Effect of different thermal treatments on the antioxidant capacity of a pea puree

Efecto de diferentes tratamientos térmicos en la capacidad antioxidante de un puré de guisantes

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Abstract

Legume puree development under eco-innovative technologies is an interesting market. Consumers are demanding appetizing, healthy ready-to-eat products due to a desire for a healthier lifestyle. The present study evaluates the total antioxidant capacity (TAC) of two different assays (DPPH and FRAP) of a pea puree throughout 24 days of storage at 5 °C. Peas were treated with steam (5 min, 80°C) or continuous microwave (MW) flow (9 kW, 40s) before being blended in a food processor (3 min, 3000 rpm) to obtain a consistent puree and then vacuum packed. Control (CTRL) samples consisted on fresh blended peas in a food processor (3 min, 3000 rpm) at room temperature and vacuum packaged. The TAC of the pea puree, evaluated in both FRAP and DPPH assays studied increased, especially after MW treatment. This trend was observed at the end of the storage, reporting differences with to steam and CTRL treatments in relation to DPPH assay. The lowest TAC was observed in CTRL puree samples. These results determined that MW heating of pea seeds is an appropriate technique to improve the quality of a pea puree.

Keywords: *Pisum sativum*; minimal processing; microwave; sustainable techniques.

Resumen

Los purés de legumbres desarrollados bajo tecnologías eco-innovadoras son un mercado interesante, ya que los consumidores están demandando productos saludables listos para consumo debido al estilo de vida. El presente estudio evalúa la capacidad antioxidante total (TAC) por dos métodos diferentes (DPPH y FRAP) de un puré de guisantes durante 24 días a 5 °C. Los guisantes se trataron con vapor (5 min, 80 °C) o en un horno microondas (MW) semindustrial de flujo continuo (9 kW, 40 s), antes de ser triturados en un procesador (3 min, 3000 rpm) para obtener un puré consistente. Posteriormente se envasaron al vacío. El Control (CTRL) consistió en guisantes frescos triturados en el procesador (3 min, 3000 rpm) a temperatura ambiente y envasado al vacío. El TAC del puré de guisantes evaluado por FRAP y DPPH aumentó especialmente después del tratamiento con MW. Esta tendencia se observó hasta al final del almacenamiento, con diferencias en los tratamientos con vapor y CTRL en relación al ensayo de DPPH. La menor capacidad antioxidante se observó en muestras CTRL de puré. Estos resultados apuntan el calentamiento MW en las semillas de guisantes, como una técnica adecuada para mejorar la calidad del puré de guisantes.

Palabras clave: *Pisum sativum*; procesado mínimo; microondas; técnicas sostenibles.

1. INTRODUCTION

Consumers are showing new interest in functional and healthy food and increasing the demand for ready to eat products due to their lifestyle. Peas are legumes with an important source of protein (ca. 24%), vitamins and minerals for diet [1]. Furthermore, a vital phenolic content and antioxidant activity in pea seeds have been previously reported [2] as well as positive associations between increased intake of legumes and health [3]. The development of 'ready-to-eat' pea puree is an alternative, which would help to increase the intake of legumes by consumers at different population segments.

In order to satisfy the current consumers demands, it is necessary to process technologies which can guarantee safety and stability and also offer high quality products [4]. Heating of food products by using continuous flow microwave systems (MW) is a technology considered an interesting alternative to conventional techniques that have been shown to provide preservation of bioactive compounds [5]. In addition it offers rapid and relatively uniform heating, reduced space utilization and precise process control [6]. On the whole, MW blanching would benefit the industry by decreasing energy costs.

The aim of the present study was to evaluate the impact of MW and steam thermal processing on the total antioxidant capacity (TAC) evaluated by two different assays (DPPH and FRAP) of a ready-to-eat pea puree throughout 24 days of storage at 5 °C

2. MATERIALS AND METHODS

2.1 Plant Material

The puree formulation was constituted by peas (*Pisum sativum L*) from an open field crop, hand-picked and immediately transported to the laboratory of the Universidad Politécnica de Cartagena (Murcia, Spain). Upon arrival they were kept in darkness at 5°C. The next day, the plant material was peeled and immature seeds were immersed in cold water. After that, they were sanitized by immersion in NaClO (100 $mg.L^{-1}$, pH 6.5) before processing.

2.2 Processing treatments and storage conditions

Sanitized pea seeds samples (100 g) were packed in polyethylene bags to MW pasteurization treatment with an innovative semi-industrial prototype of continuous MW oven (SI-MAQ0101, Sairem Ibérica SL, Barcelona, Spain). Based on our preliminary studies, appropriate combination of temperature/ time of 9 kW / 40 s was selected. Alternatively, pea seeds (100 g) were treated with steam (5 min) produced by a domestic Thermomix cooking. In both steam and MW processing the final temperature in all treatments was 85 ± 4 °C. After both kinds of pasteurization, samples were blended in a 3,7 L processor Robot Cook® (Robot Coupe, Montceau-en-Bourgogne, France) for 3 min at 1.450 g-1 and subsequently samples of puree (100 g) were packed in polyethylene bags embossed and vacuum sealed (Egarvac, Barcelona, Spain) rapidly cooled (5°C) with an ice-water bath. Control samples consisted of fresh peas blended in food processor (3 min, 1.450 g-1) at room temperature and then vacuum packed. All samples were stored at 5°C in darkness and analyzed at day 0, 7, 15 and 24 of storage at 5ºC. Three duplicates per treatment and sampling day were evaluated.

2.3 Total Antioxidant Capacity

The antioxidant capacity (TAC) was determined by DPPH and ferric reducing antioxidant power (FRAP) assays [7, 8] and was expressed as Trolox equivalent antioxidant capacity (TEAC) per 100 g^{-1} fw.

2.4 Statistical analysis

An analysis of variance (ANOVA) was performed to compare different treatments and storage times at a significant level of $P \leq 0.05$ using PASW Statistics 22 for Windows (SPSS Inc., Chicago, IL, USA). In some cases, when significant differences were observed, the Tukey´s HSD (Honestly Significant Difference) test was applied.

3. RESULTS AND DISCUSSION

The antioxidant capacity (TAC) of pea puree evaluated by FRAP and DPPH assays is presented in the Figures 1 and 2. TAC evaluated by DPPH assay at day 0, in pea puree samples, showed values around 26.18±2.41, 53.21±0.44 and 47.38±4.72 mg TAEC 100 g^{-1} fw to CTRL, MW and STEAM treatments, respectively. MW treatment significantly ($p < 0.05$) increased the TAC evaluated by DPPH assay in respect to CTRL and STEAM treated samples during 24 days of storage at 5°C (Fig. 1). At the end of the storage, MW treated samples showed losses of 16% regarding values on processing day, while STEAM treated samples showed losses of 22% (Fig. 1).

In relation to TAC evaluated by FRAP assay, CTRL, MW and STEAM treatments, values of 18.87±1.04, 49.25±3.04 and 34.34±1.04 mg TEAC 100 g-1 fw, were shown, at day 0, where MW treatment showed significant differences in relation to other treatments (Fig. 2). On the other hand, Mitra et al., (2017) [9] reported TAC losses of 6% after MW treatment (3150 W, 150s) in tomato puree in relation to untreated samples. After 7 days of storage at 5°C, there were no significant differences in MW and STEAM samples treated (Fig. 2). This trend was observed until the end of the storage.

The lowest antioxidant capacity was observed in CTRL puree samples in both assays studied (FRAP and DPPH). Thermal treatments (MW and STEAM) applied in the pea seeds avoided TAC losses of the pea puree during storage probably due to the heat inactivation of enzymes involved in the degradation of antioxidant compounds or because of softening or disruption of plant cell walls and the destruction of complex phenolics [10].

4. CONCLUSIONS

As main conclusion, it has been found that a pea puree with nutritional quality can be produced by an innovative processing technique such as continuous MW, since total antioxidant capacity by FRAP and DPPH assay were improved.

5. ACKNOWLEDGMENTS

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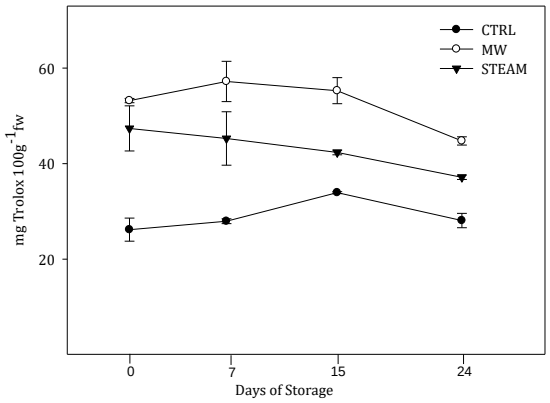

Figure 1: Total antioxidant capacity by DPPH assay of pea puree samples treated by Control (CTRL), Microwave (MW) and Steam storage at 5 °C up to 24 days.

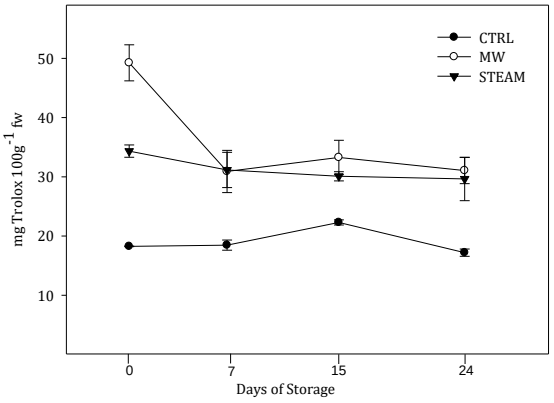

Figure 2: Total antioxidant capacity by FRAP assay of pea puree samples treated by Control (CTRL), Microwave (MW) and Steam storage at 5 °C up to 24 days.