LWT - Food Science and Technology 81 (2017) 299–305

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

The effect of Chios mastic gum addition on the characteristics of rice dough and bread

Iva Burešová [a, *], Richardos Nikolaos Salek [a], Erika Varga [b], Lucie Masaříková [a], David Bureš [a]

[a] Tomas Bata University in Zlín, Faculty of Technology, Department of Food Technology, Nám. T. G. Masaryka 5555, 760 01 Zlín, Czech Republic
[b] University of Debrecen, Faculty of Medicine, Department of Food Sciences, Nagyerdei Körút 98, 4032 Debrecen, Hungary

A R T I C L E I N F O

Article history:
Received 22 November 2016
Received in revised form
6 March 2017
Accepted 2 April 2017
Available online 4 April 2017

Keywords:
Gluten-free
Rheology
Texture
Fortification

A B S T R A C T

The applicability of Chios mastic gum (MG) in gluten-free breadmaking was investigated in rice flour blended with 0.5–20.0 g/100 g of gum. The presence of MG significantly ($P < 0.05$) increased Hencky strain from 0.726 to 0.730–0.738 and peak stress from 2.5 kPa to 7.3–10.4 kPa during elongation test. The presence of MG strengthened dough during frequency sweeps at 30 °C and during heating from 30 to 90 °C. Bread evaluation revealed limited applicability of MG. Loaf volume was not significantly ($P < 0.05$) impacted by the presence of MG. High rice crumb hardness was significantly improved only in bread with 0.5 g/100 g. Rising amounts of MG generally increased rice bread hardness, which may be related to the creation of small pores (0.0–2.0 g/100 g), nonporous areas (2.5–5.0 g/100 g) and the formation of dry crumb belt (10.0–20.0 g/100 g). The typical MG flavor reduced the overall acceptability of breads; only breads with 0.5–1.5 g/100 g of gum were acceptable for consumers.

1. Introduction

The intake of foods containing wheat may cause celiac disease and other health issues to a wide range of people (Biesiekierski, Muir, & Gibson, 2013; Di Sabatino & Corazza, 2009; Fasano et al., 2008). The only effective treatment is the consumption of gluten-free (GF) products (Cosnes et al., 2008; Gallagher, Gormley, & Arendt, 2004; Norström, Sandström, Lindholm, & Ivarsson, 2012). The exclusion of flours containing gluten proteins from bread-making brings a range of technological problems, since these proteins form a network with a unique ability to stretch without rupturing in response to the expansion of leaving gas in dough, which is essential for obtaining final bread volume and porosity.

GF bread is often prepared from rice flour because of its colorlessness, nutritional characteristics, bland taste and low hypoallergenic properties (Gujral & Rosell, 2004). Rice bread volume and porosity is low due to weak stability of dough surrounding gas bubbles during dough expansion.

The baking process can be divided into cold (mixing, proofing) and hot (baking) phases. During mixing, the dough is formed from hydrated flour macromolecules. Small air bubbles are, moreover, incorporated into the dough. The gas bubbles are subsequently enlarged by the accumulation of leavening gas. The dough film surrounding bubbles must be able to extend without rupturing. During baking, the growth of gas bubbles determines the expansion of the dough and subsequently the final bread volume and texture. Dough behavior during cold and hot phases can be measured using empirical and fundamental rheological methods. The results are the indicators of dough structure and predictors of its functional behavior. Dough behavior under small oscillation deformation is related to bread volume, while behavior under large uniaxial deformation is correlated to loaf height (Dobraszczyk & Morgenstern, 2003; Mondal & Datta, 2008; Weipert, 1990; Zhang, Lucas, Doursat, Flick, & Wagner, 2007). Although these tests were designed for testing wheat dough, they are also used for GF dough.

Dough behavior may be modified by the incorporation of a filler. Mavrakis and Kiosseoglou (2008) previously described the ability of Chios mastic gum (MG) to change the behavior of pure protein or polysaccharide networks. MG is the air-dried resinous exudation from the small evergreen tree *Pistacia lentiscus* L. var. *chia* (belonging to the *Anacardiaceae* family) native to the European Mediterranean, and is cultivated mainly in southern Chios, a Greek island in eastern Aegean sea (Papageorgiou, Bakola-Christianopoulou, Apazidou, & Psarros, 1997; Paraskevopoulou, Tsoukala, &

* Corresponding author.
E-mail address: buresova@ft.utb.cz (I. Burešová).

http://dx.doi.org/10.1016/j.lwt.2017.04.010
0023-6438/

Kiosseoglou, 2009). MG has been extensively used as food ingredient, herbal remedy and dietary supplement in the Middle Eastern and Mediterranean regions for centuries. Traditional Greek recipes contain 0.4–0.6 g/serving (http://gummastic.gr/en/recipes/). Additionally, MG is contemporarily used as chewing gum base, a flavoring additive in ice-cream, confectionery and liqueurs, and as a texture modifier in baked products (Kaliora, Stathopoulou, Triantafillidis, Dedoussis, & Andrikopoulos, 2007; Mavrakis & Kiosseoglou, 2008). This gum moreover provides protection against bacterial infections and exhibits antacid effects for the gastrointestinal system. Scientific research has shown hepatoprotective, cardioprotective, cytoprotective, anti-inflammatory, antileukaemic and antiatherogenic properties and anti-tumor activity against human colorectal cancer (Al-Habbal, Al-Habbal, & Huwez, 1984; Al-Said, Ageel, Parmar, & Tariq, 1986; Deshpande, Gowda, & Mahammed, 2013; Dimas, Hatziantoniou, Wyche, & Pantazis, 2009; Dimas, Pantazis, & Ramanujam, 2012; Giaginis & Theocharis, 2011; Heo et al., 2006; Koutsoudaki, Krsek, & Rodger, 2005; Loutrari et al., 2006; Magiatis, Melliou, Skaltsounis, Chinou, & Mitaku, 1999; Paraschos et al., 2011). Therapeutic dose of MG ranges from 1 to 5 g/person/day (Triantafyllou, Chaviaras, Sergentanis, Protopapa, & Tsaknis, 2007), although the gum is not toxic even in a dose of 28 g/person/day (Kang, Wanibuchi, Salim, Kinoshita, & Fukushima, 2007). Hence the fortification of GF bread with MG may improve the nutritional quality of bread, characterizing it as a new age food product with plethora of probable health benefits.

Although the impact of the added gum on rice dough may become a crucial factor impacting bread quality, this cannot be easily predicted. Additionally, no study focused on the effect of MG addition on GF bakery products has been published yet. The aim of the study was therefore to evaluate the impact of the added MG on the behavior of rice dough during tests simulating dough proofing and baking. The effect of MG addition on rheological, textural and sensory characteristics of biologically leavened rice bread was also evaluated.

2. Material and methods

2.1. Material

The study was performed on rice flour kindly provided by Extrudo Bečice, s.r.o., Czech Republic (saccharides 89.7 g, protein 7.7 g, fat 1.3 g, fiber 1.3 g per 100 g of dry flour). The flour was blended with 100% natural Chios Mastiha powder (MG) bought from the Chios gum mastic growers association, Chios, Greece. MG is a white to yellowish powder with particles smaller than 300 μm containing Mastic oil (1–3 g/100 g), masticadienonic acid (10–15 g/100 g), isomasticadienonic acid (10–15 g/100 g), other triterpenic acid, aldehydes and alcohols (45–55 g/100 g) and natural polymer poly-β-myrcene (20–25 g/100 g). The content of natural impurities was lower than 1.5 g/100 g (Anonymous, 2009, 2013).

2.2. Dough preparation

A basic formula for dough preparation consisted of rice flour (100 g), water (110 g), sucrose (1.86 g), salt (1.50 g) and yeast (1.80 g). The amounts of 0.5 g, 1.0 g, 1.5 g, 2.0 g, 2.5 g, 5.0 g, 10.0 g, 15.0 g and 20.0 g of MG were added on top of other ingredients. The amounts of all ingredients were related to 100 g of flour dry matter. A 100 g of fresh bread contained 0.25–10.00 g of MG. Since the average daily bread consumption is between 130 and 220 g/capita in Europe (The Federation of Bakers, 2010), the intake of MG from bread is 0.3–22.0 g/person/d, which is under safe dose limit of 28 g/person/d (Andreadou et al., 2016; Kang et al., 2007). Doughs for rheological testing were prepared without yeast.

2.3. Small deformations

Rheological tests were performed using HAAKE RheoStress 1 (Thermo Scientific, Czech Republic). After mixing, the dough was left to rest at 30 ± 1 °C for 5 ± 1 min in a sealed bowl to allow relaxation of stresses generated during the sample preparation. The sample was placed between 35 mm P35 Ti L parallel plates and compressed to a gap adjusted to 1.5 mm. The dough edges were afterwards trimmed with a spatula. The exposed side was coated with methyl silicone polymer Lukopren N1000 (Lučební závody a.s. Kolín, Czech Republic) to minimize dough drying out during the measurement. After 5 min rest between the plates, frequency sweep test was performed at 30 °C with angular frequencies of 0.06–63.00 rad/s and a strain of 0.1%. The temperature was controlled by a water bath A 10 equipped with control unit AC 200 (Thermo Scientific, Czech Republic). Tests were examined within the linear viscoelastic range. The values of elastic modulus G' and viscous modulus G'' were recorded.

Thermally induced changes of rheological characteristics were measured using temperature sweeps performed at a strain of 0.1% and a frequency of 6.283 rad/s, with the temperature increasing from 30 to 90 °C at 0.058 °C/s. The tests were performed within the linear viscoelastic region. The values of elastic modulus G' and viscous modulus G'' were recorded.

Each test was performed on dough samples prepared at least in three replicates. The given results are represented as mean values.

2.4. Uniaxial deformation at 30 °C

Although the uniaxial elongational test was designed for testing wheat dough, it is also used for GF dough (Van Riemsdijk, Van der Goot & Hamer, 2011), due to the positive correlation between peak stress and GF specific loaf volume (Burešová, Kráčmar, Dvořáková, & Středa, 2014). Dough test pieces were formed into 5 cm long chunks with a trapezoidal cross-section of 3 × 5 × 4 mm using a lubricated Teflon mold. The doughs were left resting for 40 ± 1 min at 30 ± 1 °C. The test was performed using the TA.XT plus (Stable Micro System Ltd., UK) texture analyzer with an SMS/Kieffer Dough and Gluten Extensibility Rig. During testing, the dough sample was stretched by the hook until it fractured. The speed of the hook was 3.00 mm/s with trigger force adjusted to 5 g. The force required to stretch the dough and the displacement of the hook were recorded as a function of time. The curves were recalculated into stress-strain curves as described by Dunnewind, Sliwinski, Grolle, and Vliet (2004) to obtain the values of peak stress σ_M and peak Hencky strain ε_{HM}. Each test was performed on dough samples prepared at least in six replicates. The given results are represented as mean values.

2.5. Bread preparation

Dry yeast was reactivated for 10 ± 1 min in a sugar solution (35 ± 1 °C). The dough ingredients were placed into a Spar mixer bowl (Spar Food Machinery MFG, Co., Ltd. Taiwan) and mixed for 6 min 150 g of dough was scaled into bread pans of 5 × 7 cm and placed into a proofer for 20 ± 2 min at 30 ± 1 °C and 85% relative air humidity. The loaves were baked for 20 ± 2 min at 180 ± 5 °C in an oven (MIWE cube, Pekass s.r.o. Plzeň, Czech Republic) previously steamed for 10 s. Baked breads were removed from the pans and stored at room temperature for 2 h. Three batches of 3 samples were baked for each MG addition. Loaf volume was determined using plastic granulates of rape-seed size. Loaf specific volume (mL/g) was obtained by dividing the bread volume by bread weight. The