Innovative Food Science and Emerging Technologies 34 (2016) 24–28

Contents lists available at ScienceDirect

Innovative Food Science and Emerging Technologies

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

Impact of conventional sterilization and ohmic heating on the amino acid profile in vegetable baby foods

Marta Mesías [a,*], Magali Wagner [b], Stéphane George [b], Francisco J. Morales [a]

[a] Institute of Food Science, Technology and Nutrition, ICTAN-CSIC, 28040 Madrid, Spain
[b] Centre Technique de la Conservation et des Produits Agricoles (CTCPA), Site Agroparc, F-84911 Avignon Cedex 9, France

ARTICLE INFO

Article history:
Received 20 October 2015
Received in revised form 2 December 2015
Accepted 31 December 2015
Available online 27 January 2016

Keywords:
Baby foods
Protein
Amino acids
Retort sterilization
Ohmic heating

ABSTRACT

Loss of nutrients during processing of baby foods should be minimized to maintain the nutritional quality and therefore to support a satisfactory nutritional status in infants. The present study aimed to evaluate the advantages of the ohmic heating versus conventional retort sterilization on the maintenance of the amino acid content and protein quality of sterilized vegetable baby foods. Results revealed that total protein content was not affected after both sterilization methods. However, after retort sterilization the content of total essential and non-essential amino acids significantly decreased in 35% and 9%, respectively, thus decreasing the quality protein. Contrarily, ohmic heating did not have effect on the total amino acid content and, therefore, this alternative process did not modify the protein quality of the sample. In conclusion, ohmic treatment may be successfully applied as an alternative method to conventional sterilization to maintain the nutritional quality of protein in vegetable baby foods.

Industrial relevance: Ohmic heating is an emerging technology which applies an electric current to the food, promoting uniform and rapid heating in the product. This fact facilitates the destruction of microorganisms in a shorter period of time and reduces the possible losses of labile nutrients caused with the conventional thermal treatments such as pasteurization or sterilization. The purpose of the present study was to evaluate the effect of conventional retort sterilization and alternative sterilization by ohmic heating on the amino acid content and protein quality of vegetable baby foods. These findings could be used for the baby food industries in order to improve nutritional quality of these products after heating processes.

1. Introduction

Thermal treatment is employed in food processing in order to preserve the product, extends its shelf-life and ensures consumer safety. Conventional treatments such as pasteurization or sterilization are associated with the application of high-temperature for an extended period of time, thus guaranteeing an appropriate destruction of the microorganisms. However product quality can be deteriorated resulting in undesirable sensorial and nutritional changes and specifically in losses of heat-sensitive nutrients (Awuah, Ramaswamy, & Economides, 2007).

Over the past few years some emerging technologies have been researched with the aim of improving traditional thermal processing characteristics. Among them ohmic heating provides advantages over the conventional classic retort sterilization, since the electrical current applied increases the temperature rapidly and uniformly for both homogeneous and heterogeneous products allowing a controllable heating rate and the monitorization of energy inputs online (Sastry, Heskitt, Sarang, Somavat, & Ayotte, 2014). This rapid application facilitates the destruction of microorganisms in a shorter period of time, thus reducing the negative effects on the sensory properties and losses of labile nutrients (Akdemir Evrendilek, Baysal, Icier, Yildiz, Demirdoven, & Bozkurt, 2012) and, in turn, reduces the maintenance costs. However, the electrical conductivity of foods and the excess costs of commercial ohmic heating can limit the application of this alternative method (Ramaswamy, Marcotte, Sastry, & Abdelrahim, 2014).

Thermal treatments applied to infant foods are critically important to guarantee microbiological safety. However, loss of nutrients linked to heating processes must be avoided to maintain the nutritional properties. Since baby purees together with infant formulas or breast milk are the only food sources for babies, it is very important that this type of food has an adequate nutritional quality to support a satisfactory nutritional status and a normal growth rate (Hernández Rodríguez, 2001). Due to the advantages linked with ohmic heating, it might be an alternative heating method to achieve the sterilization of baby products.

Conductivity of fruits and vegetables allows ohmic heating to be implemented as a sterilization method of these products. Ohmic heating has been tested in the treatment of artichoke heads (Guida, Ferrari, Pataro, Chambery, Di Maro, & Parente, 2013), carrots (Lemmens et al., 2009), cauliflower (Eliot-Godéreaux, Zuber, & Goullieux, 2001) papaya

* Corresponding author. Institute of Food Science, Technology and Nutrition, ICTAN-CSIC, José Antonio Novais 10, 28040 Madrid, Spain. Tel.: +34 91 549 2300; fax: +34 91 549 3627.
E-mail address: mmesias@ictan.csic.es (M. Mesías).

http://dx.doi.org/10.1016/j.ifset.2015.12.031
1466-8564/

pulp (Gomathy, Thangavel, Balakrishnan, & Kasthuri, 2015) and fruit desserts (Castro, Teixeira, Salengke, Sastry, & Vicente, 2004; Pereira, Pereira, Teixeira, & Vicente, 2006; Louarme & Billaud, 2012) and the effects on nutritional parameters have been compared with those showed after the application of conventional treatments. These studies are mainly focused on the evaluation of the stability or degradation of sugars, ascorbic acid, carotenoids or polyphenols. However, to our knowledge little is known about the effect of ohmic method on protein and amino acid profile in a food product and specifically in infant foods. The composition of amino acids in a food can be used as a measure of its nutritive value since it is the factor determining the quality of protein (Levesque, Elango, & Ball, 2012). In the present study the amino acid profile of vegetable baby purees before sterilization (control samples) and after retort sterilization (as conventional treatment) and ohmic heating (as alternative treatment) was evaluated. The aim was to investigate the feasibility of the ohmic treatment to provide vegetable purees with an enhanced amino acid profile as compared with conventional sterilization.

2. Materials and methods

2.1. Reagents and chemicals

Ethylenediaminetetraacetic acid (EDTA), ninhydrine, norleucine and amino acid standards were purchased from Sigma (St Louis, MO, USA). Chloroform, methanol and hydrochloric acid were supplied from Panreac (Barcelona, Spain). The Milli-Q water used was produced using an Elix3 water purification system coupled to an Advantage10 Milli-Q module (Millipore, Molsheim, France). All other chemicals and reagents were of analytical grade.

2.2. Vegetable baby puree manufacture

Vegetable baby purees were prepared at semi-industrial scale by the Centre Technique de la Conservation et des Produits Agricoles (CTCPA) in Avignon (France). The recipe of purees was as follows: 40% carrots, 20% peas, 15% zucchini, 0.1% salt and 24.9% water. Frozen vegetables were directly provided by a large international company dedicated to baby foods. Vegetables were mixed and precooked through boiling water for 10 min at 90 °C, then were crushed with a colloidal grinder to make a smooth puree, which was reheated to 85 °C with stirring. Afterwards the puree was divided into three aliquots. One of the aliquots was kept as a control sample (puree without sterilization), a second aliquot was retort sterilized (conventional treatment) and the remaining aliquot was treated by ohmic heating (alternative treatment). For the conventional retort sterilization, the purees were placed in jars and sterilized by the classic static retort system (Lagarde multiprocess, France), spraying hot water on the jars at 129 °C (Fo = 10 min). For the alternative process the purees were sterilized by ohmic heating system (SIMACO, Italy) which consisted of a static ohmic heater made of a cylindrical polycarbonate tube. Stainless steel electrodes were installed at both ends of the tube and alternatively connected to the ground potential and the 25 kHz high voltage from the regular 50 Hz network. The tube was cooled and the product was heated in the center, in the whole volume, at 129 °C and 350 L/h (Fo = 11 min) and aseptically filled in pouches. Both procedures were performed twice and four samples of control and sterilized purees were taken for analyses. Samples were homogenized with a hand blender (Vital CM; Taurus, Barcelona, Spain), lyophilized and stored at 4 °C until analysis. The proportion of water lost during lyophilization was taken into account for the expression of the results as fresh matter.

2.3. Determination of total protein content

Total protein content was determined in the samples using an automated nitrogen analyzer (FP-2000; Dumas Leco Corp., St. Joseph, MI), after calibration of the instrument with EDTA. The nitrogen-to-protein conversion factor was N × 6.25. Analysis was performed in triplicate. The results were expressed as g of protein/100 g of product (fresh matter).

2.4. Determination of total and free amino acids

Free amino acids were extracted from the lyophilized samples with water:chloroform:methanol (3:5:12, *v*/*v*) following the method reported by Hacham, Avraham and Amir (2002). For total amino acids determination, samples were hydrolyzed using 6 N HCl containing phenol for 21 h at 110 °C prior to chromatographic separation. Total and free amino acids were determined according to Spackman, Stein and Moore (1958). Analyses were conducted with a Biochrom 30 series amino acid analyzer (Biochrom Ltd., Cambridge Science Park, UK) using a Na-cation exchange column (20 × 0.46 cm i.d.). Amino acids were post-column derivatized with ninhydrin reagent and detected by absorbance at 440 nm (proline) and 570 nm (all the other amino acids). A standards amino acid mixture (Sigma Chemical Co.) was used for the calibration and norleucine was used as an internal standard.

Results were expressed in mg/100 g of fresh sample. The composition of the amino acids in mg/100 g protein was compared with the FAO pattern (FAO, 2013) in order to estimate the quality of the protein. The amino acid score index was calculated comparing the content of the essential amino acid in the protein with its content in the requirement pattern for the different age groups. An essential amino acid showing a score less than 1 was a limiting amino acid. The essential amino acid index (EAAI) was calculated by using the ratio of amino acid in test protein to the amino acid in the reference protein according the equation proposed by Steinke, Prescher and Hopkins (1980).

2.5. Statistical analysis

Statistical analyses were performed using the Statgraphics Centurion XV statistical program (Herndon, VA). Data were expressed as the mean value ± SD. Analysis of variance (ANOVA) and the Duncan test were applied to determine differences between means. Differences were considered to be significant at $p < 0.05$.

3. Results and discussion

Total protein content was 1.8 g/100 g in the three baby foods, without significant differences in the samples before and after the different sterilization treatments. Data are expressed for fresh matter taking into account the water content of the baby purees (89–91%) in order to provide a more realistic approximation about the composition of the baby food for consumption. Protein content was in line with that which was expected according to the ingredients of the purees and the Table of Food Composition (Moreiras-Tunio, Carbajal, Cabrera-Forneiro, Cuadrado-Vives, 2013). Considering an average weight of 200 g for a vegetable baby food sample, it would provide around 27–33% of the recommended daily protein intake for children aged 6 months–3 years (National Research Council, 2005).

Seventeen amino acids were quantified in the vegetable baby food samples. During analyses asparagine and glutamine can be quantitatively converted into aspartic and glutamic acid, therefore these amino acids were determined together and encoded as Asx (aspartic acid + asparagine) and Glx (glutamic acid + glutamine). Tryptophan was not quantified due to its loss during the analysis and digestion of the samples. Amino acid profile was similar for unsterilized samples (control), retort and ohmic treated samples and for both free and total amino acids. Results for free and total amino acids content are shown in Table 1 and Table 2. Among free amino acids, arginine was the most abundant amino acid, followed by alanine, glutamic acid + glutamine and glycine. In contrast, the less abundant amino acids were firstly cysteine with methionine (total sulphur amino acid) and secondly glycine