Innovative Food Science and Emerging Technologies xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Innovative Food Science and Emerging Technologies

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

Study of physiological and textural properties of roasted peanuts defatted by an innovative oil extraction process. Correlation with consumer evaluation

Joelle Nader *, Charbel Afif, Nicolas Louka **

Laboratoire d'Intensification des Procédés Agro-Industriels (LIPAI) - Unité de Recherche: Technologie et Valorisation Agroalimentaire (TVA) - Centre d'Analyses et de Recherche – Faculté des Sciences - Université Saint Joseph - Campus des Sciences et Technologies - Beirut, Lebanon

ARTICLE INFO

Article history:
Received 11 June 2015
Received in revised form 13 November 2015
Accepted 7 December 2015
Available online xxxx

Keywords:
Peanuts
Texture
Consumer evaluation
Oil extraction
Optimization
Food engineering

ABSTRACT

The growing demands for novel low-fat products and health conscious awareness posed a strong incentive to develop a new efficient defatting process of high quality. In this study, mechanical oil extraction, reconstitution by soaking and roasting were conducted on peanuts followed by quantitative and qualitative studies on the morphological and textural properties of the defatted grains to investigate the best extraction parameters (water content, pressure, processing duration). The novelty of this defatting process lies in the use of a specific separation material to avoid irreversible deformation and damage. Instrumental results and consumer evaluation were extremely correlated and findings showed that defatting promotes better grain appearance and increase in expansion ratio, hardness, friability and work required to crush the roasted peanuts that become less crunchy. A multiple optimization, using Response Surface Methodology, resulted in the following optimal conditions: 13.2% d.b. water content, 12 MPa pressure and 19.2 min processing duration.

Industrial relevance:

- This study was performed within the Lebanese food project and low-fat peanuts were produced in an industrial environment.
- The work described is innovative in the process implementation and design, thus, results were recently patented under the following publication numbers LB-10,492 and LB-10,493.
- This article reveals a novel process of defatting called MEPPI "Mechanical Extraction Preserving Product Integrity", applied on hydrated peanuts (7 to 13% d.b.) using mechanical expression method at pressures varying between 4 and 10 MPa for different processing durations (10 to 30 min). The additional advantage of this process is that high oil extraction yields (attaining 70 to 80%) have been obtained without any recourse to conventional polluting agents such as chemicals (hexane, petroleum ether,...etc.). Only mechanical pressing and hydration by soaking have been used during this healthy, eco-friendly and cost effective defatting process.
- By applying this new process, higher oil yields have been achieved with lower processing times (3–4 min) and lower pressures (<10 MPa), lower irreversible deformation ratios (<1%) and higher consumer acceptability (by preserving the sensory, textural, physiological and organoleptic qualities of the finished product etc.) than what was previously obtained.
- Previous defatting processes were abandoned by the industries as they yielded high percentages of broken and cracked nuts with a harsh texture. Contrariwise, the novelty of this study lies in the use of a specific separation material to avoid irreversible deformation and damage during defatting and to preserve by that the appearance and texture of the finished product.
- The results of the present study were significant and would be helpful for the food industries as the textural and morphological quality of the new product was studied and the process parameters were optimized for a better acceptance by the consumers.

* Correspondence to: J. Nader, Centre d'Analyses et de Recherche, Faculté des sciences - Université Saint Joseph, B.P. 11-514 - Riad El Solh, Beirut 1107 2050, Lebanon. Tel.: +961 70 935 172.
** Correspondence to: N. Louka, Directeur du Centre d'Analyse et de Recherche, Directeur de l'Unité de Recherche TVA, Faculté des sciences -Université Saint Joseph, Campus des sciences et technologies, B.P. 11-514 - Riad El Solh, Beirut 1107 2050, Lebanon. Tel.: +961 1 421 386; +961 70 897 054 (Cell); fax: +961 4 532 657.
E-mail addresses: joelle.nader@net.usj.edu.lb (J. Nader), nicolas.louka@fs.usj.edu.lb (N. Louka).

http://dx.doi.org/10.1016/j.ifset.2015.12.007

- These results demonstrated that this novel process has successfully found solutions to health conscious consumers who are in need of high protein crunchy snacks but of reduced fat, and to food industry by having developed a cost-effective method in comparison to current applications.
- This innovative process can have a broader perspective by applying it to other snack products in order to reduce their fat content while preserving shape integrity, without using any chemical agent.

1. Introduction

Peanuts (*Arachis hypogaea* L.) have gained recognition as rich source of protein (22–30%) (Savage and Keenan, 1994), lipids (45.9–55.4%) (Wang, Raymer, Chinnan, and Pittman, 2012) naturally free of trans-fats, niacin contributing in a healthy blood flow and brain function, folate, antioxidants, vitamin E, magnesium, phosphorus and dietary fibers (Kris-Etherton et al., 1999). Thus, peanut has been an important oilseed crop product of high use in confectioneries, snacks and mostly in fat and oil industries. Meanwhile, the high fat content limiting peanuts consumption as a snack product and the increased consumer preference for low-fat products have proven to be a driving force for the development of a new defatting process to produce lower oil content roasted peanuts that still retain the desirable taste, texture and appearance.

Partial removal of oil from oleaginous seeds has been processed either by mechanical (hydraulic (Lanoisellé, 1995), extrusion (Bargale, Ford, Sosulski, Wulfsohn, and Irudayaraj, 1999), etc.) or by chemical methods (enzymatic (Dominguez, Nunez, and Lema, 1993), solvent (Cerutti, de Souza, and de Arruda Guelli Ulson de Souza, 2012), supercritical CO_2 extractions (Bravi, Bubbico, Manna, and Verdone, 2002; Hu et al., 2012), etc.) in a batch or continuous process. The high pressure-high temperature mechanisms were generally destructive, damaging the edible quality of the obtained defatted product, deteriorating structural integrity of the residual matrix and consequently altering the textural attributes of the roasted low-fat peanuts. Furthermore, these oil extraction techniques could adversely affect the shape of the nuts, their organoleptic properties, their chemical composition, or they were simply polluting, excessively costly or not highly efficient. Therefore, the previously mentioned drawbacks have restricted their wide application in the food industry.

Appearance and texture are important sensory quality aspects that attract consumers of snack products. Among the several texture characteristics, hardness is often used to determine the freshness of food and crispness is the key texture attribute of dry snack products which is perceived through a combination of kinesthetic, visual, auditory (Vickers and Bourne, 1976; Chanvrier, Jakubczyk, Gondek, and Gumy, 2014) and tactile sensations (Heidenreich, Jaros, Rohm, and Ziems, 2004). Overall, there are two methods to evaluate food texture: descriptive sensory and instrumental analyses that were often correlated allowing a development of a texture profile and a relevant measurement of consumer acceptability (Kim et al., 2012).

Snacks texture and crispness has been related to their moisture content (Martinez-Navarraete, Moragu, Talens, and Chiralt, 2004), water activity (Katz and Labuza, 1981), seed microstructure, chemical and physical changes occurring during processing (Kaur, Singh, and Singh Sodhi, 2005; Luscher, Schlüter, and Knorr, 2005).

Mechanical extraction has been definitely used as a tool to reduce fat from many foods, but, in the literature review, little attention has been paid to the structural and textural profile of the reduced-fat snack products such as peanuts. In fact, partially defatted nuts lack the desirable texture, appearance and flavor of full fat nuts. Such products felt gritty and chalky during chewing and left an unsatisfactory mouthfeel. Many researchers (Holloway & Wilkins, 1982; Wilkins and Gannis, 1984) also recognized the adverse effect partially defatting nuts had on flavor and texture. This was caused by the destruction of the nut microstructure during pressing.

Thus, although the prior studies hold out opportunities for partially-defatted nut products, high quality product of this type has not yet been produced as flavor, appearance and texture problems remain. Moreover, currently there are no published researches using consumer acceptability as well as instrumental verifications to understand the physical and textural characteristics of reconstituted and roasted partially defatted peanuts.

The objective of this study was to evaluate the physiological and textural characteristics of partially defatted roasted peanuts as affected by hydraulic pressure, processing time and initial water content. The more specific objectives were to determine the consumer acceptance and compare them to the quantitative instrumental analyses of peanuts defatted to different ratios, to model the effects of mentioned process parameters on consumer acceptance, physical and textural results and to identify the optimum conditions of a simple oil extraction process without adversely affecting the structural and textural quality of the resultant defatted nuts, obtaining by that an overall combination of texture, flavor, and mouthfeel with a significant reduction in caloric intake.

2. Material and methods

All experimental parameters mentioned in the below described process were set after a series of preliminary trials which were carried out in LIPAI laboratory.

2.1. Sample preparation

Raw unshelled peanuts (*Arachis hypogaea* L.) of Virginia type were imported from China (Laixi city shunxiang peanuts product's Co. LTD) and delivered to LIPAI laboratory by a local roastery, "El Kazzi" (Beirut, Lebanon). Raw peanuts were previously dehulled and naturally dried to a moisture content of 5.56 ± 0.24% d.b. Ten kilograms of these peanuts were randomly selected, manually cleaned and were sieved twice using 9.5 and 8.5 mm square mesh sieves in order to select medium and whole seeds with a geometric mean diameter (MD) of 12.41 ± 0.26 mm and a sphericity ratio (SR) of 0.59 ± 0.02. For the purpose of determining the average size, length (L), width (W) and thickness (T) were measured for 100 seeds randomly chosen from the batch previously sieved, using micrometer calipers with a reading accuracy of 0.01 mm. According to Mohsenin (1986), MD and SR were calculated using the following formulas:

$$MD = \sqrt[3]{LWT} \tag{1}$$

$$SR = \frac{MD}{L} \tag{2}$$

2.2. Pretreatments

2.2.1. Light initial roasting and peeling

An initial roasting (140 °C, 15 min) was performed in order to develop the flavor and color characterizing peanuts, to reduce the water content (2.48 ± 0.12%) and to partially denature proteins in order to facilitate subsequent oil extraction. Furthermore, excessive roast was

Please cite this article as: Nader, J., et al., Study of physiological and textural properties of roasted peanuts defatted by an innovative oil extraction process. Correlation wi..., *Innovative Food Science and Emerging Technologies* (2015), http://dx.doi.org/10.1016/j.ifset.2015.12.007