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Physical and sensory aspects of maltodextrin gel addition used as fat replacers in confectionery filling systems

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ABSTRACT

Confectionery fillings are products used in confectionery and baking industry containing approximately 30–40 g fat/100 g product. Due to the high fat content, they have considerable high caloric value. Therefore, there is a trend to decrease fat content in confectionery filling formulations. The objective of this study was to investigate the feasibility of using two types of maltodextrin gels as potential fat replacers in confectionery fillings.

Vegetable fat was partially replaced by potato maltodextrin and specially derived waxy-maize maltodextrin aqueous gels (15 and 20 g/100 g) in three different ratios (5, 10 and 15 g/100 g). The increase in the amount of fat reduction resulted in an increase in hardness and change in colour of the final product. According to sensory analysis performed by trained sensory panel as well as by measurements of product acceptance–preference performed by untrained panellists (consumers), confectionery filling with 5 g/100 g fat reduction had the highest scores. However, according to product acceptance–preference test, it was estimated that the final product with 15 g/100 g fat reduction was also sensory acceptable.

1. Introduction

Due to increased fat consumption in modern human nutrition during recent decades, wide spectra of fat replacers have been developed. The most commonly found classification of fat replacers is as follows: carbohydrate based, protein based and fat based fat replacers as well as their combinations (Akoh, 1995; Harrigan & Breene, 1989). Carbohydrate based and protein based fat replacers are known as fat mimetics. The most commonly used carbohydrate based fat replacers are maltodextrins, modified starches, polydextrose, pectins, etc. (Akoh, 1998; Roller & Jones, 1996; Wylie-Rosett, 2002). Maltodextrins are starch hydrolysis products characterised with DE value between 0 and 20. Maltodextrin with different DE values express different physicochemical properties. Increase in DE value results in the rise in hygroscopicity, solubility, osmolality and their effectiveness to reduce the freezing point, while viscosity, cohesiveness, and coarse-crystal prevention increase with decreasing DE value (Dokić-Baucal, Dokić, & Jakovljević, 2004; Morris, 1984; Wang & Wang, 2000). However, maltodextrins with the same DE values might express very different properties which can be attributed to different hydrolysis procedure, starch botanical source, amylose/amylopectin ratio etc. (Dokić-Baucal et al., 2004). Maltodextrins have the ability to form weak gels which are results of interactions between helicoidal amylose fractions and branched amylopectins molecules (Chronakis, 1998). Due to high percentage of long oligomer chains, maltodextrins with lower DE values have more expressed tendency to form gels (Kasapis, Morris, Norton, & Clark, 1993). As maltodextrins show gel forming ability, they have been introduced in food industry as texture modifiers, thickening agents, fat replacers, etc. (Alexander, 1995; Chronakis, 1998). The characteristic of maltodextrins to reproduce fat-like mouthfeel presumably originates from three-dimensional network built by maltodextrin when gelled (Chronakis, 1998; Loret, Meunier, Frith, & Fryer, 2004). Irregularly shaped maltodextrin aggregates are 3–5 μm in diameter, which is

Abbreviations: Pmdx, Potato maltodextrin; WMmdx, Waxy maize maltodextrin.

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very similar to fat crystals particles, presumably contributing fat-like behaviour (Chronakis, 1998).

The most demanding task in reduced fat product development is to, as much is possible, mimic sensory and textural properties of full fat product. According to Tolstoguzov (2003) food system properties reflect more the interactions between its components than the properties of these individual components. Due to above mentioned, decrease in the fat content in fat reduced products might have major impact on their processing. Therefore, the role of different hydrocolloids as fat replacers and texture modifiers must be examined in relation to sensory and textural properties, flavour, mouthfeel, colour, etc. of reduced fat product (Kilcast & Clegg, 2002).

According to numerous research articles, maltodextrins used as fat replacers, can be successfully incorporated in a large group of products. It was found that maltodextrins can be used as fat replacers in different food systems e.g. yoghurt (Domagala, Sady, Grega, & Bonczar, 2005, 2006), muffins (Khouryieh, Aramouni, & Herald, 2005), salad dressing (Perrechil, Santana, Fasolin, Silva, & Cunha, 2010), frankfurters (Crehan, Hughes, Troy, & Buckley, 2000), spreads (Forrest & Harvey, 1989; Underdown, 1997), margarine spreads (Clegg, Moore, & Jones, 1996), peanut butter (Franklin, 1994), snacks (Lodge, 1995) etc. According to Karaca, Güven, Yasar, Kaya, and Kahyaoglu (2009) and Hyvönen, Linna, Tuorila, and Dijksterhuis (2003) fat replacement above 50 g/100 g in ice creams could be achieved using maltodextrins as fat replacers. Moreover, the addition of maltodextrin in reduced fat formulations might even improve their textural and sensory properties (Sudha, Srivastava, Vetrimani, & Leelavathi, 2007), making them as much as similar to full fat products. According to Clegg et al., (1996) addition of maltodextrin and gelatine resulted in the lowest destabilization of the well emulsified control spread (containing no stabilizers) in comparison to other hydrocolloids. Zoulias, Oreopoulou, and Tzia (2002) have revealed that cookies prepared with maltodextrin fat replacer were scored better by sensory panel than cookies containing other fat replacers (polydextrose, inulin, whey protein).

Fat replacement in confectionery filling is a very demanding task since they represent complex, polydispersed systems composed of sugar, cocoa, milk powder particles and other ingredients suspended in fat continuous phase. There are a few patents and papers investigating fat reduction in chocolate and confectionary fillings. Zumbe (1999) and Dubberke (1999) created reduced fat chocolates by simply removing some of the fat without adding any fat replacers. Abboud (1999) has revealed that combination of emulsifiers with inulin, prepared using particular concentrations and spray-drying conditions may be used as fat replacement in cookie cream filling. In that formulation the cookie cream filling contained no water. However, there are also some papers and patented methods of water-containing chocolate production, in which water is introduced in the form of water-in-oil cocoa butter emulsion (Beckett, Hugelshofer, Wang, & Windhab, 2010; Norton, Fryer, Parkinson, & Cox, 2009; Traitler, Windhab, & Wolf, 2000). In order to create water-containing chocolate, the special attention has to be paid to droplet stabilization in order to prevent water diffusion.

The objective of this work was to develop reduced fat confectionery filling using two different types of maltodextrin which were incorporated in the form of aqueous gel particles dispersed in vegetable fat. The effect of fat reduction on product textural properties, changes in colour and sensory properties, as well as the differences in obtained results of sensory evaluation methods (Quantitative descriptive analysis – QDA performed by trained panellists and hedonic test performed by untrained panellists) of confectionery filling systems were evaluated.

2. Materials and methods

2.1. Materials

Two commercial maltodextrin types were used in these investigations: spray-dried maltodextrin obtained by enzymatic conversion of potato starch (DE = 3.5, moisture = 4.7 g/100 g solids) – Pmdx and maltodextrin obtained by special enzyme (isoamylase) conversion of waxy maize starch (DE = 2, moisture = 5.5 g/100 g solids) – WMmdx.

Confectionery filling was prepared according to formulation (Table 1) provided by the Aarhus United A/S, Aarhus, Denmark in the laboratory Ballmill Refiner CAO-B5 (Caotech, Wormerveer, The Netherlands). The following ingredients were used: sugar (Crvenka sugar factory AD, Serbia), vegetable fat – hydrogenated soybean oil and palm oil blends (Dijamant AD, Serbia), cocoa butter (Bary Calebaut, Switzerland), whole and skim milk powder (Polsero, Polland), lecithin (Sojaprotein, Serbia), vanillin (Curt Georghi, Germany) and nougat paste (Pionir d.o.o, Serbia).

2.2. Methods

In order to investigate the influence of fat replacement by maltodextrin gel on textural and sensory properties as well as on colour of confectionery filling systems, maltodextrin solutions at solid concentration of 15 and 20 g/100 g were prepared and kept for 24 h at room temperature to form gel. The obtained maltodextrin gels were mixed with the part of vegetable fat using Ultraturrax T-25 (Ika-Werke, Staufen, Germany) at applied mixing speed of 6000 rpm during 120 s. Maltodextrin gel/vegetable fat blends were prepared in three different ratios containing 16.7, 33.3 and 50 g/100 g of both maltodextrin gels (Hadnađev, Dokić, Dapčević Hadnađev, Pajin, & Krstonošić, 2011). Consequently, 30 g/100 g of vegetable fat in confectionery filling was replaced by different vegetable fat/maltodextrin gel blends in three different proportions and confectionery fillings with 5, 10 and 15 g/100 g reduced fat content were prepared.

2.2.1. Dynamic oscillatory measurements of maltodextrin gels

Dynamic oscillatory measurements were performed using a Haake Mars rheometer (Thermo Scientific, Karlsruhe, Germany). All measurements were performed at 20 ± 0.1 °C using PP35 Ti parallel plate measuring geometry (35 mm diameter, 1 mm gap). After loading, the excess of the sample at the plate edges was neatly trimmed and exposed surface was covered with a thin layer of paraffin oil to prevent the sample from drying during the measurements. Sample was rested for 10 min after loading, so that residual stresses could relax. Stress sweep measurements were performed at constant frequency of 1 Hz by increasing the stress from 0.1 to 1000 Pa. Subsequently, frequency sweep tests were performed by increasing frequency values from 0.1 to 10 Hz at constant stress, which was within the linear viscoelastic region. Data obtained in stress sweep and frequency sweep tests were storage (elastic) modulus (G') as well as complex modulus (G^*).

Table 1
Confectionery filling composition – control sample.

Raw material[a]	(g/100 g)
Sugar	37
Vegetable fat	32
Cocoa powder	8
Milk powder (whole fat)	8
Milk powder (free fat)	3
Nougat paste	12

[a] Lecithin and vanillin were added in the amount of 0.4 and 0.05 g on 100 g of confectionery filling.