Food Hydrocolloids 77 (2018) 796–802

Contents lists available at ScienceDirect

Food Hydrocolloids

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

Utilization of foam structured hydroxypropyl methylcellulose for oleogels and their application as a solid fat replacer in muffins

Im Kyung Oh, Suyong Lee*

Department of Food Science & Technology, Carbohydrate Bioproduct Research Center, Sejong University, 209 Neungdong-ro, Gwangjin-gu, Seoul, 05006, South Korea

ARTICLE INFO

Article history:
Received 29 August 2017
Received in revised form
14 November 2017
Accepted 14 November 2017
Available online 16 November 2017

Keywords:
Hydroxypropyl methylcellulose
Oleogel
Shortening replacer
Muffin

ABSTRACT

Hydroxypropyl methylcellulose (HPMC) was utilized to structure sunflower oil into solid-like oleogels by generating foaming-templates and the feasibility of HPMC oleogels as a shortening replacer in muffins was evaluated in terms of physical, rheological, and tomographical properties. Sunflower oil was successfully converted into a solid form with the assistance of foam-structured HPMC. The resultant oleogels and their blends with shortening rheologically behaved as elastic gels. The replacement of shortening with HPMC oleogels produced muffin batters with lower viscosity and less shear-thinning behavior. The viscoelastic measurements also showed greater contribution of HPMC oleogels to the viscous nature of muffin batters. While the specific gravity of batter had a tendency to increase with increasing replacement levels of shortening, the specific volume of baked muffins was not significantly reduced at shortening replacement levels of up to 50%. Furthermore, the X-ray micro-computed tomographic analysis demonstrated that air cells were much larger in size and inhomogeneously distributed in the muffins prepared with HPMC-oleogels. The shortening replacement with HPMC oleogels at up to 50% by weight did not negatively contribute to the soft and chewy texture of the muffins. These results demonstrated that HPMC oleogels could be effective in replacing shortening at up to 50% without significant deterioration in the quality attributes of muffins.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

Consumer demands for healthier diets without compromising quality criteria have been consistently increasing in the food industry. Specifically, a great deal of effort has been made to reduce the levels of solid fat since it contains a high level of saturated fat that is considered a causative agent of chronic diseases such as diabetes, obesity, and cardiovascular disease when overconsumed (Chowdhury et al., 2014; Siri-Tarino, Chiu, Bergeron, & Krauss, 2015). The FAO/WHO (2010) recommends limiting the saturated fat intake to less than 10% of a daily calorie intake. Hence, solid fat replacers have been developed from a variety of lipid (Kanjilal et al., 2016; Rangrej, Shah, Patel, & Ganorkar, 2015), carbohydrate (Onacik-Gür, Żbikowska, Kapler, & Kowalska, 2016; Rodríguez-García, Laguna, Puig, Salvador, & Hernando, 2013), and protein (Laneuville, Paquin, & Turgeon, 2005) sources for food applications. However, from a food processing point of view, they are still ineffective in compensating for the functionalities of solid fat such as mouthfeel, processability, and handling convenience.

Oleogelation is a novel technique that structures liquid oils in a three-dimensional network with the assistance of oleogelators. Therefore, although oleogels are generally composed of more than 90% (w/w) liquid oil, they have solid-like properties. A number of preceding studies reported various kinds of oleogelators that are generally classified into two groups – crystalline particle and self assembly systems (Kim, Lim, Lee, Hwang, & Lee, 2017; Patel & Dewettinck, 2015; Tanti, Barbut, & Marangoni, 2016b) showing that the physicochemical and rheological properties of oleogels varied depending on the types and levels of the oleogelators used. More recently, hydrocolloids have started to be utilized as alternative oil-structuring ingredients since most of them are approved as food ingredients and their properties have been well-characterized. The hydrocolloid-based oleogelators for structuring liquid oils included methyl cellulose (Gallego, Arteaga, Valencia, & Franco, 2013; Patel, Cludts, Sintang, Lesaffer, & Dewettinck, 2014), hydroxypropyl methylcellulose (Patel and Dewettinck, 2015), and chitin (Gallego, González, Arteaga, Valencia, & Franco, 2014). Specifically, Patel,

* Corresponding author.
E-mail address: suyonglee@sejong.ac.kr (S. Lee).

https://doi.org/10.1016/j.foodhyd.2017.11.022
0268-005X/© 2017 Elsevier Ltd. All rights reserved.

Schatteman, Lesaffer, and Dewettinck (2013) reported the interesting foaming property of hydroxypropyl methylcellulose that imparted great oil sorption characteristics, consequently generating oleogels with rheologically solid-like property when sheared. However, only a few studies have been reported regarding the application of hydrocolloid-based oleogels to food products such as sandwich cookie creams (Tanti, Barbut, & Marangoni, 2016a), cakes (Patel et al., 2014), and peanut butter (Tanti et al., 2016b). It is therefore necessary to expand the utilization of hydrocolloid-based oleogels in a wider variety of food products by further investigating their processing performance for practical food applications.

In this study, foam-structured HPMC was prepared to structure sunflower oil into solid-like oleogels and their feasibility as a shortening replacer in baked goods was evaluated. In particular, the physical, rheological, and tomographical properties of muffins were investigated at different levels of shortening replacement with HPMC oleogels.

2. Materials and methods

2.1. Preparation of HPMC oleogels

Hydroxypropyl methylcellulose (HPMC) was obtained from Lotte Fine Chemical Co. Ltd. (Incheon, Korea). It had a viscosity of 4000 cP with 19–30% methoxy and 3–12% hydroxypropyl substitution. HPMC oleogels were prepared based on the methods of Tanti et al. (2016b) with slight modifications. As described in Fig. 1, the HPMC solution was prepared by dissolving HPMC in distilled water (1%, w/w) with agitation overnight. It was then homogenized (WiseTis-HG-15D, Daihan Co., Wonju, Korea) at 11,000 rpm for 15 min, followed by freeze-drying (DC 801, Yamato Scientific Co., Ltd., Tokyo, Japan). The resultant freeze-dried sample was ground using a laboratory grinder (HMF-3150S, Hanil Electronics, Seoul, Korea) and mixed with sunflower oil (Sajo Co., Seoul, Korea) to obtain 4% (w/w) HPMC oleogels by using an overhead stirrer (MS3040, Tops Misung Scientific Co., Seoul, Korea) at 400 rpm for 3 min. Fig. 1 exhibits the visual appearance of these sunflower oil-HPMC oleogels with solid-like properties. As can clearly be seen, the liquid sunflower oil was successfully converted into a solid form with the assistance of HPMC as a gelator.

2.2. Preparation of muffins

HPMC oleogels were incorporated into the formulation of muffins as a shortening replacer at four different replacement levels (25, 50, 75, and 100% by weight). The muffin samples were thus designated based on the ratio of shortening to HPMC oleogel: S100/H0 (control), S75/H25, S50/H50, and S0/H100. The formulation used in making the control muffins consisted of wheat flour (200 g; CJ Co., Seoul, Korea), shortening (100 g; Dongsuh Oil & Fats Co., Seoul, Korea), non fat dry milk (16 g; Seoulmilk Co., Seoul, Korea), sugar (130 g; Samyang Co., Seoul, Korea), baking powder (4 g; Ottogi Co., Anyang, Korea), salt (1 g; CJ Co, Seoul, Korea), water (100 g), and whole egg (100 g). First, the shortening and sugar were blended for 2 min at speed 6 using a KitchenAid mixer (St Joseph, MI, USA) and then further mixed with whole egg for 3 min. The mixture of wheat flour, baking powder, salt, and non fat dry milk were added and mixed for 1 min at speed 6. After scraping down, the water was added and mixed for 1 min at speed 6. The muffin batters (70 g) were poured into muffin pans and baked in an oven (OFP-202, Daeyoung Bakery Machinery Co. Ltd. Seoul, Korea) at 185 °C for 28 min, after which they were left to cool for 1 h at ambient temperature.

2.3. Rheological measurement

The rheological measurements of shortening/HPMC oleogel blends and muffin batters were made by using a controlled stress-rheometer (Discovery HR-2, TA instrument, New Castle, USA) equipped with 40 mm parallel plate geometry. The dynamic oscillatory storage (G') and loss (G'') moduli of the blends of shortening and HPMC oleogels (S100/H0 (control), S75/H25, S50/H50, and S0/H100) were measured in the frequency range of 0.1–10 Hz at a strain of 0.1% that was within the linear viscoelastic limit. In case of muffin batters, their steady shear viscosities were measured at 25 °C in the range of shear rate from 0.1 to 100 s^{-1} and the flow curves were fitted to the power law model; $\eta = K(\dot{\gamma})^{n-1}$, where n and K values refer to the flow behavior index and consistency index, respectively. The viscoelastic properties of muffin batters were measured at 25 °C in the frequency range of 0.01–10 Hz (0.1% strain). A thin layer of mineral oil was used along the outer edge of samples to prevent evaporative loss during the rheological measurements.

2.4. Measurement of specific gravity

The specific gravity of muffin batter was determined by comparing the weights of the batter and water at equal volumes.

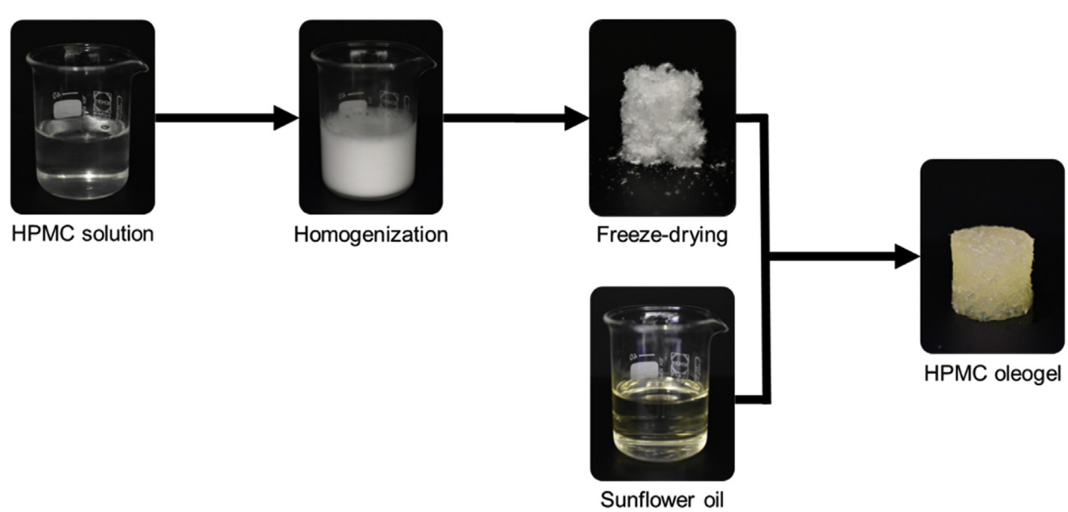

Fig. 1. Experimental procedure to prepare sunflower oil-HPMC oleogels.

Download English Version:

https://daneshyari.com/en/article/6986533

Download Persian Version:

https://daneshyari.com/article/6986533

Daneshyari.com