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EDIBLE COATINGS – ENVIRONMENTAL REPLACING OF TRADITIONAL CANDY PAPER WRAPPER OF "KORIVKA" CANDIES

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Abstract: *The article presents a study on the changes occurring in the qualitative and quantitative characteristics of "Korivka" fondant candies when replacing traditional paper wrapper with edible coating. Paper industry refers to sources of intensive pollution. It is expedient to use edible films and coatings for confectionery products in order to comply with the requirements of the Directive 94/62 / EU of the European Parliament and Union on Packaging and Packaging Waste, aimed at minimizing packaging materials waste. Edible coating is made of natural polymers – starch, gelatin together with plasticizer – urea or glycerol and hydrophobic component – linseed oil and solvent. The proposed composition of edible coating is completely utilized due to its use along with candies. Candies have been studied according to organoleptic parameters, humidity and mass change, as well as substances in view of reducing 3 month-shelf life. In addition, the change in sucrose crystals size during the storage period through a microscope with further image rendering by computer program has been determined.*

Keywords: *edible coating fondant candy, paper wrapper, storage.*

1. Introduction

The first mentioning about edible coatings can be found in the works of the 40's of the last century. Chocolate or confectionery glaze can also be attributed to edible coatings, but some foreign experts call them chocolate films [1]. However, edible coating is an independent term, which for the time being is not fixed yet in normative documentation of Ukraine. Distinguishing edible coating as a separate term is necessary and valid, since the composition of glazes obligatory includes 12% or more fat (cocoa butter, confectionery fat, etc.). However, the composition of edible coating can not contain fat at all; it is added in the amount of 10% or less in order to improve their barrier properties [2]. For edible coatings, the term of edible films [3] is also used as they are made from natural carbohydrate polymers (starch, pectin, cellulose, etc.), proteins (soy, whey, etc.), but, as a rule, obtained films have small elongation index values, therefore the term "edible coating" occurs.

Most researchers do not see the difference between the notion "edible film" and "coating". These notions are used interchangeably to вуашту a thin layer of edible material that can be applied directly to a food product or placed as a barrier between the product and the environment and consumed together with this product. Others believe that edible coating is a thin layer applied directly to the product, and the previously obtained film, serving as a wrapper then, is the edible film itself. In this aspect, based on classifying edible packaging into films and coatings, there are only different methods for their obtaining. Films are pre-obtained materials, for example, by extrusion. Coatings are applied to food directly by casting film-forming solutions, spraying, immersion or using a brush, and are formed when dried on the product.

It is expedient to use edible films and coatings for confectionery products in order to comply with the requirements of the Directive 94/62/EU of the European Parliament and Union on «Packaging and Packaging Waste», aimed at minimizing waste of packaging materials.

Today, the literature provides data on edible film use for biscuit only [4].

Edible coatings do not only help to preserve the freshness of products, but also can have functional properties [5]: antimicrobial [6], probiotic [7] and others.

Ukrainian confectionery industry does not use edible films and coatings yet, although the problem of storage extension term of some confectionery, including fondant candy remains unsolved. The main obstacle for long-term storage of these products is presented by desorption processes indicated by A. Kokhan and A. Dorokhovich [8]. At present, to extend fondant candies shelf life one uses invertase, glazing [9], packaging into a sealed polymer container [11], as well as adding to their recipes substances that could hamper the removal of moisture from bodies (increase of hygroscopic – retaining agents wet) [11].

Today «Korivka» candies are packed in paper materials. It is known [12] that paper industry belongs to sources of intense enviromental pollution. A plant with a capacity of 15000 tons of packaging paper per year consumes annually 500000 m^3 of wood, 95000 tons of fuel oil or 82000 m^3 of natural gas, 1070 MW of electricity per year, and 24800000 m^3 of fresh water; it also requires the removal of almost 150 hectares of land from agricultural property for the construction of a concrete reservoir for collecting river water, reservoirs with a capacity of 150 m^3 each providing treatment facilities with technical water. Wastewater treatment involves the construction of water treatment plants with capacity of 100,000 m^3/day, including incoming equipment block, septic tanks and water treatment reagent filters. Consequently, reducing the consumption of paper materials is necessary regarding the complicated environmental situation in the world.

"Korivka" are candies produced with liquid stuffing. Traditional "Korivka" includes sugar, whole condensed milk (with sugar), butter, syrup, flavoring. The name was obtained due to cow picture on the wrapper. Candy viscosity lasts for the first 10-14 days, and then it is slightly saccharified. Taste is not affected by the presence of viscosity, in fact, as well as its quality. The candy caloric content is 351 kcal per 100 g of product.

The objective of the study is to determine the effect of edible coating on candies "Korivka" quality during their storage and raising their biological value.

2. Materials and methods

The coatings applied to the surface of "Korivka" candies were made in the following way: starch (corn or potato), gelatin (E 441) as film formers, urea (E

927b) or glycerol (E 422) as plasticizers, linseed oil as hydrophobic component and the source of vitamin F were added. Film formers were mixed in dry form, water was added and solution was heated to dissolve gelatin and starch gelling, after that plasticizer was added. The solution was cooled to 40 °C and linseed oil was added whisking until homogeneous emulsion. Emulsion obtained was applied to candies surface and held up until the film became dry completely (6-8 h). Control sample was stored in traditional paper wrapper.

The samples were stored in a dry, clean, well-ventilated room without a foreign smell, without pest infection of grain stocks at the temperature of (18 ± 3) °C and relative air humidity not more than 75% for 3 months. Candies were not exposed to direct sunlight.

Organoleptic parameters of candies have been determined by tasting in accordance with the State Standard of Ukraine (SSU) 4683:2006. The content of reducing substances has been determined in accordance with SSU 5059:2008.

Humidity hss been defined by the refractometric method according to SSU 4910:2008.

The crystals size change of "Korivka" candy solid phase has been estimated by microscopy with subsequent processing using ImageJ – the open source software for analysis and image processing, written in the Java language by the National Institute of Health and distributed without license restrictions as public property. This program was also used to determine edible coating thickness on the product surface.

3. Results and discussion

Edible coating after drying on the surface of candies is transparent and smooth, so it does not change the appearance, as seen in Figure 1. According to SSU 4135:2014, on the basis of organoleptic parameters taste, smell, appearance, shape are determined.

Fig. 1. "Korivka" Candies in edible coating

Taste of proposed edible coating is neutral, therefore, the eating of candies with coating will not change the usual taste of the classic product, which will not lose traditional consumers and involve new groups to consume this product.

In order to create contrast while determining coating thickness on candies, red dye was added to coating, as shown in Figure 2.

After image processing using the ImageJ computer program, thickness of coating was determined as 0,504 ± 0,05 mm at the top of the product, 0,382 ± 0,05 mm on the lateral surfaces and 0,111 ± 0,05 mm at the bottom. Different coating thickness on the surface of candies is explained by the lack of adhesion between the forming solution in the cut to determine coating thickness of edible coating on the surface of product and therefore the bottom and lateral

Fig. 2. Picture of«Korivka» candies

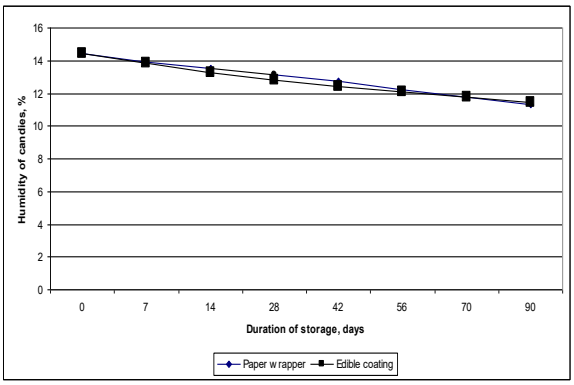

Fig. 3. Humidity changes in of "Korivka" candies during storage

According to the results shown in Figure 3, the reduction in mass fraction of moisture content in products with edible coating is at the same level as in products with classical paper packaging. The given regularity is grounded, since edible coatings possess barrier properties, in particular, vapor permeability [13]. It should be noted that vapor permeability is the value that numerically equals to the amount of water vapor in milligrams passing for 1 hour through a layer of material with 1 m^2 area and 1 m thick, provided that the temperature of opposite sides is the same, and the difference in partial pressure of water vapor equals to 1 Pa [14].

Changing the mass fraction of moisture will cause change of products' mass, therefore it is also advisable to determine the reduction of products mass during the storage period. Results of study are presented in Table 1.

According to the results obtained, mass reduction of products in edible coating is at the same level as of products in paper packaging. Consequently, the barrier properties of coating allow moisture to be kept inside the product, which in turn allows storing a lot of products during the shelf life.

Change of reducing substances content characterizes stability of sugar confectionery products during the term of storage. Accumulation of reducing substances gives them stickiness due to their hydrophilic properties. However, higher content of reducing substances will allow delaying fondant sweets aging and increase the coarse-sugar crystal phase, which will be considered further.

Results of study of quantitative change "Korivka" candies reducing substances are given in Figure 4.

Results of study (Figure 4) show that reducing substances content in edible coatings is slightly higher due to slightly higher amount of moisture in products (see Figure 1). Higher reducing substances content allows to keep fresh fondant candy longer, and edible coating protects from stickness, which can be caused by higher content of reducing agents.

One of the factors characterizing freshfondant candy is also the size of sucrose crystals, which is known to increase throughout the storage period [9].

According to the results of study, the increase of fraction with larger size of sugar crystals in products with edible coating occurs more slowly compared with products in paper packaging. Thus, for example, in 2 week storage in candy with paper wrapper, sugar fraction with crystal size of 46-55 μm appears.

Table 1.

"Korivka" candies mass reduction during storage period

Type of packaging	Shelf life (days),%					
	14	28	42	56	70	90
Paper wrapper	0.52	1.60	3.18	4.02	4.89	5.78
Edible coating	0.61	2.11	3.63	4.67	5.01	6.24

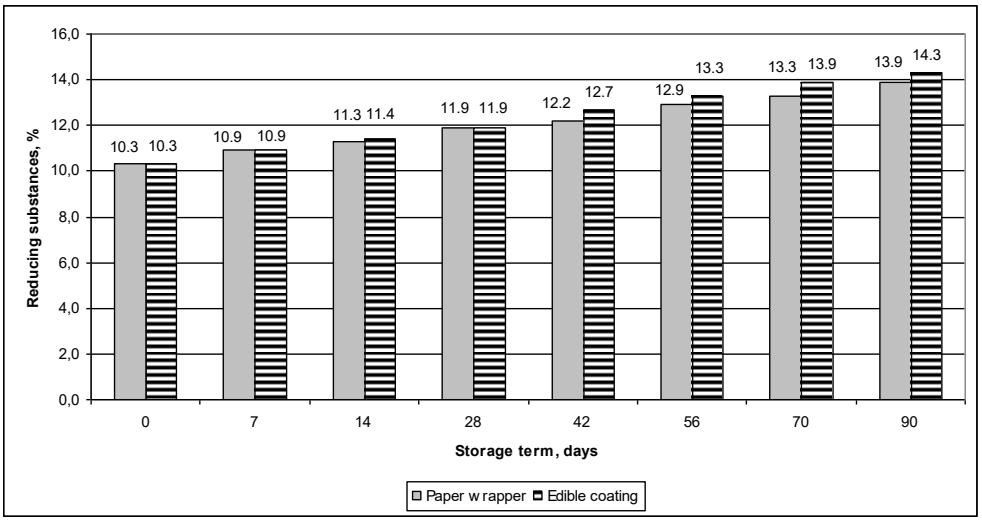

Fig. 4. Content change of reducing agents depending on packaging material type

Table 2.

Size and number of sugar fractions in candies during storage period, μm

Duration of storage, days	Type of packaging	Number of sugar crystal fractions (μm),%				
		15 - 25	26 - 35	36 - 45	46 - 55	56 and more
0	Paper wrapper, edible coating	21	49	30	-	-
14	Paper wrapper	16	37	25	22	-
	Edible coating	25	50	25	-	-
28	Paper wrapper	-	-	33	50	17
	Edible coating	-	-	50	39	11
42	Paper wrapper	38	25	37	-	-
	Edible coating	62	28	10	-	-
56	Paper wrapper	-	50	33	17	-
	Edible coating	22	33	34	11	-
70	Paper wrapper	-	-	50	50	-
	Edible coating	-	66.7	16.7	16.6	-
90	Paper wrapper	-	29	43	28	-
	Edible coating	11	78	11	-	-

On the 28th day of storage in both samples sugar crystals fraction of 55 μm or more in size appears, but this fraction disappears in both samples during further storage. This can be explained by two factors: change in climatic conditions in the room where candies were stored (increasing humidity due to dissolution of large crystals) or place where sample was taken for microscopy is closer to candy's edges). At the end of candy's shelf-life in paper wrapper, 28% of the fraction had the crystals size of 46-55 μm, while of that in edible coating such a fraction was absent. This can be explained by barrier properties of edible coating: the ability to pass moisture, which can dissolve crystals of sugar, and then it evaporates.

In order to ensure demand for proposed change in "Korivka" candy packaging, the price of edible coating is also important. The cost of paper packaging for "Korivka" candies today amounts to $ 349,79 per 1 ton of sweets on the average, according to

technological design norms of confectionery industry, paper wrapper is spent in the amount of 5,8 kg/ton, the label paper – 45,3 kg/ton. The cost of proposed edible coating in accordance with calculated and approved recipe is $ 341,02 per 1 ton of sweets. Consequently, proposed edible coating will not increase the cost of candies, even a little decrease, which will positively affect of products retail price.

4. Conclusion

It has been proposed to replace paper packaging (wrapper) of "Korivka" candy with edible coating. The feasibility has been confirmed by organoleptic parameters. Moisture mass fraction change and products mass reduction occur at the same level. At the end of the shelf life, reducing substances content of candy in paper wrapper is 13.87%, and that of candies in edible coating is 14.33%, which is 0.5% within the error margin. Fraction increase of larger size sugar crystals in products with edible coating occur more slowly compared with those in paper packaging. The cost of proposed edible coating is lower by $ 8.77 per 1 ton of candies compared with traditional paper material. The results obtained will help producers, as well as consumers, to take an active part in setting the environmental situation in case of support of proposed environmental packaging.

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