DEVELOPMENT OF SPAGHETTIS WITH ALTERNATIVE FLOURS

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Abstract

Development of new foods with an impact on human health (functional foods) is of interest for the food industry due to the increase in diseases associated with food consumption, such as obesity, diabetes mellitus, celiac disease, heart disease, cancer and malnutrition (Patiño-Rodríguez *et al*., 2018).

Pasta is among the most consumed foods worldwide, and more specifically, spaghetti is the pasta type most consumed. Spaghetti is produced by mixing wheat semolina and water, however is considered as a good product for the addition of highly nutritious raw materials. This enhancement aims mainly to increase its nutritional quality as regards to protein, dietary fibre, vitamins and minerals contents (Chillo *et al*., 2001), since one of the negative characteristics of gluten-free spaghetti is its low nutritional quality, hence, the addition of ingredients with nutraceutical potential is feasible in the production of a paste with acceptable nutritional properties.

Another property in gluten-free spaghetti, which should not be forgotten, is the fact that the compactness of spaghetti structure is mainly due to the gluten network produced during its processing, thus the main problem in gluten-free spaghetti is the poor protein network due to the absence of gluten. Many of the commercial gluten-free products are made from corn and rice due to its low cost and its abundance. However, it has low nutritional value, including low protein and dietary fibre contents (Giménez *et al*., 2013). Therefore, the use starch-rich flours such maize (*Zea mays*) can be used in combination with hydrocolloids to increase the viscoelastic properties of the dough (Mancebo *et al*., 2015).

In this study, alternative ingredients such as cassava, unripe plantain, *colocasia esculenta,* breadfruit, and maize and rice flour were used to prepare spaghetti with functional characteristics. Namely the potential unripe plantain fruit can be used as a source of antioxidants of interest for the development of gluten-free spaghetti (Hoyos-Leyva *et al*., 2015).

Therefore, the aim of this work was to evaluate the chemical composition, physical properties, texture and sensory of gluten-free spaghettis manufactured with gluten-free flours and enriched

with different levels of the above-mentioned fruits. On the other hand, in an attempt in a fist approach to develop spaghetti, it was study different types of wheat flour (durum or soft) as a control sample, to be precise the flours were evaluated in order to decide if its characteristics were or not suitable for pasta's manufacture, and in a second step the flours with or without wheat and other fruits were developed and analysed.

Thus, in first instance, to evaluate how different wheat flours affected spaghetti quality, were made analysis to its flour properties (gluten index, flour strength), and to its cooking and nutritional properties. The chemical composition, cooking quality, physical behaviour (rheometry and texture analysis) and sensory analysis in different processing steps (dough formation, uncooked and cooked) were analysed. Afterwards, several formulations were prepared using flours from cassava, breadfruit, *colocasia esculenta,* unripe plantain (pulp), maize and rice. In all spaghetti samples manufactured, either in the control wheat ones or the gluten-free ones, were made the chemical analysis of moisture, ash, protein, fat, fibre, and then determine the optimal cooking time (OCT) and the cooking loss (CL), which is considered the amount of solid substance lost in the cooking water, according to Padalino *et al*. (2013). All the analysis was determined in triplicate. In the cooked samples was made the texture in a Stable Micro System Texturometer with a light knife probe by shear compression test with the samples at room temperature, in order to evaluate shear force (hardness). In sensory analysis was compared two commercial spaghetti products, brands A (fresh) and B (dried), using a hedonic test by 50 untrained panellists of students and academic staff. Sensory evaluation was carried out using a hedonic test with a five-point rating scale. Each category was rated from 1 (dislike very much) to 5 (like very much), the spaghettis were cooked at the optimal cooking time before they were served to the panellists as warm products (around 40-45ºC). Commercial brands were used as reference products. The data were analysed by one-way analysis of variance (ANOVA) followed by the Tukey's post hoc test to determine the significant differences between spaghetti samples ($p < 0.05$) and a Statistica software version 7.0 (StatSoft. Inc., USA) was used to perform the statistical analysis of the data.

Indeed the cooked spaghetti made with durum wheat flours showed a good performance after cooking and those were harder than samples made with soft wheat. Even although wheat durum spaghetti did not show the same technological quality as the one with soft wheat flour, those ones offered a better nutritional profile due to higher protein and other healthy compounds, like fibre and antioxidants.

The spaghetti samples showed a similar chemical composition, but the whole wheat flours with fruits had a higher dietary fibre and protein content (10 to 16%), while in commercial brands with semolina mentioned can present data from 12,10 to 12,95 % and in rice flour with defatted soy flour the protein content was from 6.28 to 10.69 g/100 g pasta (Sereewat, et al. 2015). Some differences in cooking loss of the spaghetti samples were found, namely the cassava spaghettis without maize flour had showed significant differences in the CL from 6,1 g/100g to 10,0 g/100g, while in other studies (Sereewat, et al, 2015) commercial brands can present 4,78 to 4,92 (g/100g).The spaghetti samples showed different hardness than the commercial spaghetti (fresh or dried). In rheological features, the samples presented some significant differences between the formulations, however with low hardness (2-4 N), and in all gluten-free dough formulations, the viscous modulus (G”) showed a similar tendency to G’ which was greater than G”, which suggests a solid elastic-like behaviour of all the gluten-free formulas. In terms of sensory acceptability this study presented data very satisfactory with high scores, mainly in texture. In terms of antioxidants, it was found differences in some formulations, which might increase the interest of mixing this fruits in the conventional flours to make spaghetti.

It was possible to develop gluten-free spaghetti with quality characteristics using alternative flours rather than wheat flours, and due do this efforts it might be useful to think in the countries where this alternative fruits flours are native, to motivate those flours production in order to enrich the population sustainability and nutritional needs. Texture acceptability of the product obtained was not significantly different from a commercial spaghetti product tested. The results showed that maize flour and other alternative flours as cassava could be used as the ingredients for making gluten-free spaghetti.

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