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Use of β-glucan from spent brewer's yeast as a thickener in skimmed yogurt: Physicochemical, textural, and structural properties related to sensory perception

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ABSTRACT

Powdered β-glucan extracted from brewer's yeast (Yestimun, Leiber GmbH, Bramsche, Germany) was incorporated into skimmed-milk yogurt at varying concentrations (0.2–0.8% wt/wt) to investigate its potential application as a thickener. The effect of β-glucan fortification on the nutritional profile, microstructure, physicochemical properties, and texture of freshly prepared yogurts was investigated. Sensory evaluation was also conducted and was correlated with instrumental analysis. The addition of Yestimun significantly reduced the fermentation time of the yogurt mix from 4 h to 3 h. Scanning electron microscopy revealed that β-glucan particles formed small spherical clusters within the yogurt matrix. The majority of the physicochemical properties (syneresis, viscosity, color, and titratable acidity) remained unaffected by the incorporation of Yestimun in the recipe. Textural properties showed a gradual increment with increasing β-glucan concentration. Hardness, total work done, adhesive force, and adhesiveness increased by 19.27, 23.3, 21.53, and 20.76%, respectively, when using the highest amount of Yestimun powder. Sensory analysis (n = 40) indicated that fortifying yogurt with Yestimun at 0.8% (wt/wt) concentration may affect overall acceptance ratings, which was attributed to adverse flavor and aftertaste effects. However, the overall liking score of the yogurt (5.0/9.0) shows potential for commercialization of the product.
Key words: yogurt, β-glucan, brewer's yeast, thickener

INTRODUCTION

Yogurt is a popular dairy product traditionally made by the lactic acid fermentation of liquid milk. Natural yogurt is considered to be a healthy food with beneficial effects on human health (Granato et al., 2010; Tripathi and Giri, 2014). Its nutritional value is owed to the nutrients present in milk used as starting material, with cow milk being the predominant milk type used for yogurt manufacturing across the world (Chandan and O'Reil, 2006). In addition, yogurt contains lactic acid bacteria, which are essential for fermentation, and is therefore widely accepted as a probiotic product. The Food and Agriculture Organization of the United Nations/World Health Organization Working Group defined probiotics as "live microorganisms which when administered in adequate amounts confer a health benefit on the host" (FAO/WHO, 2001). This definition is widely accepted and adopted by the International Scientific Association for Probiotics and Prebiotics (Hill et al., 2014).

The macronutrient composition of milk, in particular the fat content, is a major determinant of the sensory qualities of yogurt. Dietary fats contribute to the flavor, appearance, and texture of foods and, as a result, have a positive effect on consumer liking and acceptance (Folkenberg and Martens, 2003). On the other hand, consumers are becoming increasingly aware of the scientific evidence linking high-fat diets and the development of chronic diseases such as obesity, diabetes, cancer, and cardiovascular diseases (Astrup et al., 2008; Willett, 2013). Thus, although creaminess and thickness are desired attributes for yogurt based on consumer preferences, there is an increasing demand for products that have little to no fat present in the formulation.

Recently, dietary fiber has been gaining popularity as a food ingredient in various food formulations. The beneficial effect of fiber on human health is attributed to a certain extent to its prebiotic effects. As a result, food manufacturers are keen to identify ways to include these nondigestible food ingredients in their products (Lam and Cheung, 2013). A few attempts to introduce dietary fiber in dairy products have been documented and include konjac glucomannan (Dai et al., 2016), date fiber (Balthazar et al., 2016), chitosan (Seo et al., 2009), inulin (Balthazar et al., 2015), xylooligosaccharides (Ferrão et al., 2018), and galactooligosaccharides

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(Balthazar et al., 2015; Belsito et al., 2017). β-Glucans are a type of dietary fiber isolated from a variety of natural sources such as oats, yeast, bacteria, algae, barley, and mushrooms (Ahmad et al., 2012; Zhu et al., 2015). β-Glucans are D-glucose monomers linked through β-glycosidic bonds, and their structure, molecular weight, and functionality largely depend on the source of origin as well as the method used for extraction and purification (Zhu et al., 2016). Spent brewer's yeast (*Saccharomyces cerevisiae*), which is known to be rich in β-glucans, is a by-product of beer manufacture produced in huge amounts (Aimanianda et al., 2009). The European Food Safety Authority (EFSA) has approved the inclusion of yeast β-glucans as a new ingredient in food formulations and recommends a portion ranging between 50 and 200 mg per serving (EFSA Panel on Dietetic Products, Nutrition, and Allergies, 2011).

Recent research has indicated the potential of β-glucans from spent brewer's yeast as a thickening, water-holding, or oil-binding agent and emulsion stabilizer for food applications (Thammakiti et al., 2004). Furthermore, a few attempts to modify the properties of food products such as bread and mayonnaise with yeast β-glucans have been documented (Worrasinchai et al., 2006; da Silva Araújo et al., 2014; Martins et al., 2015). To the best of our knowledge, there is no report in the literature on the use of yeast β-glucans as a functional ingredient in yogurt. The objective of this study was to assess the potential of a commercially available β-glucan powder (Yestimun) manufactured from spent brewer's yeast as a thickening agent in skimmed yogurt. The effects of β-glucan inclusion on the yogurt gel formation during the fermentation process was monitored. The physicochemical and structural properties of yogurts with varying concentrations of β-glucan were determined, and a correlation with the product's sensory perception was attempted.

MATERIALS AND METHODS

Materials

Dried skimmed cow milk powder (Marvel, Premier Foods Group Ltd., London, UK) was obtained from a Tesco supermarket (Aberdeen, UK). Insoluble (1/3)-(1/6)-β-glucan powder made from brewer's yeast (Yestimun) was kindly provided by Leiber GmbH (Bramsche, Germany). Freeze-dried yogurt starter culture containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (Goat Nutrition Ltd., Ashford, UK) was used to prepare yogurt starter. Phenolphthalein was purchased from Sigma-Aldrich (St. Louis, MO). All reagents used were of analytical grade.

Scanning Electron Microscopy

Morphological characterization of Yestimun powder by scanning electron microscopy was performed according to the method of Limberger-Bayer et al. (2014) with some modifications. Yestimun powder samples were sprinkled onto the surface of a carbon tape on a 12.5-mm pin stub. The stub surface was gently blown with an air duster to remove unattached β-glucan powder. The samples were then made electrically conductive by coating with a thin layer of gold-palladium using a Quorum Q150 ES sputter coater (Quorum Technologies Ltd., East Sussex, UK). The specimens were then imaged at an accelerating voltage of 10 kV using a Zeiss EVO MA10 scanning electron microscope (Carl Zeiss Ltd., Cambridge, UK).

Yogurt Mix Preparation

Five samples of yogurt were prepared, including a skimmed yogurt control along with yogurts containing varying concentrations of Yestimun powder (0.2, 0.4, 0.6, and 0.8% wt/wt). Up to 1 kg of yogurt mix was made for each sample using milk powder, filtered water, freshly prepared yogurt starter, and Yestimun powder. Yogurt starter was prepared by dissolving the freeze-dried culture (5 g) in 840 g of water and adding 155 g of dried skimmed cow milk powder (0.5 g of lactic culture/100 g of milk). The recipe for all samples included 16% (wt/wt) of dried milk powder and 3% (wt/wt) of yogurt starter. Yestimun powder was added to the samples according to the different percentages (0.2–0.8% wt/wt), and the water content was adjusted accordingly. Yogurt mixes (milk powder, water, and Yestimun powder if applicable) were heated to 80°C for 10 min and then immediately cooled to a temperature of approximately 45°C. This was followed by the addition of 30 g of yogurt starter to the mixes. Samples were then poured in a sterile container and placed in a yogurt fermenter (Lakeland, Aberdeen, UK) set at 44°C. A portable food and dairy pH meter (Hanna Instruments Ltd., Leighton Buzzard, UK) was used to measure the changes in pH of the samples during fermentation on an hourly basis until a pH of 4.5 was reached. At the end of the fermentation process, samples were gently stirred and stored at 4°C overnight until further analysis.

Turbiscan Measurements

The fermentation process of yogurt samples was monitored using a Turbiscan MA2000 (Formulaction, Ramonville St. Agne, France). The apparatus comprises a detection head equipped with a near-infrared light