valve serves to return some of the NO OYUCH energy. From there, the detector sends O to the oscilloscope via the main DT. O The oscilloscope serves as an indicator of the uniform supply of power from the generator.Γ

The controlled attenuator allows you to change the power, regardless of the power of the ATT generator. The measuring line is the main element of the IL device, the wavelength in the waveguide,. constant wave coefficient, minimum electric field. is used to measure the displacement. The recording device RP fixes the division of the stationary wave field and the propagation of the field to obtain quantitative information. Kundalang cross-section is used in the search for liquid dielectrics to obtain the bending source of a rectangular copper waveguide - VI, the vertical position of the short-circuit wave N.PD_R

Determination of dielectric properties (conductivity) of fruits and vegetables was carried out by the following experimental method:

1. When preparing the device for operation (Fig. 2), the GZ-10A UYUCh generator and M95 microammeter and its pre-external rod are switched on for experiments.

2. A short-circular part not filled with a dielectric (product) is connected to the bent part of the waveguide.

3. After heating the generator, by changing the position of the waveguide detector, the position of the minimum of the standing wave inside the conductor relative to the arbitrary reference plane() is found.D_R

4. Measure the distance between the contact minimum of the standing wave and the wavelength of the waveguide() is calculated to be equal to twice the value of the distance obtained.$\lambda_{\text{в}}$

5. The short-circuited part of the waveguide is filled with the fruit and vegetable product under study in such a way that it easily fits into the waveguide edges of the dielectric. To do this, cut the product into a predetermined rectangular shape and place it in the waveguide in order.

6. Standing wave minimumD_1 is measured relative to the reference plane.

7. The standing wave coefficient is measured. $\rho_1 = (\frac{I_{max}}{I_{min}})^{-\frac{1}{2}}$

In this case, - the indication of the microammeter at the maximum of the standing waveI_{max}

I_{min} - standing wave minimum.

8. Similarly, the other thickness of the product being measured is determined.$l_2 D_2$ ва ρ_2

9. After that, calculate the size using the obtained.$\beta = 2\,\pi/\lambda_{в}$

10. Calculate the determinants and quantities using the following formulas:$\mathrm{D}_1 \mathrm{\rho}_1$

$\varphi_1 = 2\,\beta\,(\mathrm{D}_1 - \mathrm{D}_\mathrm{R} - l_1)$ i.$|\Gamma_1| = \frac{\rho_2 - 1}{\rho_1 - 1}$

11. First the complex is calculated using the following formula:

$C_1 < -\psi_1 = \frac{1}{j\rho l}\,(\frac{1 - |\Gamma_1| e^{j\varphi_1}}{1 + |\Gamma_1| e^{j\varphi_1}})$.

12. The solution of the equation is found with respect to. $C_1 < -\psi = \frac{th\,(T_1 < \tau_1)}{T_1 < \tau_1}$ T_1ва τ_1

13. Several similar complex numbers are:

$$y_{1.} = \left(\frac{T}{\beta l_1}\right)^2 [\cos 2\,(\tau_1 - 90^0) + \ j \sin 2\,(\tau_1 - 90^0)]$$

14. Similarly, for a dielectric of thickness, it is calculated:l_2

$\varphi_2 = 2\,\beta\,(\mathrm{D}_2 - \mathrm{D}_\mathrm{R} - l_2)$ i.$|\Gamma_2| = \frac{撼_2 - 1}{\rho_2 + 1}$

15. The second complex number is:C_2

$C_2 < -\psi_2 = = \frac{1}{j\beta l}\,(\frac{1 - |\Gamma_2| e^{j\varphi_2}}{1 + |\Gamma_2| e^{j\varphi_2}})$ and the solution of the following equation is found

$C_2 < -\varphi_2 = \frac{th\,(T_2 < \tau_2)}{T_2 < \tau_2}$.

16. Thus several complex numbers are found:

$$y_2 = \left(\frac{T_2}{\beta l_2}\right)^2 [\cos 2\,(\tau_2 - 90^0) + \; j \sin 2\,(\tau_2 - 90^0)].$$

17. Now, using the following formulas corresponding to the found; ; is; $y\ \varepsilon' \varepsilon'' tg\delta$

$$y = g + j\beta \;; \quad \varepsilon' = \frac{g + \left(\frac{\lambda_{\text{в}}}{2\,a}\right)^2}{1 + \left(\frac{\lambda_{\text{в}}}{2\,a}\right)^2} \;; \varepsilon'' = \frac{B}{1 + \left(\frac{\lambda_{\text{в}}}{2\,a}\right)^2} \;; \; tg\delta = \frac{\varepsilon''}{\varepsilon'},$$

where is the length of the wide wall of the waveguide.a

The results of the experimental study of the dielectric properties (conductivity) of fruits and vegetables, obtained and calculated by the above methodology are included in the table:

Table 1

Dielectric conductivity of fruits and vegetables

T / r	Fruit is the name of a vegetable	Juice content,%	Dielectric conductivity $f = 2300$ мГц $t = 20^0$C		
			ε'	ε''	$tg\delta$
1.	Don't: -Simirenko -Apport	 85.8 78.4	 60.2 59.6	 16.1 14.9	 0.26 0.25
2.	Urik: - diameter 24 mm with grain and husk - diameter 26 mm with grains and husks -merged 15 mm, with grains$\delta =$ -with soaked grains	 80.5 80.5 80.5 80.5	 63.7 62.5 64.1 64.4	 17.1 17.8 18.2 18.3	 0.28 0.28 0.29 0.29
3.	Plum: - 34 mm in diameter with grains and husks - with grain and husk, diameter 30 mm -baked 18mm, with grains$\delta =$ 16 mm without soaked stones,$\delta =$	 80.0 80.0 80.0 80.0	 61.4 61.1 62.3 61.8	 16.8 16.7 16.9 16.7	 0.27 0.26 0, 26 0.26
4.	Carrots cut into slices	75.5	56.7	15.4	0.27
5.	Potatoes:				

	brusochka cubic- 15 mm 40 mm in diameter with potato peelings 15 mm in diameter with potato peelings	 81.0 81.0 81.0	 59.6 59.3 56.7	 15.8 15.6 14.7	 0.26 0.27 0.27
6.	Beets: cuttings beets diameter 60 mm 80 mm	 84.5 84.5	 57.1 57.9	 14.9 15.2	 0.26 0.25
7.	Onion Half ring	 89.4	 53.8	 14.3	 0.28

It can be seen from the table that the dielectric constant of fruits and vegetables varies. Their value depends mainly on the amount of juice (water) in the composition of fruits and vegetables. There is also the effect of their ingredients.

Changes in the size of fruits and vegetables affect their value, but giving different shapes does not change the cut. In general, the average value of the dielectric constant number of fruits and vegetables can be used in different calculations.

V. CONCLUSION/RECOMMENDATIONS

The dielectric constant of fruits and vegetables varies depending on their type, moisture content, UMF EMM frequency. Changes in the size of fruits and vegetables affect their value, but their presence in different forms does not change the dielectric constant. It is advisable to use their average value in technical calculations

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