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Physicochemical, texture properties, and microstructure of yogurt using polymerized whey protein directly prepared from cheese whey as a thickening agent

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ABSTRACT

The aim of this study was to investigate suitability of polymerized whey protein prepared directly from cheese whey on the physicochemical, texture properties, and microstructure of the yogurt. The results indicated that addition of polymerized whey protein obtained by heating the liquid whey protein concentrate at 75°C for 10 min had no significant differences in pH, titratable acidity, total solids, protein content, viscosity, texture, and syneresis between the yogurt with polymerized liquid whey protein (YWPS) and the yogurt with polymerized whey protein concentrate. However, the YWPS had significant differences in viscosity, texture, and syneresis compared with the control yogurt. Scanning electron micrographs of YWPS displayed a compact and homogeneous protein network for polymerized whey protein solution (PWPS) samples. The 4 yogurt samples were evaluated by the quantitative descriptive analysis method, and 14 sensory attributes were analyzed by principal component analysis. All 3 principal components had significant effects on the sensory profiles, accounting for 52.3, 24.32, and 10.8% of the variability in the results, respectively. Polymerized whey protein prepared directly from cheese whey may be a good protein base as a thickening agent for yogurt making.
Key words: cheese whey, polymerized whey protein, thickening agent

INTRODUCTION

Cheese whey is a byproduct of cheese-making (Castro et al., 2009). Biochemical and chemical oxygen demand of whey can cause environmental pollution (Yadav et al., 2015; Remón et al., 2016). Whey proteins, once thought to be the waste product of cheese making, have received a lot of attention from researchers not only because of their availability but also because they have certain desirable functional properties and high nutritional value and is often used to fortify protein in dairy products (Mulvihill and Ennis, 2003). The functional properties of whey protein can be improved by formation of polymerized whey protein (**PWP**), including emulsifying properties, foaming capacity, and thermal properties (Schmitt et al., 2007; Nicolai et al., 2011). Therefore, formation of PWP provides new opportunities to expand whey protein applications. Heat treatment has been used to improve emulsification properties of whey proteins including whey protein concentrate (**WPC**) and whey protein isolate (**WPI**) in the food industry (Mensi et al., 2013). In addition, the heat-induced aggregation of whey proteins may improve turbidity, viscosity, surface hydrophobicity, and gelation of whey proteins to achieve the desired structure and sensory properties of certain foods (Ren et al., 2017). It has been reported that PWP improved the body texture and enhanced the water-holding capacity of fermented dairy foods (Li and Guo, 2006).

Yogurt is one of the most consumed dairy products in the world (Cardines et al., 2018). Besides its nutritional value, the viscosity and rate of syneresis of yogurt are important indexes of sensory qualities and stability of yogurt products (Domagała et al., 2013). The most common means to improve the texture of yogurt is to increase the TS content of milk, which can be achieved by adding milk protein and solids (Zhang et al., 2015). Addition of PWP in yogurt making could improve the viscosity and syneresis of goat milk yogurt (Li and Guo, 2006). Native whey proteins are not commonly used as an ideal thickening agent because their solutions have lower viscosity because of the compact approximate globular structures and low molecular weight (Fitzsimons et al., 2008). However, heating can be used to

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Effects of polymerized whey protein prepared directly from cheese whey as fat replacer on physiochemical, texture, microstructure and sensory properties of low-fat set yogurt

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ABSTRACT

The aim of this study was to investigate the effects of polymerized whey protein (PWP) prepared directly from cheese whey on physiochemical, texture, microstructure and sensory properties of low-fat set yogurt. The Cheddar cheese whey was subjected to a sequential processes, including pasteurization, pre-filtration, microfiltration, ultrafiltration, and electrodialysis, to obtain a concentrated whey solution with ~10.0% of protein content and 90% of salt removed. The majority (~72%) of particle size distribution of PWP (70 °C for 10 min, pH 7.0) prepared directly from whey was in the range of 1–3 μm. The PWP (1.4% protein, w/w) was added to skim milk as fat replacer. The texture, apparent viscosity, and sensory properties of the yogurt samples were analyzed in comparison with full-fat (3.0% fat, w/w), low-fat (1.0% fat, w/w) and non-fat (0% fat, w/w) yogurts. The non-fat yogurt incorporated with PWP (1.4% protein, w/w) had comparable sensory and textural characteristics to the low-fat (1.0% fat, w/w) yogurt. PWP prepared directly from whey through membrane separation technology can be used as a fat replacer to develop low-fat yogurt with desired characteristics. PWP might be used as a natural and economical ingredient for formulation of low fat fermented dairy foods.

1. Introduction

Milk fat plays an important role in the appearance, flavor and texture aspects of yogurt (Liu et al., 2016). Therefore, Low-fat or non-fat yogurt is usually low in total solids content and may exhibit a poor texture, low viscosity, high syneresis and an undesirable mouthfeel (Lee & Lucey, 2010a, 2010b). To overcome these defects caused by fat reduction, several approaches have been taken to improve the acceptance of low-fat yogurt, including optimization of processing conditions (Ciron, Gee, Kelly, & Autya, 2012) and addition of fat replacers (Nguyen, Kravchuk, Bhandari, & Prakash, 2017). Fat replacers can not only decrease the calorific value of yogurt, but improve some physical and organoleptic properties of low-fat yogurt (Guven, Yasar, Karaca, & Hayaloglu, 2005). Various kinds of fat replacers have been used in an attempt to improve the quality of low-fat yogurt, including modified starch, polysaccharide and milk ingredients (Torres et al., 2018). Milk ingredients are commonly used due to their high nutritional value and good functional properties (Torres et al., 2018). Reduced-fat yogurt supplemented with whey protein concentrate as fat replacers showed good comparable textural characteristics to full-fat yogurt, which suggested that whey protein would be one of the promising candidates to improve the texture of low-fat yogurt (Sandoval-Castilla, Lobato-Calleros, Aguirre-Mandujano, & Vernon-Carter, 2004). Whey proteins also can enhance sensory properties of low-fat yogurt (Torres, Janhøj, Mikkelsen, & Ipsen, 2011).

Whey protein ingredients have been widely used for food formulations. Whey protein ingredients have been widely used for food formulations. Li and Guo (2010) made it possible to improve the functional properties of goat's yogurt with addition of polymerized whey proteins prepared from whey protein isolate (Li & Guo, 2010). Polymerized whey proteins, tried to be used as a thickening agent, could increase the viscosity and decrease the syneresis of full fat yogurt (Cheng et al., 2016). There are three main types of whey protein ingredients available, including isolate, concentrate and hydrolysate (Amaral et al., 2018; Coutinho et al., 2019). These commercial ingredients can be prepared from cheese whey after a series of separation

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