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Thickening of sweet and sour sauces with various polysaccharide combinations

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Abstract

Influence of a type and concentration of oat starch and various polysaccharide-based thickening combinations (oat starch–xanthan gum, oat starch–oat hydrolysate, oat hydrolysate–xanthan gum and potato starch–xanthan gum) upon rheological, textural, and sensory properties of sweet and sour (S&S) sauces were studied. Either oat starch or combinations of oat starch with xanthan gum, and oat hydrolysate with xanthan gum provided superior adhesiveness, and stringiness of S&S sauces Every tested thickener offered statistically equally good penetration force, and sensory properties of S&S sauces. In sauces thickened with potato starch xanthan gum blends, penetration force, adhesiveness, and stringiness increased, and the same trends could be observed in sauces thickened with blends of oat starch with oat hydrolysates. In sauces containing either the blends of oat starch with xanthan gum or three component blend of oat starch with oat hydrolysate and xanthan gum these textural parameters decreased on storage, although in the latter blends changes in stringiness were negligible. Changes in area of thixotropy, and K constants in the Ostwald-de Waele and Herschel–Bulkley models followed the same direction as penetration force, adhesiveness, and stringiness under the influence of particular thickeners.

Keywords: Oat hydrolysate; Oat starch; Potato starch; Sensory analysis; Textural analysis; Thixotropy; Xanthan gum

1. Introduction

Results of intermolecular interactions in polysaccharides depend, among others, on thermodynamic compatibility between them (Tolstoguzov, 2003). Good such kind compatibility between two amylose molecules results in well known, fair retrogradation (Fredriksson, Silverio, Andersson, Eliasson, & Aman, 1998) whereas because of imperfect thermodynamic compatibility retrogradation of amylopectin is slow (Gudmunsson, 1994). On attempts of reconstitution of native amylose amylopectin complex in starch granules (Gallant, Bouchet, & Baldwin, 1997) amylose and amylopectin, aqueous phases separate because of lack of thermodynamic compatibility between both polysaccharides (Kalichevsky, Oxford, & Ring, 1986; Lii, Tomasik, Hung, & Lai, 2002). Several benefits in controlling texture and sensory properties of foodstuffs, rheology of aqueous solutions of hydrocolloids come from polysaccharide–polysaccharide interactions in their blends. Because prediction of even qualitative results of blending of various polysaccharides is, frequently, difficult

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numerous studies on properties of combinations of various polysaccharides have been published. Since understanding of the nature of interactions and role of entropy factor improve and more advanced instrumental techniques become available, the study in that area steadily develops. The results of such studies of the polysaccharide blends with starches being one of the component of the blend have been recently reviewed (Sikora & Kowalski, 2003). Also reports describing behaviour of other two-component blends, for instance, guar gum dextrin (Pinder, Nash, Hemar, & Abd Singh, 2003), alginate pectin (Walkenstroem, Kidman, Hermansson, Rasmussen, & Hoegh, 2003), κ-carrageenan–xanthan gum (Dunsten et al., 2001), gellan-ι–carrageenan and gellan–xanthan gum (Rodriguez-Hernandes & Tecante, 1999), and many others are available in the literature

In this paper former attempts (Sikora, Sady, Krawontka, Ptaszek, & Kowalski, 2003a, 2003b) of thickening of sweet and sour sauces (S&S sauces) are continued. Formerly, S&S sauces were thickened with modified starches such, as acetylated distarch adipate, acetylated starch and combinations of potato starch, oxidized starch, acetylated distarch adipate and acetylated starch with xanthan gum. The problem was approached involving potentially texture forming polysaccharide polysaccharide interactions. Because of formerly achieved success (Sikora, Juszczak, Sady, & Krawontka, 2003) in thickening of cocoa syrups with combinations of either potato starch or corn starch with xanthan gum the application of similar as well as some others combinations have been checked in case of S&S sauces. Involving oat products in this study is rationalized with a high nutritional value of β-glucans (Praznik, Huber, & Cieślik, 2004, chap. 13; Tomasik, 2004, chap. 20). Evaluation of the thickener performance was based on its effect upon penetration force, sensory properties and rheology (Bourne, 2002). Rheological properties of syrups were fitted and interpreted according to mathematical models described in the literature (Steffe, 1996; Schramm, 1998).

2. Materials and methods

2.1. Materials

Potato starch (24.55% moisture, 125.4 mg% total P, and 24.03% amylose) and low saccharified glucose syrup N-1 (DE 30–38, glucose ± 15%, maltose ± 12%) were purchased from Zetpezet Wronki Ltd. in Wronki, Poland. Soya sauce was purchased from Tan Viet, Gdańsk, Poland. Sucrose KN (refined 99.8%) from sugar beet was manufactured by Cukier Małopolski SA in Kazimierza Wielka, Poland. Tomato paste (30%) and wine vinegar (6% solution) were manufactured by Kotlin Ltd. in Poznań, Poland. Curry was a product of Kotanyi Polonia Ltd. in Warszawa, Poland. Sweet red pepper, grounded black pepper, and granulated garlic were manufactured by Prymat Ltd. in Jastrzębie Zdrój, Poland. Iodized salt (NaCl) was prepared in Dębieńsko Ltd. in Dębieńsko, Poland. Oat starch (10.83% moisture, 76.7 mg% total P, 1.23% lipids and 11.88% amylose) was isolated according to Paton (1977), and oat hydrolysate was prepared in the Department of Carbohydrate Technology of the Agricultural University in Cracow, Poland, from oat grains, by the procedure described by Inglet and Newman (1994). Xanthan gum was purchased from JAR Jaskulski Aromaty, Warszawa, Poland. Vegetables (onion, red, sweet pepper, carrot, parsley, celery) purchased on a green market in Cracow, Poland.

3. Methods

3.1. Preparation of oat hydrolysate

Oat hydrolysate was prepared from grounded oat grains (GOG) subjected to enzymatic hydrolysis with bacterial α-amylase (Nervanase T, activity 800–850 u/l cm^3, optimum activity at pH 5.8–6.2, temperature 90–105 °C, Ubichem, Southhampton, UK).

GOG of the granularity below 0.5 mm (75 g) were suspended in distilled water (425 ml) and 1 M aqueous solution of $CaCl_2$ (1 ml) was added followed by adjusting pH to 5.8–6.2. That solution was placed in 1 dm^3 three-necked reaction flask weighed with precision of ±0.01 g and heated in the oil bath preliminarily to 70 °C. The reaction flask was fitted with thermometer, pH-meter and mechanical stirrer. On agitation at 450 temperature was increased to 95 °C and within 15 min pasting was achieved followed by addition of enzyme (0.8 ml) and maintaining that temperature for further 5 min at 350 rpm. After that period 2 M hydrochloric acid (6 ml) was added and enzyme was inactivated for 10 min pH of the reaction mixture was then brought to 6.1–6.3 by an addition of 2 M NaOH. Temperature of the reaction mixture was lowered to 50 °C and water was added to return to the initial weight of the reaction mixture. The latter was 30 min centrifuged at 7000 rpm. Supernatant was decanted, refrigerated in Petri dish and lyophilised to the solid residue. The product was grounded to <0.2 mm granularity. It contained: mono- and oligosaccharides G_1–G_8 7.0–10.7%, proteins 2.6–3.3%, ash 3.0–3.9%, β-glucans 4.4–5.3%, cellulose 0.0–0.1%, fat 0.1%, and chlorides up to 0.9%.

3.2. Recipe draw up and the preparation of S&S sauces

The recipe of S&S sauces was elaborated in the laboratory. As the basis at development of sauces list of ingredients of those commercially available was taken