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Original article

Effect of Blanching Time Variation on Nutritional and Functional Quality Attributes of Pea Pods

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Abstract

Pea pods (PP), which account for 30–40% of fresh green peas weight, are by-products that may emanate from pea processing industry. They are promising sources of compounds beneficial to human health and are considered as a possible functional food ingredient for developing health-promoting products with high added value. In this study, blanching pre-treatment step has been applied to pea pods (PP) to promote enzyme inactivation which can lead to quality loss during storage. The main objective of this experiment was to determine the effect of different blanching times (2, 4, 6, 8 and 10 min) on reducing sugars, phenolic and carotenoids contents, and water holding capacity (WHC) of the treated product. Pea pods (PP), that were subjected to the different blanching times mentioned above, were transformed in powders that were compared to unblanched pea pods (PP). Results showed a significant ($P<0.05$) decrease in reducing sugars and phenols due to blanching treatment from 18 g 100 g-1 DW (unblanched sample) to 10 g 100 g-1 DW (blanched pea pods for 10min) and from 428 mg 100 g-1 DW (unblanched sample) to 232 mg 100 g-1 DW (blanched pea pods for 10min), respectively. However, the increase of blanching time from 2 to 4 min was efficient in increasing carotenoids content. Similarly, lower values of WHC were found with longer bleaching time (from 6 to 10 min), while unblanched and blanched pea pods (PP) for 2 and 4 min exhibited the same water holding capacity (WHC). Globally, blanching for 2min was found better for preserving the product nutritional value and its functional property.

Keywords: Pea Pods, By-Products, Blanching, Nutritional Properties, Functional Property.

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INTRODUCTION

Pea pods (PP) are by-product generated from processing pea (*Pisum sativum L.*). They are a valuable source of bioactive compounds such as vitamins, minerals, dietary fibers, carotenoids etc. (Ahmed et al., 2020; Sagar, Pareek, Sharma, Yahia, & Lobo, 2018). Despite this nutritional relevance, pea pods (PP) have not received much attention in human nutrition (Mateos-Aparicio, Redondo-Cuenca, & Villanueva-Suárez, 2010) and are mostly used as animal feed (Rogerson & Matthews, 1977). Pea pods (PP) are also used in a limites way, in other applications including bioethanol production (Wadhwa, Kaushal, & Bakshi, 2006), extraction of cellulosic materials (Kassab, Abdellaoui, Salim, & El Achaby, 2020), and polysaccharide and carbohydrate recovery (Mary et al., 2016) or conversion (Vojvodić, Komes, Vovk, Belščak-Cvitanović, & Bušić, 2016). Therefore, the valorization of this underused residue is quite promising, it not only addresses environmental concerns but also bolsters economic resilience and societal well-being, epitomizing a key step towards sustainability.

Furthermore, the development of high value-added products from pea pods (PP) holds significant importance in enhancing human health through nutrition and foresting sustainable food systems, as several studies report their large number of pharmacological benefits. It has been revealed that pea pods (PP) have an antidiabetic, renoprotective, and reproprotective activities (Mejri et al., 2019), an hepatoprotective activity (Seida et al., 2011), an antibacterial activity (Hadrich, Arbi, Boukhris, Sayadi, & Cherif, 2014), and an α-Amylase inhibition activity (Hadrich et al., 2014; Kamalakkannan & Stanely Mainzen Prince, 2006; Wang, Du, & Song, 2010). Because of these important health-promoting benefits, pea pods (PP) can be used and added to food products, as they can improve human nutrition and health.

As it is well known, the presence of enzymes in food products can lead to a deterioration of quality during storage such as flavor, texture, color and even the nutritional quality of the product. To avoid undesirable enzyme changes during storage that can plague a sample until it is used, products often undergo some type of pre-treatments during processing to inactivate these enzymes. Generally, a brief heat treatment such as blanching is most commonly used. However, heat treatment of products can lead to greatl losses of desirable properties such as texture and nutritional composition. Therefore, it should be kept to a minimum but be sufficient to completely inactivate harmful enzymes responsible for the main quality damage and to minimize at the same time undesirable losses of quality attributes. In fact, an optimum blanching pretreatment will provide maximum product quality (Dutta, Chaudhuri, & Chakraborty, 2009).

Hence, the aim of the present work was to evaluate the effect of the variation of blanching time on some quality attributes of pea pods (PP) in order to find the most adequate processing time for further utilization of pea pods (PP) powder.

MATERIALS and METHODS

Plant Material and Treatments

Green peas (*Pisum sativum L.*) were purchased from the same Tunisian local producer during the March-April (2023) period. The scrap material was obtained by removing manually green peas. Pea pods (PP) were washed several times with tap water to remove dust and extraneous matters, divided into batches and bleached at different times, i.e. 2, 4, 6, 8 and 10 minutes at 100 °C, then cooled with tap water for 2 min. Each blanched sample of pea pods (PP) was dried in a ventilated oven (Memmert, France) at 45 °C for 6h as it is the case for raw material, ground using a grinder (Moulinex LM34, France), sieved through a 250 µm mesh screen and stored at room temperature (22-25 °C), in an air-tight bottle for further use.

Characterization of Blanched Pea Pods Powders

Dry matter was determined according to the Association of Official Analytical Chemists (AOAC, 1997) method. Reducing sugar was analyzed using the DinitrosaIicyIic acid method (Miller, 1959).

For total phenolic content (TPC), 1g of each (PP) powder was weighed into an amber flask and 10mL methanol 80% was added, left at room temperature under continuous stirring for 2h and then filtered through Whatman # 1 filter paper, the methanol extract was collected and stored at −20°C until analysis.

TPC was determined using the Folin-Ciocalteu method as described by Singleton and Rossi (1965). Briefly, a 250µl of each extract or the standard gallic acid was mixed with 1.250 µLof 10-fold diluted Folin-Ciocalteu reagent and incubated for 4 minutes before the addition of 1000 µL 7.5% $Na2CO3$. After 2h incubation, the absorbance was measured at 760 nm using a UV-Visible spectrophotometer (Jenway, 6715 spectrophotometer UK), and TPC were expressed as milligrams Gallic Acid Equivalents (GAE), per 100g of dry matter.

The estimation of total carotenoids content was carried out using the method described by Ahluwalia, Kaur, and Dhillon (2012). 0.5g of each sample was mixed and crushed with 2 mL acetone, then 10 mL of petroleum ether and 30 mL of 5% sodium sulfate were added. The mixture was homogenized for 1 min and incubated during 5min for phase separation. The supernatant was collected and 10 mL of petroleum ether was added to the mixture. Petroleum ether was used as a blank reading and absorption was measured at 452nm using a UV-Visible spectrophotometer (Jenway, 6715 spectrophotometer, UK). Total carotenoids were evaluated using equation 1:

$$\text{Total carotenoids}(\text{mg}/100\text{g}) = \left(\frac{3.8 \times V \times \text{Abs} \times \text{Dilution factor}}{\text{weight of sample} \times 1000}\right) \times 100 \qquad (1)$$

Where :

V = total volume of filtrate

Abs = absorbance measured at 452 nm

For the functional property, which is water hold capacity (WHC), it was determined according to the method reported by Du, Jiang, Yu, and Jane (2014) with some modifications. Each powder sample of blanched PP (1g) was weighed into a centrifuge tube and 10 mL of distilled water was added. The samples were mixed for 30 s and allowed to hydrate at room temperature for 2 h, followed by centrifugation for 30 min at 2800 rpm (Hermle Z 206 A, Germany). Supernatants were discarded and the weight of hydrated sample was recorded. WRC was expressed as gram of water held per g of sample.

For the purposes of comparison, all analyses were performed on the raw material as well as on the bleached samples.

Statistical Analysis

All analyses were conducted in triplicate and data were expressed as mean values ± standard deviation (SD). An ANOVA analysis was performed using SAS software (version 9.2. SAS Institute, 2005). Mean comparisons were carried out using Duncan Test. Statistical analysis was performed at 95% confidence level.

RESULTS and DISCUSSION

Changes in chemical composition of pea pods (PP) powders with and without blanching are shown in Table 1. There was a decrease in the dry matter content with the increase of blanching time. It dropped from 92.86 % for unbleached PP to 87.69 % for bleached one for 10 min. This decrease in dry matter content is mainly related to the loss of some soluble components such as vitamins, minerals and nitrogen compounds (Bamidele, Fasogbon, Adebowale, & Adeyanju, 2017).

As shown in Table 1, TPC significantly decreased as a function of the blanching time increase. Raw PP sample contained the highest content (428.75 mg 100 g^{-1}) of TPC, while PP blanched for 10 min contained the least phenols contents (232.28 mg 100 g^{-1}), with a reduction of approximately 46%. Blanching pretreatment significantly reduces PP phenols. Reductions in polyphenols concentrations may be attributed to several reasons. Losses may result simply from leaching of water soluble phenols into the soak water. It may be also attributed to decreases in extractability, as lower molecular weight phenolic compounds polymerize, thus becoming insoluble in water (A, Kaur, Aggarwal, & Kaur, 2024). The activation of the enzyme polyphenol oxidase, may be another factor that may result in degradation and consequent losses of polyphenols (Bamidele et al., 2017). Other authors have attributed the losses of such molecules to their binding with other organic molecules such as protein and carbohydrates (Khandelwal, Udipi, & Ghugre, 2010). The effect of blanching time on legume or legume by-product has not been reported in the literature, hence, results described in this study were in agreement with those of several authors (Abd El-Hady & Habiba, 2003; Khattab & Arntfield, 2009) on some legumes such as pea, chickpeas, faba beans, and cowpea, who studied the effect of soaking in hot water and found that such a pretreatment was always accompanied by a significant loss of phenols.

Table 1. Proximate composition of raw and blanched pea pods (PP) powders at different times

Parameters	Unblanched PP	Blanched for 2 min	Blanched for 4 min	Blanched for 6 min	Blanched for 8 min	Blanched for 10 min
Dry matter (%)	$92.86^{a}\pm0.08$	$91.72^{ab}\pm0.16$	$90.54^{cb}\pm1.67$	$90.02^{c}\pm0.03$	$88.11^{d}\pm0.10$	$87.69^{d}\pm0.18$
TPC (mg GAE/100g)	$428.75^{a}\pm0.70$	$428.67^{a}\pm3.87$	$380.06^{b}\pm1.70$	$309.95^{c}\pm1.49$	$280.95^{d}\pm3.18$	$232.28^{e}\pm1.88$
Carotenoids (mg/100g)	$7.78^{a}\pm0.01$	$8.52^{b}\pm0.13$	$8.04^{c}\pm0.08$	$7.57^{d}\pm0.04$	$5.65^{e}\pm0.12$	$4.64^{f}\pm0.07$
Reducing sugar (%)	$18.64^{a}\pm0.06$	$17.36^{b}\pm0.02$	$14.06^{c}\pm0.14$	$12.89^{d}\pm0.05$	$12.63^{d}\pm0.05$	$10.65^{e}\pm0.07$

Results are shown as mean ± SD (n=3)

a,b,c,d,e,f : values followed by different superscripts in the same line are significantly different ($p<0.05$)

As shown in Table 1, a significant increase of the carotenoid content was noticed when PP were blanched for 2, 4 and 6 min if compared with the raw material. As reported by (Behsnilian & Mayer-Miebach, 2017; Dutta et al., 2009), thermal processing such as blanching has a potential for increasing the bioavailability of total carotenoids in vegetables. Also, enhancement of carotenoids content may be attributed to increased tissue breakdown during blanching and better accessibility to the carotenoids, as explained by Behsnilian and Mayer-Miebach (2017). Carotenoids are found in plant tissues in the chromoplasts and chloroplasts, either in a crystalline state surrounded by a membrane, or associated with lipoproteins and lipids of the inner chloroplast membrane. During blanching the plant tissue is disrupted, making the organelles containing carotenoids more accessible and possibly accounting for the enhanced carotenoid extraction efficiency (Behsnilian & Mayer-Miebach, 2017). This phenomenon has also been reported by other authors (Bureau et al., 2015; Dutta et al., 2009; Palermo, Pellegrini, & Fogliano, 2014) for various fruits and vegetables such as broccoli, carrots and pumpkin. In addition to the tissue disruption, the denaturation of carotenoid-associated proteins during blanching is another key factor in improving carotenoid extraction.

However, further increase of the blanching time (8 and 10 min) caused a significant reduction in the total carotenoid content when compared with the control. The same trend was described by (Dutta et al., 2009) when pumpkin sample were blanched at 95°C for 10min, and the authors explained this result by the fact that a prolonged blanching at high temperatures lead to the leaching of water-soluble protein molecules bound to carotene in the form of globules in the aqueous solution.

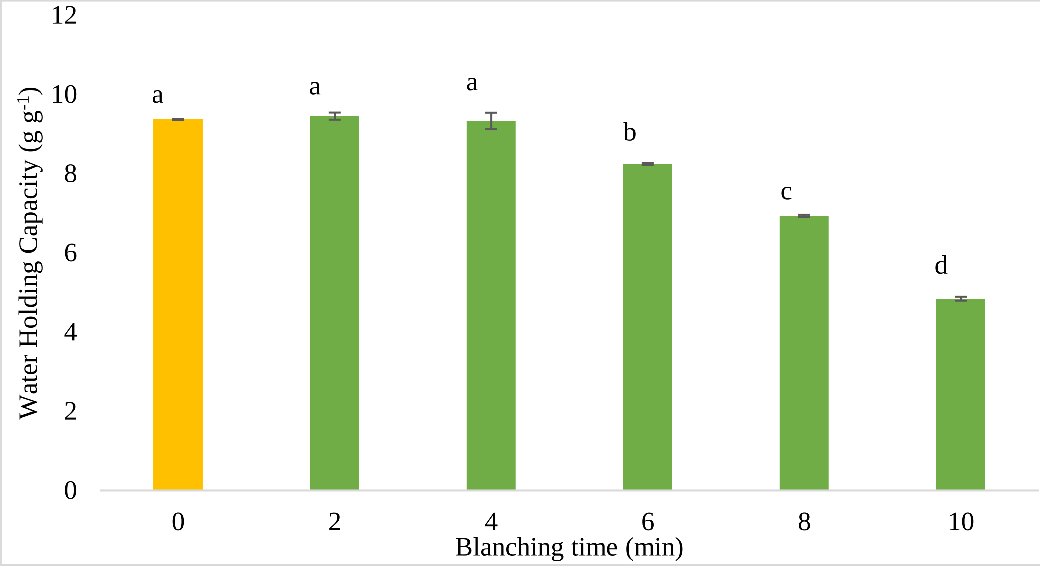

Figure 1. Water Holding capacity of raw and blanched pea pods (PP) samples

The water holding capacities (WHC) of PP powder samples are shown in Figure 1. Results showed that there was no significant difference between unbleached PP and those bleached for 2 and 4 min (9 g g^{-1}), then from 6min, it decreased with the increase of blanching time (6, 8 and 10 min). According to Belghith-Fendri et al. (2016); Du et al. (2014) and Kaur and Singh (2005), flours with high WHC contain more hydrophilic compounds like fibers, starch and polysaccharides to bind water. This hypothesis may explain the results found in this study, assuming that these compounds were not denatured during bleaching for 2 and 4 min. Since blanching can lead to the leaching of certain molecules such as polysaccharides and affect the composition of soluble, insoluble and total dietary fiber, thus contributing to the decrease in water holding capacity of pea pods (PP) exposed to longer blanching times.

Conclusion

As with all plant material, blanching pretreatment is used to inactivate undesirable enzyme, but it may affect some product quality attributes, when inadequate blanching duration were used. The main results of this study showed that banching treatment led to an increase in the carotenoids availability in the pea pods (PP), being greater at a blanching time of 2 min. Longer blanching times promoted higher losses of reducing sugars, total phenols and also reduced water holding capacity. The present study showed that pea pods (PP) blanching pretreatment must be performed during 2 min for a maximal preservation of quality.

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