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A WAY TO PREVENT SYNERESIS IN FRUIT FILLINGS PREPARED WITH GELLAN GUM

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Abstract

The present research investigates the effectiveness of incorporating amylopectin starch with gellan gum in fruit compositions to develop heat-stable fruit fillings resistant to syneresis. The heat-stable and water-retaining properties of the fruit fillings prepared in a wide range of soluble solids (30-70 ºBrix) and containing amylopectin starch and gellan gum in different concentrations were investigated. The novel amylopectin starch Eliane BC-160 was studied in bake-stable fruit fillings' development not only as water-binding agent but also for a partial replacement of gellan gum used to improve heat-stable properties. The fruit filling samples with the same pH and various soluble solids were produced locally from apple puree, sugar, low acyl gellan gum, amylopectin starch and citric acid. The degree of syneresis wad determined for all fruit fillings along with control samples prepared without amylopectin starch. During the study it was revealed that amylopectin starch could be applied in combination with gellan gum for the development of bake-stable and syneresis-free fruit fillings with high quality characteristics, while reducing the standard doses of each of the ingredients by finding their common synergetic effect on heat-stable properties.

Key words: *filling, gellan gum, syneresis, starch.*

INTRODUCTION

Hydrocolloids are high-molecular-weight biopolymer substances soluble in water which create viscous colloidal solutions. They are mainly used to influence functional properties of foods (structure, texture, etc.), improving heat-stable characteristics, adjusting the microstructure, prolonging shelf-life and maintaining taste firmness in frozen products (Mikuš et al., 2011). Hydrocolloids posses neutral taste and flavor, which enables them free access to food insertion. Natural hydrocolloid gums represent a good source of soluble dietary fiber (up to 85% of dry mass), which reduces the concentration of cholesterol and improves gastrointestinal functions and glucose tolerance (Sozer, 2009), while their energy value is minimal to none.

The most common hydrocolloid used in canning and confectionery industry is high methoxyl pectin because of its simplicity of gelatinization in low acidity in high soluble solids content conditions (Basu and Shivhare, 2010). However, other food hydrocolloids with strong heat-stable properties, like gellan gum, can be used in bake-stable fruit fillings formulations as pectin substitutes.

Every fruit filling should have a characteristic fruit flavor, with good mouth-clearing properties and no artificial or chemical aftertaste. Some fruit fillings need added flavor to compensate that which is lost or changed during processing or to make up for low fruit content. Gellan gum incorporated into fruit filling's composition can accent and intensify fruit flavor notes and aromas, which could be impossible to make with other hydrocolloids such as pectin, agar or gelatin – and acts so even in low quantities (from 0.1%).

It was also established in previous research that baking stability of a fruit filling could be enhanced by applying gellan gum as heat-stabilizer. Although this hydrocolloid was used at concentrations less than 1% (from 0.1 to 0.9%) in fruit fillings formulations, it possessed substantial effect on heat-stable, textural and sensory properties of final products. However, gellan gum requires the presence of another stabilizer with good water-retaining properties, because fruit fillings made only with gellan gum as stabilizer exhibit a strong tendency to syneresis, which negatively affects the quality of pastry after baking and leads to a finished product with a less desirable appearance.

The name and description of syneresis was given by Graham in 1864 to the phenomenon of the breaking up of jellies on long standing or when disturbed. The jelly product, instead of consisting of one homogeneous mass, becomes segregated into solid lumps surrounded by a thin liquid (Graham, 1876).

Starches are widely used in fruit fillings, creams, toppings and glazes alone or in combination with hydrocolloids such as pectin, gelatin, agar, alginates and others. In cold prepared fruit fillings, starches are applied to retain free water avoiding syneresis, and to ensure also clarity, quick viscosity built-up and a smooth shiny appearance of the final product.

Some modern types of starches exhibit more shear-resistance, more freeze/thaw and heat stability and a certain type of texture compared to ordinary native starch. The novel amylopectin starch Eliane BC-160 is worth to be studied in heat-stable fruit filling development along with gellan gum, because it not only can prevent water release, but can also provide proper texture, eliminate bake-out of the filling while baking, improve appearance and ameliorate freeze/thaw properties of the finished product. This starch can also resist breakdown from shear, low pH and heat attack. For extremely high-solid fillings, the amylopectin starch is especially required due to its good cold-water-swelling properties.

The aim of this study consists in the development of heat-stable and completely syneresis-free fruit fillings may be improved by applying gellan gum in conjunction with a special starch with a high temperature resistance, such as amylopectin starch, in order to minimize the doses of each of the ingredients.

MATERIALS AND METHODS

Raw materials

Sugar was purchased at a local supermarket (Chisinau, Republic of Moldova). Apple aseptic puree was manufactured at the canning plant 'Conserv-E' (Chisinau, Republic of Moldova). Citric acid solution (50%) was prepared locally in the Laboratory of Functional Foods of the Practical Scientific Institute of Horticulture and Food Industry (Republic of Moldova). Low acyl gellan gum powder (KELCOGEL F) was acquired from the Moscow International Exhibition for Food Ingredients, Additives and Flavorings – "Ingredients Russia" (Moscow, Russian Federation). Amylopectin potato starch Eliane BC-160 (AVEBE) was kindly supplied by the Trading House AVERS (Sankt-Peterburg, Russian Federation).

Sample preparation

The fruit filling samples were produced locally in a wide range of soluble solids (30÷70 ºBrix) from apple puree (12 ºBrix), sugar, low acyl gellan gum KELCOGEL F, amylopectin potato starch Eliane BC-160 and citric acid on the basis of two-level factorial design. In this research gellan gum and amylopectin starch were selected in two concentrations according to the levels established in design of experiments. The levels of these concentrations (%) were set at: 0.5 (min) and 1.0 (max) for amylopectin starch and 0.1 (min) and 1.0 (max) for gellan gum.

The fruit filling samples were prepared according to the procedure for jam manufacturing presented by Basu et al., i.e. mixing the ingredients, evaporation to reach the desired Brix level, finally cooling (Basu et al., 2011). The total soluble solids were monitored through the fruit filling making process with a benchtop refractometer ABBE to reach the required soluble solids content according to the filling formulations. All samples of fruit fillings were prepared with the same pH (3.35) established by a potentiometric method, introducing the electrode directly into the fruit fillings.

To achieve proper structure formation through gel setting, the fruit filling samples were placed in refrigerator (after sterilization in glass jars) for up to 24 hours at (4 ±1ºC). After that filling samples were removed from the refrigerator for further testing. The test results obtained through application of two-level factorial design were verified by conducting the validation experiments under the optimized conditions.

Determination of syneresis

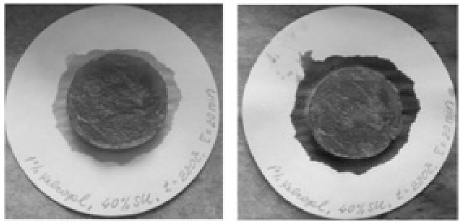
Degree of syneresis in fruit fillings samples was measured before bakery test for thermal stability determination, as follows: a specific amount of prepared fruit filling was given into a base of special filter paper named 'Blue ribbon' with a diameter of 120 mm by a metal ring with defined geometry (50 mm diameter and 10 mm height) and the diameter of released liquid was measured after 30 minutes. Then the filling samples were baked under exactly fixed conditions: at a temperature of and 220°C for 20 minutes (*Herbstreith & Fox KG) to determine their thermal stability*. The syneresis degree was determined by measuring the released liquid diameter by placing a line across the sample and calculating using the following formula:

$$S = \frac{D_2 - D_1}{D_2} \cdot 100$$

(1)
where
S – syneresis degree,%;
D_1 – average sample diameter, mm;
D_2 – average released liquid diameter, mm.
Diameter of the filling sample before baking is 50 mm, because it's the diameter of the metal ring used in bakery test. For measuring the released liquid diameter depending on its shape, from two to four lines were drawn, and the average was calculated.
the pastry samples we selected another metal ring with the following dimensions: 30 mm diameter and 10 mm height.

RESULTS AND DISCUSSIONS

Quality characteristics of the fruit fillings analyzed under laboratory conditions have demonstrated that they meet the international food standard CODEX STAN 296-2009 FOR JAMS, JELLIES AND MARMALADES.
The lowest achievable syneresis degree is 0 when the sample is completely stable and no water releasing from the fruit filling is observed. Fruit filling is considered syneresis-free if its syneresis degree is in the range 0÷5.



a) b)

Figure 1. Appearance of a fruit filling prepared only with gellan gum as stabilizer: before (a) and after baking at 220ºC for 20 minutes (b)

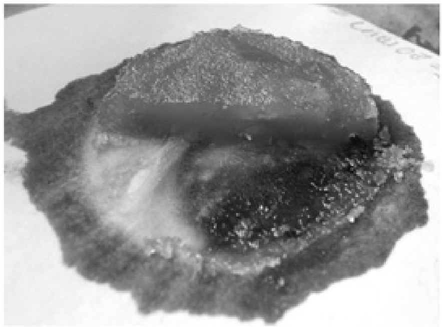


Figure 2. Cross-sectional view of a fruit filling prepared only with gellan gum after baking at 220ºC for 20 minutes

Judging from the first picture, it is evident that fruit fillings prepared with gellan gum Kelcogel F (0.5 – 1%) are characterized by high thermal stability (BI = 90÷100), maintaining their original shape, volume and initial sensory characteristics after baking under a temperature of 220°C for 20 minutes. But despite this, gellan gum requires the presence of one more ingredient with water-binding properties, because fruit fillings made with only one gellan gum exhibit a strong tendency to syneresis, which may negatively affect the quality of pastry after baking. Formation of the 'absorption band' on the filter paper around the filling (with a characteristic color after baking process) indicates the separation of moisture (Figure 1 and 2).

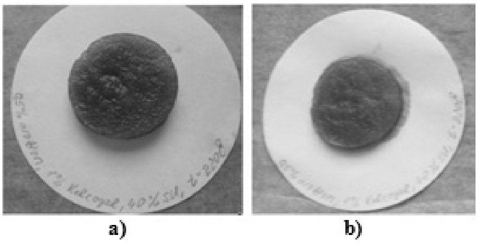


Figure 3. Appearance of fruit fillings prepared with gellan gum and amylopectin starch: before (a) and after baking at 220ºC for 20 minutes (b)

Adding the amylopectin starch even at low quantities (0.5 – 1.0 w/w) into fruit fillings prepared with gellan gum, not only prevents them from syneresis, but also improves heat-stable properties of the finished products (Figure 3).

The table 1 below shows the relationship between syneresis degree and percentage of gellan gum and amylopectin starch in fruit fillings prepared with various soluble solids.

Table 1. Relationship between gellan gum and amylopectin starch contents and syneresis degree of fruit fillings prepared within a large range of soluble solids

Soluble solids, °Brix	Gellan gum content, w/w	Starch content, w/w	Syneresis degree
30	0.1 – 1.0	0.6 – 1.0	0 – 5
40	0.1 – 1.0	0.5 – 1.0	0 – 5
50	0.1 – 1.0	0.5 – 1.0	0 – 5
60	0.1 – 1.0	0.5 – 1.0	0 – 5
70	0.1 – 1.0	0.5 – 1.0	0 – 5

According to the data presented in table 1, for the same low percentage of gellan gum (0.1 – 1.0%) used as heat-stabilizer, the least amount of amylopectin starch is required to eliminate syneresis in bake-stable fruit fillings prepared with 40, 50, 60 and 70 soluble solids. For the production of heat-stable fruit fillings with 30°Brix a slightly more amylopectin starch is needed to achieve the lowest syneresis degree than in previous examples.

Therefore, it is more advantageous to use this type of starch as water-binding agent for production of heat-stable fruit fillings prepared within 40-70°Brix with addition of gellan gum.

CONCLUSIONS

At present time consumers demand high-quality foods in various innovative forms at competitive prices. Developing the novel heat-stable and syneresis-free fruit fillings will lead to the emerging of new high quality products for baking, confectionery and canning industries.

As a result of conducted investigation it was established that gellan gum could be applied in combination with amylopectin starch for the development of bake-stable and syneresis-free fruit fillings with high quality characteristics, while reducing the standard doses of each of the ingredients by finding their synergetic effect on heat-stable properties.

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