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CHANGES OF TEXTURAL PROPERTIES OF FRUIT-VEGETABLE JUICES WITH THICKENING AGENT ADDITION

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Key words: gels, textural properties, thickening agents

The purpose of the presented study was to evaluate selected textural properties of gels produced from fruit and vegetable juices after application of chosen thickening agents. The following substances were applied as gelating agents: xanthan gum with carob flour at the amount of 1% (E415+E410); xanthan gum with carob flour at the amount of 2%; gelatin at the amount of 1% (E441); and gelatin at the amount of 2%. Juice was poured into a beaker (0.5 L capacity) and placed in a water bath. When the temperature of juice reached 80°C, it was transferred to 300-mL beaker and a thickening agent was added, and then, the sample was stirred using an electric stirrer. The following juices were subjected to tests: beet, apple, carrot, and multi-vegetable. Achieving a good quality gel is possible on the basis of vegetable juice and plants hydrocolloids. It is required to elaborate a proper recipe by studying the possibility of using different thickening agents, different proportions of the agents and their mutual correlation. It is not possible to obtain one universal agent for gelling all juices.

INTRODUCTION

Various food additives are often added in foodstuff production, which allows achieving new and attractive products on the market. There are many technologies of food processing for consumption purposes [Świderski, 2001]. Hydrocolloids or substances that easily dissolve in cold and warm water are capable of modelling structure; their ability for thickening is a great virtue.

Principles of hydrocolloid action consist in increasing the solution's viscosity and gel formation. Moreover, these substances may show other properties such as: emulsifying, stabilizing or covering the micro-capsules [Rutkowski *et al*., 1997; Sobczak *et al*., 2005].

Gelatin is used most frequently. It is a product of animal origin that plays thickening, stabilizing and gelating functions. Gelatin solutions (3%) form, after cooling, transparent jelly that melts in mouth. Its general application in the foodstuff industry includes gel formation and juice, wine and honey clarifying. Dairy industry uses gelatin to produce yogurts and various types of cheese, meat industry utilizes it to produce jellies and jelly meat products. It is also applied in bakery, confectionery and concentrate industries. Gelatin should be produced under strict veterinary control, from domestic materials, in which BSE was not detected. It performs its role within a wide pH range. Xanthan gum is produced by biotechnological means and plays a role of thickener and stabilizer. It does not form gel itself, but carob flour gives elastic and thermo-reversible gel. It finds its application in beverage, fruit juice, and vegetable-meat canned food production. Due to a low energetic value and resistance to enzymes, it is applied for dietetic products and baby-food. It efficiently works within a wide pH range [Maga & Tu, 1995; Sadowska & Kotłowski, 1999; Taderko & Makała, 1999].

Texture is a sensory property used to describe food. It can be: hardness, cohesiveness, viscosity, springiness, adhesiveness as primary mechanical parameters or others: particle size and shape, moisture content *etc*. [Surmacka-Szcześniak, 2002; Szcześniak, 1963].

There is a lot of resources on textural properties of various gels. Studies were carried out for 1% low and high acyl gellan gels and the mixtures using a compression test and water holding capacity (WHC) [Yiqun *et al*., 2003; Mao *et al*., 2000]. Some hydrocolloids are added in ice-creams and frozen desserts to product smooth texture. A 0.3% of guar gum or of locust bean gum plus xanthan gum was mixed in a sucrose solution to analyse ice crystal formation [Fernandez *et al.*, 2007; Boyong & Fenema, 1988; Fuchigami & Teramoto, 2003].

The purpose of the presented study was to evaluate selected textural properties of gels produced from fruit and vegetable juices after application of chosen thickening agents.

MATERIALS AND METHODS

Materials. The following juices were subjected to tests: beet, apple, carrot, and multi-vegetable. All juices used in the study originated from the same product's lot. The following

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TABLE 1. Percentage and weight of thickening agents added.

Concentration (%)	Xanthan gum (g)	Carob flour (g)	Juice (mL)
1	0.67	0.33	99
2	1.34	0.66	98

substances were applied as gelating agents: xanthan gum with carob flour at the amount of 1% (E415+E410); xanthan gum with carob flour at the amount of 2%; gelatin at the amount of 1% (E441); and gelatin at the amount of 2%.

Doses of gelating agents added to the juices are presented in Table 1.

Gel preparation. Juice was poured into a 0.5-L beaker and placed in a water bath. When the temperature of juice reached 80°C, it was transferred to 300-mL beaker and thickening agent was added, and then, the sample was stirred using an electric stirrer (at stirrer speed of 500 r.p.m and time of 1 min). In the case of xanthan gum with carob flour, the latter gelating component was added after preliminary stirring of the former one. The sample was poured into 100-mL plastic and transparent cups covered with aluminum foil.

Methods. Tested samples were observed for 4 weeks; their appearance and consistence were evaluated in weekly intervals. At the same time, textural traits were determined using a TA-XT2i device (Stable Micro System) at the following parameters: probe diameter – 20 mm; head shifting rate – 1 mm/s; and sample deformation up to 50%.

Four textural parameters were evaluated: (1) hardness T (N) characterised by the maximum force on the curve of first compression; (2) cohesion (-) expressed as the proportion of energy necessary to second compression (W_2 (J)) and the first compression (W_1 (J)) (Figure 1); (3) elasticity (mm) being a raise of sample strain during second compression (L_2 (mm)) (Figure 1); and (4) chewing ability (N) that represents the force (energy) required during chewing to disintegrate solid products and make their swallowing possible; in instrumental measurements it is a product of hardness, cohesion and elasticity.

RESULTS

Table 2 presents characteristics of the achieved gel after 4-week storage. The samples were subjected to assessment once a week.

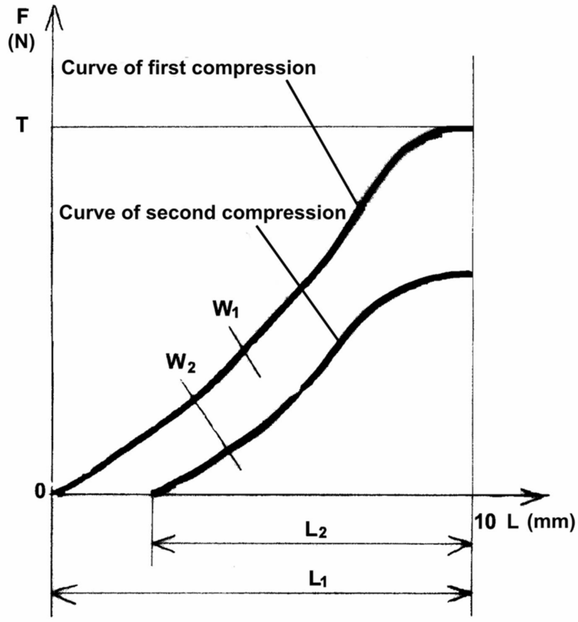

FIGURE 1. An exemplary course of curves during tests.

All tested juices formed gels after addition of xanthan gum plus carob flour. Consistency of that gel depended on the additive's amount. After 4-week storage, no change was observed in gel structure.

However, gelatin applied at the amounts of both 1% and 2% caused solid, elastic consistency remaining for 4 weeks. The same dependencies were recorded for all types of tested juices.

The highest hardness of the tested gels was achieved using 2% gelatin for beet juice and 2% xanthan gum with carob flour for apple juice (about 450 N). Addition of 1% gelatin to carrot and multi-vegetable juice formed very soft gels (Figure 2).

Figure 3 presents elasticity of the tested gels. It was uniform regardless the amount and type of addition for every juice.

For xanthan gum with carob flour, the highest gel cohesion was recorded at 1% of the additive to multi-vegetable juice (0.496). Gels with gelatin addition were characterised by higher cohesion (Figure 4).

Figure 5 presents chewiness of achieved gels. Beet gel with addition of 2% gelatin had the highest chewiness. For xanthan

TABLE 2. Characteristics of juice gels with addition of xanthan gum and carob flour.

Gel type	Concentration (%)	Storage time			
		1 week	2 weeks	3 weeks	4 weeks
Beet	1	Very soft	Very soft	Very soft	Very soft
	2	Soft, solid	Soft, solid	Soft, solid	Soft, solid
Apple	1	Solid, very soft	Solid, very soft	Solid, very soft	Solid, very soft
	2	Solid, soft, elastic	Solid, soft, elastic	Solid, soft, elastic	Very soft
Carrot	1	Very soft, breaks down	Very soft, breaks down	Very soft, breaks down	Very soft
	2	Very soft, breaks down	Very soft, breaks down	Very soft, breaks down	Very soft
Multi-vegetable	1	Soft, breaks down	Soft, breaks down	Soft, breaks down	Soft
	2	Solid, elastic, soft	Solid, elastic, soft	Solid, elastic, soft	Solid, elastic

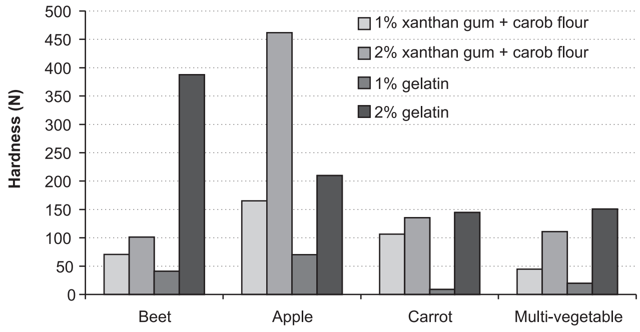

FIGURE 2. Changes of gel hardness.

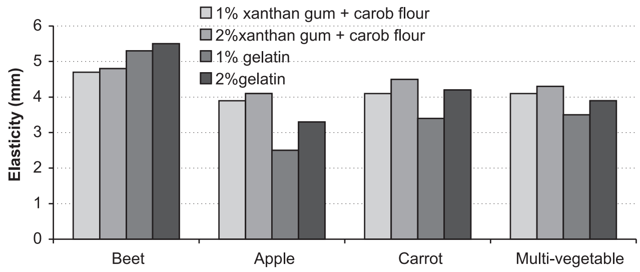

FIGURE 3. Changes of gel elasticity.

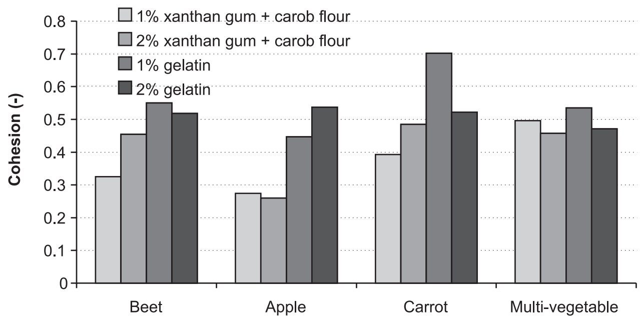

FIGURE 4. Changes of gel cohesion.

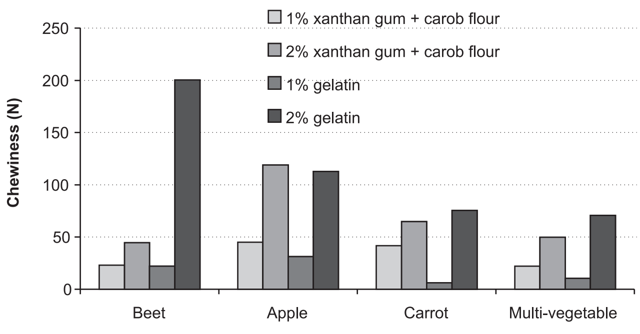

FIGURE 5. Changes of gel chewiness.

gum plus carob flour, apple juice was distinguished by the highest chewiness.

DISCUSSION

A solution of 1% xanthan gum with carob flour was sufficient to achieve the gel form in most of the studies juices but increasing the concentration of the solution to 2% yields a similar effect at higher doses of a thickening agent. Achieving good quality gels is possible on the basis of vegetable juice and plants hydrocolloids. It is required to elaborate a proper recipe by studying the possibility of using various thickening agents, different proportions of the agents and their mutual correlation. It is not possible to receive one universal agent for gelling all juices.

Various mixtures of thickening agents were tested to ice-creams and frozen deserts. [Fernandez *et al*., 2007; Fuchigami & Teramoto, 2003; Boyong & Fenema, 1988]. It was achieved smooth texture and protection of the product during its storage. Similar results were obtained in gels, after 4 weeks of storage no changes were observed in gel structure. Different papers [Sobczak *et al*., 2005; Tederko & Makała, 1999] examined the shearing force as affected by thickening agents. Experimental results revealed an influence of binding agents on the value of the shearing force. Textural properties of gels depend also on the binding agents value and the type of juice.

CONCLUSIONS

1. Juice type was found to affect appearance and consistency of gels after addition of xanthan gum with carob flour. In the case of carrot juice, even 2% addition did not form gel.
2. The type of tested juice affected gel texture after thickening agents addition. Increasing the dose of xanthan gum with carob flour addition by 1% caused almost 3-fold increase of gel hardness. Similar tendencies were also observed in gels made of other juices.
3. In all tested gels, the increase of additive amount resulted in the increase of product chewiness.

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ZMIANY WŁAŚCIWOŚCI TEKSTURALNYCH SOKÓW OWOCOWO-WARZYWNYCH Z DODATKIEM ZWIĄZKÓW ZAGĘSZCZAJĄCYCH

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Celem pracy było określenie wybranych właściwości teksturalnych otrzymanych żeli z soków owocowo-warzywnych po zastosowaniu wybranych dodatków zagęszczających. Jako środki żelujące zastosowano następujące substancje: ksantan z mączką chleba świętojańskiego w ilości 1% (E415+E410), ksantan z mączką chleba świętojańskiego w ilości 2%, żelatyna w ilości 1% (E441), żelatyna w ilości 2%. Do zlewki o pojemności 0.5 L nalewano sok i umieszczano w łaźni wodnej. Po osiągnięciu temperatury 80°C przelewano sok do zlewki o pojemności 300 mL i dodawano zagęstnik. Następnie całość mieszano za pomocą miksera kuchennego. Badaniom poddano następujące soki: burakowy, jabłkowy, marchwiowy, wielowarzywny. Badane próbki poddano obserwacji przez 4 tygodnie oceniając wygląd i konsystencję w odstępie co tydzień przez 4 tygodnie. Jednocześnie przeprowadzono badania analizy cech teksturalnych na urządzeniu TA-XT2i (Stable Micro System). Po dodatku ksantanu z mączką chleba świętojańskiego wszystkie badane soki przechodziły do postaci żelu. Konsystencja powstałego żelu była zależna od ilości dodatku. Po 4 tygodniowym przechowywaniu żelu nie zaobserwowano zmiany konsystencji produktu.