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Assessment of techno-functional and sensory attributes of tiger nut fresh egg tagliatelle

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A B S T R A C T

This work aims to evaluate the effect of tiger nut flour -TNF- (rich in insoluble fiber, minerals and lipids of healthy fatty acid profile) incorporation on the techno-functional and sensory attributes of durum wheat fresh egg tagliatelle. Durum wheat semolina was replaced by 10, 20 and 30% (w/w) of TNF and the resultant tiger nut tagliatelles were compared to traditional pasta (100% durum semolina). The maximum substitution level was chosen in order to obtain tagliatelle with fair techno-functional properties and acceptable sensory quality. In addition, the 30% substitution level assures a product with more than 3% of fiber content. The cooking properties, texture, colour attributes, sensory profile and water uptake kinetics of tagliatelle were evaluated. The proximate chemical composition and particle size distribution of raw materials was assessed as well. The higher cooking loss, water absorption ratios and swelling indexes associated with higher substitution levels of TNF resulted in a darker and stickier product, with a lower firmness, hardness and cohesive structure. The overall acceptability of tiger nut pasta depends more on visual and textural characteristics than on taste. No significant changes on the initial water absorption rate during cooking were observed between the control and tiger nut pasta.

1. Introduction

Pasta is a staple food produced mostly by mixing durum wheat semolina and water. It is widely consumed across the world and has become a popular carbohydrate dish thanks to its long shelf life, low cost, simple preparation and sensory characteristics (Foschia, Peressini, Sensidoni, & Brennan, 2013; Mastromatteo et al. 2012). Pasta products made from durum wheat are characterized by the proteins that form a viscoelastic network and their optimal dough properties during the mixing and extrusion steps (Mariotti, Iametti, Cappa, Rasmussen, & Lucisano, 2011), thus producing better strength and stability in the final product. Common pasta, produced by using durum wheat semolina, has better quality characteristics (cohesive and elastic dough, minimal cooking loss, no stickiness, reasonable firmness after cooking, etc.) than non-conventional pasta. Gluten is the key of the structure-forming protein in flour, and it is responsible for the viscoelastic properties of the dough. Gluten contributes to the appearance and texture of many cereal products, especially of baked goods. Total or partial gluten replacement results in major problems and work for bakers, and presently, many gluten free products available on the market are of reduced quality, presenting poor mouthfeel and flavour (Arendt, O'Brien, Schober, Gormley, & Gallagher, 2002). Furthermore, gluten is considered the most important factor in terms of pasta cooking quality, and it is responsible for the elasticity and "al dente" texture of pasta. It is perhaps the most important pasta quality parameter, as it is highly appreciated by consumers. Due to the increased concern for health awareness, nutritious pasta products rich in fiber and micronutrients -and having a low glycaemic index- may be preferable. In the last years, various healthy ingredients have been used in the production of pasta in order to enhance its nutritional profile or confer different functional properties. However, the amount of raw material that can be used as a substitute for wheat semolina, or which can be added to wheat flour, represents a compromise between the nutritional improvement and satisfactory sensory properties of pasta (Chillo, Laverse, Falcone, Protopapa, & Del Nobile, 2008). The possibility of using non-durum wheat ingredients to improve the nutritional or functional characteristics of pasta products has been widely investigated. Legumes such as peas,

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field beans, lentils, field peas, split peas, faba beans or chickpea flours high in proteins, have been used to improve the nutritional value of pasta (Gallegos-Infante et al. 2010; Wójtowicz & Moscicki, 2014). Other authors have studied the effect of adding soluble and insoluble fibers, vitamins and minerals on pasta quality (Aravind, Sissons, & Fellows, 2012a, Aravind, Sissons, Egan, & Fellows, 2012b; Knuckles, Hudson, Chiu, & Sayre, 1997). The addition of dietary fiber can further reduce the glycaemic index and introduce other health benefits (Aravind, Sissons, Fellows, et al., 2012a; Yokoyama et al. 1997). Recently, Kaur, Sharma, Nagi, and Dar (2012) analysed the functional properties of pasta enriched with a variable content of cereal bran. Results are promising as 15% (wheat, rice and oat) or 10% (barley) replacement levels can be achieved without negatively affecting the physicochemical, sensory and cooking properties of dried pasta. Nevertheless, most of these works are about dried pasta and to the authors' knowledge, no research has been conducted on composite fresh egg pasta, based on replacing durum wheat semolina with tiger nut flour. Tiger nut (Cyperus esculentus L.) is a sweet brown coloured tuber that is grown worldwide in its different varieties, in warm and temperate regions such as Southern Europe and Africa. Although it is underutilised in many countries of the world, tiger nut is an important crop in Spain (Ukwuru, Ibeneme, & Agbo, 2011), where it is used to produce a milky beverage -for human consumption- called "horchata de chufa". It is a tuber that is rich in carbohydrates, lipids, fiber, some minerals (potassium, phosphorus and calcium) and vitamin E and C (Sánchez-Zapata, Fernández-López, & Angel Pérez-Alvarez, 2012). This tuber is also rich in lipids (23–31 g/100 g) with a fatty acid profile similar to olive and hazelnut oil. Consequently, in addition to its high fiber content (8–15 g/100 g), this confers healthy properties to this tuber (Alegría-Torán & Farré-Rovira, 2003; Sánchez-Zapata et al. 2012). Recently, many authors have shown a growing interest in the potential of the tiger nut as an important source of food nutrients. Accordingly, scientific studies on tiger nuts have been conducted mainly focusing on the qualitative and quantitative assessment of its nutritional properties and on the utilization of these components for industrial food purposes. Tiger nut flour could be used in bakery products (Chinma, Abu, & Abubakar, 2010) as well as elaborating gluten-free bread with good baking and nutritional characteristics (Aguilar, Albanell, Miñarro, Guamis, & Capellas, 2014; Demirkesen, Sumnu, & Sahin, 2013). By considering the tiger nut as a potential source of food nutrients, this work was aimed at studying the effect of tiger nut flour incorporation, up to 30%, on the techno-functional and sensory properties of fresh egg tagliatelle. The water absorption index, swelling index, cooking loss, firmness, hardness, adhesiveness, springiness, cohesiveness, gumminess, chewiness, colour and sensory attributes were evaluated. A maximum 30% substitution level was chosen in order to obtain acceptable quality standard tagliatelle with more than 3% fiber content ("source of fiber").

2. Materials and methods

2.1. Raw materials

Commercial durum wheat semolina -abbreviated as DWS- (Harinas Villamayor, S.A., Huesca, Spain), tiger nut flour -abbreviated as TNF- (Tigernuts Traders S.L., Valencia, Spain) and pasteurized liquid egg -abbreviated as PLE (Avícola Llombai, S.A., Valencia, Spain) was used.

The raw materials were analysed for their moisture content, ash, fat, protein and fiber, according to the American Association of Cereal Chemists approved methods (AACC, 2000). The digestible carbohydrates were determined by difference (100 − per cent estimated proximate chemical composition).

The particle size distribution (PSD) of both DWS and TNF, and their mixtures (10, 20 and 30% replacement level) was determined by using a MasterSizer® Laser Diffraction Particle Size Analyser (Malvern Instrument Ltd., Malvern, England), equipped with a PS 65 (dry sample). Distributions were made in triplicate and for each sample, 10–20 g of flour mixture was used. Size distribution was quantified as the relative volume of particles in size bands, presented as size distribution curves (Malvern MasterSizer Micro software v 5.40). The PSD parameters recorded included largest particle size d(0.9), mean particle volume d(0.5), smallest particle size d(10), Sauter mean diameter (D[3,2]), and mean particle diameter/volume mean diameter (D[4,3]). The Span value or measurement of the width of the size distribution, calculated from the values of standard percentiles, was complementarily reported. The wider the particle size distribution, the bigger the Span becomes. The fundamental size distribution by laser diffraction method is expressed in terms of equivalent spheres (the results are volume based), so the number distributions should only be considered as a guide of the volume distribution.

2.2. Experimental design

The significance of wheat semolina replacement by tiger nut flour at 10, 20 and 30% (w/w) was assessed through changes on the dough characteristics (texture, colour), cooking properties (water absorption index (WAI), swelling index (SI), cooking loss (%CL)) and properties of the ready-to-eat product, that is, the cooked pasta (texture, colour and sensory analysis). For this purpose, tagliatelle samples were tested, before and after cooking, for their mass, water content, dimensions, colour and mechanical properties (analysis explained below). All the measurements were made in triplicate. In addition, a sensory analysis was performed on the cooked samples, as described on section 2.8.

Wheat semolina was replaced with tiger nut flour up to 30% (w/w) to obtain pasta with more than 3% (w/w) of fiber content ("source of fiber"), according to the Nutritional Claims for Dietary Fiber Foods (Official Journal of European Union, 2006). The fiber content was estimated considering the chemical composition of the raw materials (Table 1). The obtained values for 0, 10, 20 and 30% samples were, respectively, 0.16, 1.55, 2.94 and 4.33 g/100 g pasta.

As a second step, control and 30% samples were compared in terms of water gain kinetics during cooking. The procedure and analysis are detailed on section 2.9.

2.3. Fresh egg pasta preparation

Plain pasta (used as control, 0%) was obtained by mixing durum wheat semolina (71% w/w), pasteurized liquid egg (13% w/w) and water (16% w/w). Tiger nut flour was incorporated into the basic formula at 10, 20 and 30% replacement level (w/w). Corresponding

Table 1
Proximate chemical composition of raw materials (g/100 g). Mean values of three replicates (standard deviation).

	DWS	TNF	PLE
Water	12.3 (0.4)	4.88 (0.12)	77.24 (0.09)
Protein	11.1 (0.3)	3.27 (0.03)	10.0 (0.6)
Fat	1.5 (0.7)	26.04 (0.14)	6.83 (0.98)
Digestible carbohydrates[a]	75.09 (0.99)	44.3 (1.4)	5.3 (0.2)
Ash	0.79 (0.05)	2.19 (0.14)	0.60 (0.04)
Fiber	0.22 (0.08)	19.8 (0.6)	–

DWS durum wheat semolina, TNF tiger nut four, PLE pasteurized liquid egg.
[a] Digestible carbohydrates calculated by difference.