LWT - Food Science and Technology 68 (2016) 432–438

Contents lists available at ScienceDirect

LWT - Food Science and Technology

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

Changes in physiochemical properties and stability of peanut oil body emulsions by applying gum arabic

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ARTICLE INFO

Article history:
Received 10 April 2015
Received in revised form
23 December 2015
Accepted 24 December 2015
Available online 29 December 2015

Keywords:
Oil bodies
Emulsion
Groundnut
Stability
Polysaccharide

ABSTRACT

The physiochemical properties of peanut oil bodies were studied, which was reflected in zeta potential, particle size, and stability. Zeta potential of oil bodies changed from around +37.23 mV at pH 3 to −21.83 mV at pH 7. High temperature (95 °C) did not influence zeta potential and particle size whereas low temperature (−20 °C) lead to the increase in particle sizes of peanut oil body suspension at both pH 3 and 7. However, the effects of low temperature on the particle size were weakened by the addition of gum arabic (GA). Thus, the peanut oil bodies were proved to be a new useful source of lipids for application in emulsion system. The peanut oil bodies can be a food ingredient applied in food industry and gum arabic (GA) could enhance the stability of peanut oil body under several environments.

1. Introduction

Triacylglycerols (TAGs), stored in densely packed lipid bodies that are small spherical organelles called “oil bodies”, can be found in the cytosol. These oil bodies are utilized in the seeds of higher plants. Oil bodies have been found in the cytoplasm of several plant tissues, such as leaves, roots, pollen grains, anthers, bulbs, and seeds. Specifically, seeds are the most common sites for storage of oil bodies which served as food reserves for germination and plant growth (Huang, 1996; Murphy, Pinzón, & Patel, 2001). Oil bodies can be applied in emulsion and delivery system in food and other industries. For example, oil bodies can encapsulate protein and carry bioactive lipids, active agents or pharmaceutically active ingredients.

Peanut is an important industrial and oilseed crops and also a good source of protein, lipid, and fatty acid for human nutrient (Grosso, Nepote, & Guzmán, 2000; Özcan & Seven, 2003). Peanuts are used in food including peanut butter, peanut oil, roasted peanuts and other forms of ingredients, but more than 50 percentages of peanut seeds are used for squeezing oil. Quality and stability of the oil are very important for consumers. Peanut seeds contain about 51.9% of oil, which was mainly composed of oleic acid (37–55.6%), linoleic acid (25.2–39.7%), palmitic acid (8.2–13.8%) and stearic acid (3.2%) (Wang, Raymer, Chinnan, & Pittman, 2012). Moreover, it is rich in γ-tocopherol which is major form of vitamin E and antioxidants which are important to human health (Azadmard-Damirchi, Emami, Hesari, Peighambardoust, & Nemati, 2011). Therefore, the extracted oil body from peanuts may be a new source of lipids in food industry. However, the fact that oil bodies become unstable at a pH close to the isoelectric point (IEP) limits the utilization of oil body. Oil bodies are stable at pH 2 and pHs above 6 but unstable within the pH range from 3 to 5. They are also stable at NaCl concentrations below 25 mM (pH 7) and temperatures from 30 °C to 90 °C (Iwanaga et al., 2007; Nantiyakul, Furse, Fisk, Tucker, & Gray, 2013).

Gum arabic (acacia gum) is a natural polysaccharide derived from exudates of *Acacia senegal* and *Acacia seyal* trees (William & Phillips, 2009). Gum arabic forms a protective layer around oil droplets which prevents them from aggregation. The complex chemical structure of gum arabic is mainly composed of glycoprotein, polysaccharides, calcium, magnesium and potassium salts.

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http://dx.doi.org/10.1016/j.lwt.2015.12.055
0023-6438/

Polysaccharide side chains of gum arabic link D-galactose with branches of L-arabinose, L-rhamnose and D-glucuronic acids. Importantly, the proteinriched part, which has been identified as arabinogalactan proteins, is rich in hydroxyproline. Gum arabic is a mixture of hydrophilic carbohydrate and hydrophobic protein components. Hydrophobic protein components adsorb onto the surface of oil droplets while hydrophilic carbohydrate components inhibit droplets from flocculation and coalescence through electrostatic and steric repulsions between droplets thus promoting their stability (Dauqan & Abdullah, 2013). Gum arabic can dissolve both in cold and hot water in a concentration of 50% w/v. The pH of the gum arabic solution is normally around 4.5–5.5. Gum arabic is mainly used as emulsifier, thickener and stabilizer in food and beverages. Gum arabic is also used for manufacturing pharmaceutical capsules and coating pills. Moreover, it can be used in the sector of manufacturing vitamins, lotions, cosmetics, and so on because of its high water solubility, low viscosity, and good emulsifying ability (Verbeken, Dierckx, & Dewettinck, 2003). Therefore, many studies have shown the interests of applying gum arabic in stabilizing emulsions. Wang, Wang, Li, Benu, and Shi (2011) reported that the gum arabic adsorbed at soybean protein concentrate (SPC) stabilized oil-water interface at different NaCl concentrations and high temperature. Gum arabic can decrease interfacial tension via attractive electrostatic interactions (Bouyer et al., 2011).

The aim of this study is to examine the physiochemical properties of peanut oil bodies under different environmental conditions and to apply gum arabic in the peanut oil body suspension for enhancing its stability, which is useful in the application of peanut oil bodies in food industry.

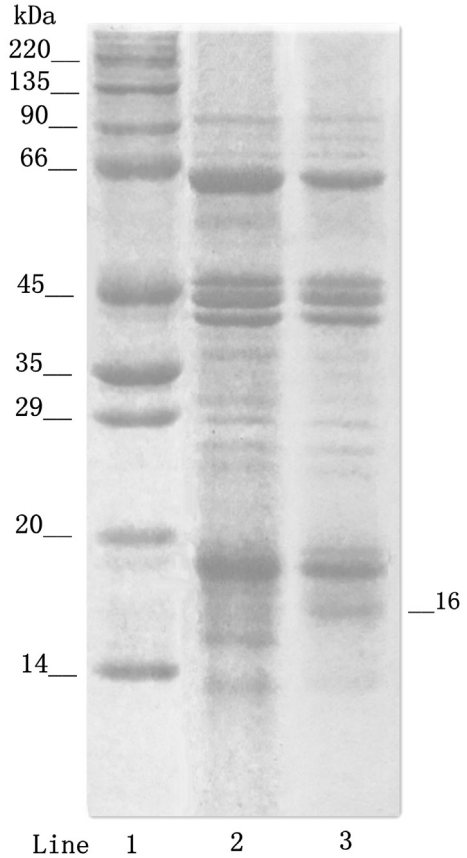

Fig. 1. SDS-PAGE profile of molecular marker (line 1), the extracted peanut oil body dispersion (line 2), and peanut oil bodies proteins (line 3).

2. Materials and methods

2.1. Materials

The raw peanuts were purchased from local market. NaOH was from Sinopharm chemical reagent Co., Ltd. Gum arabic was purchased from Xilong Chemicals (Shantou, Guangdong province, China). HCl was purchased from Beijing Chemical Works. Distilled water was used to prepare all solutions.

2.2. Extraction of peanut oil bodies

The extraction of peanut oil bodies was performed according to the method of Iwanaga et al. (2007) with slight modification. Peanuts (50 g) were soaked in 250 ml of Tris HCl buffer solution (10 mM pH 7.5) overnight at 4 °C. Swelled peanuts were blended for 2 min by a blender (JOYOUNG, Beijing) with 250 ml of 10 mM pH 7.5 Tris-HCl buffer solution containing 3 mM $MgCl_2$. The slurry was filtered through three layers of gauze cloth. The filtrate was centrifuged at 3800 rpm for 30 min (Anke LXJ-IIB, China). The creamed layer on the surface was collected and dispersed in a chilled buffer solution (10 mM Tris-HCl buffer, pH 7.5). The oil body dispersion was centrifuged under the same condition as described

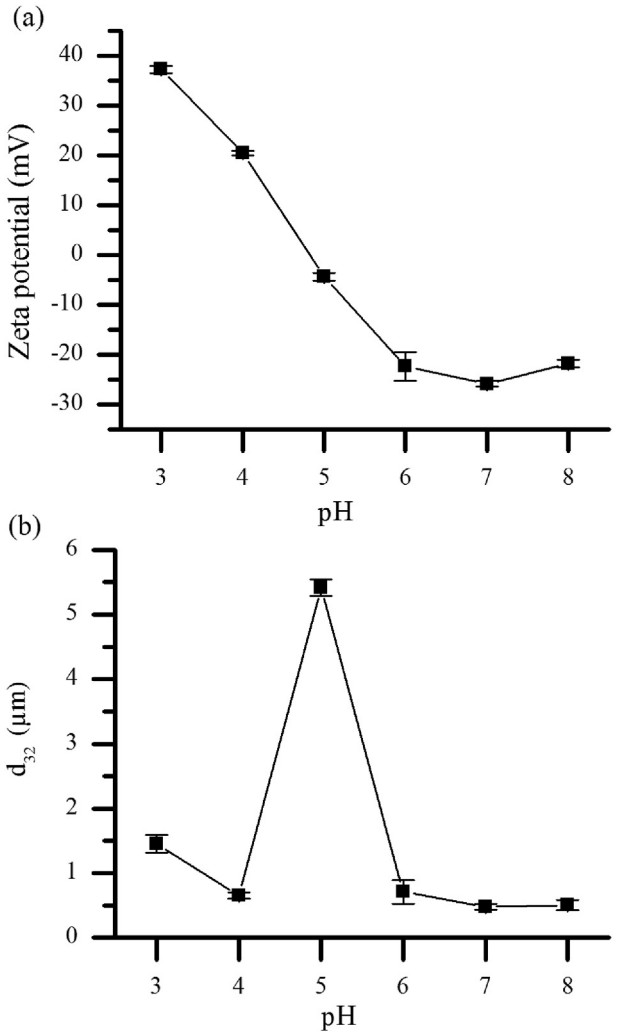

Fig. 2. Changes of the zeta potential (a) and the mean particle diameter (b) of the peanut oil body suspensions at pH 3, 4, 5, 6, 7 and 8.