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Composition and Some Properties of Green Glass Based on Mineral Raw Materials of Uzbekistan

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ABSTRACT: It is necessary to increase the output of glass containers in Uzbekistan, as a focal point for increasing the canned goods of agriculture. The calculated and experimental ways have developed new green glass compositions with the use of innovative ideas. In the first developed compositions of zeno glass with the use of feldspar Sultan - Uvais deposit. The obtained laboratory samples have satisfactory characteristics.

KEY WORDS: Preservation of agricultural products, green glass, glass containers, dalomite, feldspar.

I.INTRODUCTION

The unique soil and climatic conditions of Uzbekistan, 320 sunny days a year, the successive seasons create favorable conditions for the cultivation of environmentally friendly fruits and vegetables rich in healthy human microelements, various biological substances that are indispensable in the diet. Therefore, fruits and vegetables grown on generous Uzbek land that are in high demand abroad are highly competitive. Currently, much attention is paid to optimizing the acreage, increasing yields, deep processing of agricultural raw materials, and developing the infrastructure for storing the grown produce. Climatic conditions of Uzbekistan allow to grow fresh fruits, vegetables and berries in large quantities and a wide range. On this basis, the country is developing the agricultural processing industry, which includes enterprises for the production of canned fruits and vegetables, vegetable and fruit juices, wine and vodka products, soft drinks, fruit and vegetable puree, pastes and syrups, dried and frozen fruits and vegetables. In some of these positions (tomato paste, dried fruit and dried vegetables), Uzbekistan is among the world's largest producers [1]. The era of globalization and competition forces us to improve the quality of products, improve processing, improve the presentation of both the product and packaging materials, storage, marketing, export, strengthening public-private partnership. The development of the fruit and vegetable industry of the Republic of Uzbekistan is closely connected with the development of the glass industry, since Glass packaging materials are important materials for the agricultural product being processed.

Recently, the requirements of the food industry to the quality of glass containers have increased significantly. The preservation of food products is greatly affected by radiation in the ultraviolet region of the spectrum with a wavelength of up to 300 nm and in the visible, up to 500 nm. Light radiation adversely affects the preservation of milk, vegetable oils, juices, beer, some wines, etc. For example, in beer under the influence of light (wavelength 420-500 nm) sulfur compounds are formed, and a "light" flavor appears. Milk in a colorless bottle in daylight rapidly loses vitamin C. Light also negatively affects vitamins A, B6, etc. Vegetable oils under the influence of light (wavelength 430-460 nm) age and deteriorate.

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Typically, industrial container glasses do not transmit (or only slightly) radiation with a wavelength of less than 300 nm, which is explained by the presence of iron oxides in the glass. At the same time, radiation with a wavelength above 500 nm does not adversely affect food products. The heat transparency of glasses has a significant effect on thermal uniformity, which affects both the production of high-quality glass melt during cooking, and the distribution of glass and the appearance of various defects in the molding of glass products. In this regard, it can be argued that the thermal transparency of glasses is one of the most important factors affecting not only the production process, but also the operational reliability of glass containers.

According to the literature, green bottle glass contains up to 4.0% or more (here and later in wt.%) Al_2O_3 and as coloring oxides of chromophores - iron oxide 5% and chromium oxide up to 1% or manganese oxide - 0.5 % [2]. A dark green bottle glass is known, in which batch nepheline concentrate [3] is used to inject Al_2O_3; in addition, Mn_3O_4 and Fe_2O_3 are introduced into the glass to give green color. In another literary source it is reported for the manufacture of container glass, the marshalite is introduced into the charge [4], and the composition of the charge consists of the following components; Marshall-75.05; soda-23.26; dolomite-20.50; alumina-0.99; sodium sulfate-1,17. All the above compositions consist of scarce raw materials at least for the Aral Sea region.

In connection with the above, we were tasked to develop formulations of green glass from local raw materials. Selection of suitable raw materials was carried out taking into account economic, environmental and technological factors. To introduce SiO_2 into the composition of glass, it was necessary to take enriched quartz-feldspar sand from the Yangiarik deposit. The source of calcium and magnesium-containing components was dolomite from the Kurdan field, located in the Kashkadarya region. The Kurdan site is located in the Dehkanabad district of Uzbekistan. The total stock of dolomite in categories A + B + C is more than 100 million tons. The physicomechanical properties of dolomite are as follows: volumetric mass-2.6-2.7 t / m3; coefficient of loosening - 1.6-1.7; porosity -0.53-9.15%; water absorption is 0.44-2.8%.

Table 1 shows the chemical composition of the raw materials used in the synthesis of green glass.

Table 1
The chemical composition of the main natural raw materials for the synthesis of green glass

Namesofrawmaterials	The content of oxides, in wt.%									
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	P_2O_5	MnO	Ппп
Quartz-feldspar Sand (Yangiarik)	95,30	1,74	0,68	0,36	0,20	0,51	-	-	-	1,77
Dolomite(KurdanaKashkadarya region)	1,30	0,28	0,016	31,3	19,40	-	-	-	-	47,70
Feldspar (SultanofUvays)	68,91	16,81	0,17	0,55	0,30	2,92	9,98	0,15	0,01	0,83

In the quality of complex raw materials, the feldspar Sultan of the Uvaisky deposit of the Republic of Karakalpakstan was used. This raw material is mineralogical homogeneous with some content of quartz [5]. The habitus is tabular, in the form of short prisms with sizes from 10x10 to 50x25 microns. The ratio in the K_2O: Na_2O = 3.5 feldspar is not lower than that established by the standard, the absence of volatile substances contributes to the formation of viscous glass from it in the temperature range 1523-1573^{0}C. The introduction of feldspar into the glass makes it possible to completely replace technical alumina and to reduce the content of soda ash in the charge. It was also assumed that the potassium-containing components contained in the feldspar composition would add shine to the glass and lower the cooking temperatures, which undoubtedly affects the quality and cost of the resulting products.

A synthetic product - soda ash of Kungrad soda plant and sodium sulfate of LLC “Kungrad sodium sulfate” was chosen as the alkali-containing component introduced into the glass composition. The composition of the charge was calculated according to [6].

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Table 2
The estimated composition of the experimental glass

Rawmaterials	The content of oxides in the glass, wt.%					
	SiO_2	Na_2O	MgO	CaO	Al_2O_3	Fe_2O_3
Quartz sand of Yangiarik	63,82	-	-	-	1,11	0,670
Soda Ash (Kungrad Soda Factory)	-	12,33	-	-	-	-
Feldspar (Sultan of Uvays)	7,63	0,32	-	-	1,87	0,010
Dolomite (Kurdana)	-	-	1,79	2,90	0,2	0,001
Sodium Sulphate (Kungrad Sodium Sulphate)	-	0,39	-	-	-	0,0003
In total	71,48	13,04	1,79	10,49	3,18	0,685

The preparation of raw materials was carried out by analogy, written in [7]. At the same time, the initial quartz sand was subjected to sifting followed by electromagnetic separation in a factory-installed unit of the 2RS-12/150-090110000 type. Dolomite and feldspar were subjected to grinding in the installation of the SDR-4 and grinding in a 10 l ball mill. After processing, the raw materials were weighed according to a prescribed recipe and placed in a plastic container and moistened to a moisture content of 4%. A series of laboratory cooking in corundum rods with a volume of 200 ml was carried out.

The experimental composition was cooked in a laboratory electric furnace with silicon heaters at a maximum temperature of 1450 ° C with an exposure time of 40-60 minutes. The readiness of the glass was checked "breakdown on the thread", with fixing the uniformity of the glass thread. It has been experimentally established that for all the compositions, the mixture boiling, clarification and homogenization of the melt proceed within 30-40 minutes at a temperature of 1450-1460^0 C. The study of some indicators of the obtained glass complies with the requirements of GOST 52022-2003 Glass containers for food and perfumery and cosmetic products. The resulting glass has a greenish tinge.

Table 3.
Physico-chemical properties of the experimental glass

Indicators	Value of indicators
Temperature condition, ° C	1450
Specific weight, g / cm3	3,10
Compressive strength, MPa	905
Flexural strength, MPa	160
Weight loss due to abrasion, kg / m2	0,10
Colortone, mm	578,0
Purity of color,%	53,0

The next point for obtaining green glass was the addition of chromophores to the composition of the charge. From the literature it is known that expensive molecular dyes, such as oxides of iron, manganese, copper and cobalt, are used to obtain green-colored glasses in addition to iron oxides. The color of glass with copper is very much dependent on the conditions of cooking and chromium oxide is an environmentally harmful oxide. In this regard, in practice, try to use oxides of iron and manganese.

It is known that iron in glass is in 2 degrees of oxidation: in the form of FeO and Fe_2O_3. Iron oxide FeO gives the glass a blue tint, the degree of reduction of 25-35%, the four-coordinated ferric ion, one of the oxygen ions, which is replaced by the sulfide-sulfur reduced ion from the sulfate, gives a yellow color. Adding blue and yellow color gives a greenish color. To enhance the green color, cobalt sulfate and coke were added to the mixture. We assumed that cobalt sulfate, when decomposed, gives CoO and SO_3, and coke contributes to a more complete reduction of iron and imparting high

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heat-shielding properties to glass. At the same time, iron together with cobalt oxide enhances the blue color, and the remaining Fe_2O_3 gives an intense yellow color. The addition of these colors gives green color to the glass. The amount of cobalt sulfate added to the glass batch varied in the range of 0.5–2.0, and coke — 0.25–1.0. As a result of the research, glass with a saturated green color was obtained.

Thus, by conducting experimental studies, glass of green color was obtained from local mineral raw materials of Uzbekistan. Using the mechanisms of the redox potential, green glass was obtained without the prior introduction of chromophores.

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