Food Hydrocolloids 54 (2016) 211–219

Contents lists available at ScienceDirect

Food Hydrocolloids

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

Effect of guar gum with glycerol coating on the properties and oil absorption of fried potato chips

Lin Yu [b], Jinwei Li [b, **], Shaodong Ding [b], Feng Hang [a], Liuping Fan [a, b, *]

[a] State Key Laboratory of Dairy Biotechnology, Technology Center, Bright Dairy & Food Co. Ltd., Shanghai 200436, China
[b] State Key Laboratory of Food Science and Technology, School of Food Science and Technology, Jiangnan University, Wuxi 214122, China

A R T I C L E I N F O

Article history:
Received 12 April 2015
Received in revised form
30 August 2015
Accepted 3 October 2015
Available online 22 October 2015

Keywords:
Oil absorption
Potato chips
Oil distribution
Frying
Guar gum
Glycerol

Chemical compounds studied in this article:
Water (PubChem CID: 962)
Starch (PubChem CID: 439341)
Glycerol (PubChem CID: 753)
Sudan red (PubChem CID: 5910713)
Nile Red (PubChem CID: 65182)
Petroleum (PubChem CID: 6437559)
Glucose (PubChem CID: 5793)
Oleic acid (PubChem CID: 445639)
Stearic acid (PubChem CID: 5281)
Cetylic acid (PubChem CID: 985)

A B S T R A C T

Effects of guar gum with glycerol coating on the oil absorption of fried potato chips were investigated using dye oil methods, confocal laser scanning microscopy (CLSM) and scanning electron microscopy (SEM). The results showed that coating with guar gum and glycerol could effectively hinder the oil absorption of fried potato chips and have no negative effects on its breaking force. Compared with control or samples coated with guar gum, potato chips with guar gum and glycerol produced a reduction of oil absorption by 51.8% and 34.8%, respectively. Both for control or coated potato chips, penetrated surface oil (PSOs) was dominant in total oil (TOs), followed by structural oil (STOs) and surface oil (SOs). Coating treatment with guar gum and glycerol could significantly reduce the SOs and PSOs of potato chips ($P < 0.05$). PSOs was the main factor which attributed to the TOs reduction of fried potato chips after coating. CLSM photographs revealed the oil distribution pattern for control or coated sample, and confirmed that PSOs obviously reduced after coating with guar gum and glycerol, followed by SOs. SEM photographs indicated that guar gum, guar gum and glycerol coatings were effective in preventing oil penetration into the potato tissue during frying process. Coating formulations not only enhance the barrier properties of fried potato chips, but also avoid pores and cracks in the fried products with higher toughness.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Frying is a cooking process to achieve desirable sensory attributes such as flavor, texture and appearance. One of the most important quality changes during the process is mass transfer, mainly represented by water loss and oil uptake, and heat transfer (Mellema, 2003; Vitrac, Dufour, Trystram, & Raoult-Wack, 2002). During frying, the moisture removal inevitably results in a significant uptake of oil which amounts to around 40% of the total food product weight (Kita, Lisińska, & Gołubowska, 2007). High oil content greatly increase the risk of adverse health consequences such as obesity, high blood pressure and coronary disease (Cheng, 2012; Sayon-Orea et al., 2014; Stier, 2013), thus, reducing the oil content of fried foods is among the most important requirements.

There are lots of researches related to the reduction of oil content during frying, such as fry under suitable conditions (Kim & Moreira, 2013), use of pre-drying before frying (Niamnuy, Devahastin, & Soponronnarit, 2014), and use of edible coatings (Varela & Fiszman, 2011). Kita et al. (2007) reported that oil content of potato chips was influenced by frying temperature and the type of oil used for frying, but the effect of oil reduction was very limited. Pre-drying leads to a number of physical and chemical changes of a food material, also leads to high energy consumption and high capital costs (Huang, Zhang, Mujumdar, & Lim, 2011). Compared to the previous two methods, application of coatings is an alternative

* Corresponding author. School of Food Science and Technology, Jiangnan University, Wuxi 214122, China.
** Corresponding author.
E-mail address: fanliuping@jiangnan.edu.cn (L. Fan).

http://dx.doi.org/10.1016/j.foodhyd.2015.10.003
0268-005X/© 2015 Elsevier Ltd. All rights reserved.

method to reduce the oil content of fried foods and have no adverse effects.

Some edible coatings, particularly hydrophilic polymers, have the ability to be good oxygen, carbon dioxide and lipid barriers (Albert & Mittel, 2002), which gives them potential to decrease oil uptake in fried products. Coatings make the surface stronger and more brittle, with fewer small voids, which reduces water evaporation and leads to less oil uptake; also, coatings alter the water-holding capacity by trapping moisture inside and preventing the replacement of water by oil (Mellema, 2003; Singthong & Thongkaew, 2009). On the other hand, hydrocolloids can be used as emulsifiers in composite films (Skurtys, 2010), the surface tension between the oil and the food could also be reduced, consequently contributed to decrease oil uptake. Thus, reducing the oil content of fried potato chips by application of coatings is an effective method.

Among the hydrocolloids used for coating foods for frying, the use of guar gum has been found to be effective (Garmakhany, Mirzaei, Nejad, & Maghsudlo, 2008; Kim, Lim, Bae, Lee, & Lee, 2011; Sothornvit, 2011). Addition of plasticizer for improving mechanical properties of biodegradable films has been extensively reported. This increases the percentage elongation of films by forming hydrogen bond with the polymer and reducing polymeric interactions (Piermaria et al., 2011; Saurabh et al., 2013). Coating integrity is a critical factor related to adhesion and flexibility, decreasing possible discontinuities and brittle zones (Piermaria et al., 2011). Plasticizers, which are low molecular weight components, can improve the flexibility and handling of films, maintain integrity and avoid pores and cracks in the fried products (Donhowe & Fennema, 1993). Polysaccharide based films are commonly plasticized with polyols such as glycerol (Garcia, Ribba, Dufresne, Aranguren, & Goyanes, 2011). The addition of glycerol as a plasticizer might contribute improvement of films flexibility and significantly lower tensile strength and higher elongation at break, which allows diminishing the oil uptake (Jouki, Khazaei, Ghasemlou, & Hadinezhad, 2013).

Khalil (1999) reported that potato strips coated with a combination of 0.5% calcium chloride and 5% pectin had the highest reduction of oil content, but had the highest water content as well. Tavera-Quiroz, Urriza, Pinotti, and Bertola (2012) noted that an edible methylcellulose coating plasticized with sorbitol on potato chips caused an oil reduction of 30%.

Researches on the oil reduction using edible coating mainly focused on the effects of coating on the total oil content, little to investigated effects on the oil distribution. As a consequence, one aim of the present study was to determine the effect of guar gum with or without glycerol on the quality, oil fraction, oil reduction and breaking force of potato chips. Another important aim was to investigate oil distribution patterns of fried potato chips with or without edible coating using dye oil method and confocal laser scanning microscopy (CLSM). The third aim was to study the difference of potato chips microstructure with or without edible coating by scanning electron microscopy (SEM) during frying.

2. Material and methods

2.1. Sample preparation

Potatoes (*Solanum tuberosum* L.) and shortening (produced by Jia-li Co., Ltd., Shanghai, China, the main fatty acids are oleic acid, stearic acid and cetylic acid) were purchased from a supermarket in Wuxi, China. The potatoes were thoroughly washed with clean tap water, peeled and cut into thickness of 2.0 ± 0.1 mm and diameter of 22 mm using a manual slicing machine (Jintan Precision Instruments Co., Ltd., Changzhou, China). These slices were blanched for 5 min at 95 °C prior to the coating application in order to inactivate enzyme, remove surface starch, reduce sugars (glucose et al.) and gelatinize starch, then cooled to ambient temperature with a flow of cold water. The excess water was blotted out using lint-free tissue paper.

Based on our previous experiments, guar gum (produced by Henan Lubang food raw materials Co., Ltd., Henan, China) with concentration of 1% (w/w) was prepared, and glycerol (produced by Sinopharm Chemical Reagent Co., Ltd., Shanghai, China) with the concentration of 8% (w/w) was used as plasticizer. The potato slices of 15 g were immersed into 100 ml guar gum solution with or without glycerol at the temperature of 40 °C for 3 min. Then, samples were drained on a wire structure to allow removal of the excess surface solution for 20 min cooling to ambient temperature. Each experiment was tested in triplicate.

2.2. Frying procedure

Oil dyed with Sudan red preparation: The heat resistant dyed oil was prepared by dissolving 1 g of the fat soluble and heat resistant stain Sudan Red I in 1 L of the frying oil. Subsequently, the solution was diluted into different concentrations with petroleum ether (PE) (Sinopharm Chemical Reagent Co., Ltd., Shanghai, China), and the absorbance was determined at 459 nm (maximum absorbance) by a spectrophotometer (UV2600, Shanghai Tian Mei Scientific Instruments Co., Ltd., Shanghai, China) at room temperature.

Frying procedure: Coated and uncoated (control) samples were fried in a thermostatically temperature controlled fryer (Jintan Precision Instruments Co., Ltd., Changzhou, China) filled with 3 L of shortening. The potato weight/oil volume ratio was 1:30. The frying temperature was 180 °C, and the frying time was 8 min. According to the method of Pedreschi, Cocio, Moyano, and Troncoso (2008), 20 s before ending each frying process, 0.188 L of dyed Sudan Red I was added quickly. All fried samples were drained and cooled to room temperature before analysis.

2.3. Analytical methods

2.3.1. Water content, solid content and starch content

The water content (Ws, %) was measured in a convective oven at 105 °C until the sample mass did not change further. Ws was the water content of chips expressed against the non-fat solid content, calculated as follows:

$$Ws\ (\%) = \frac{W}{1 - W - TO} \times 100\% \tag{1}$$

where W (%) and TO (%) are the water content and total oil content of the chips (wet basis). Each sample was tested at least in triplicate.

Starch content of the potato was determined according to the National Standard GB/T 5514-2008 in China. For each coating, each sample was tested at least in triplicate.

Solid content was calculated as follows:

$$\text{Solid content } (\%wb) = 100\% - \text{Initial water content } (\%\, wb) \tag{2}$$

2.3.2. Oil content

Oil content and oil fraction (SOs, STOs, PSOs) of potato chips were analyzed by the method of Bouchon, Aguilera, and Pyle (2003) with a little revision.

2.3.2.1. Calibration curve. Calibration curve was used to determine the concentration of Sudan Red I (Sigma chemicals) in the frying oil.

Download English Version:

https://daneshyari.com/en/article/603768

Download Persian Version:

https://daneshyari.com/article/603768

Daneshyari.com