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Preparation of Fresh Noodles with Chia and Amaranth †

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Abstract: Current nutritional recommendations lead to reformulate traditional products, such as fresh noodles, in order to improve the nutrients, they provide. The objective of this work was to determine the variation of the nutritional profile of fresh noodles by partially replacing wheat flour with chia and amaranth flour. For this purpose, wheat flour was partially substituted with 15% chia flour and 11% amaranth flour, respecting the proportions of the rest of the ingredients (called FS) and fresh noodles with unsubstituted wheat flour, which is taken as the standard (F). Once prepared, protein, total fat, ash, moisture, and fiber were determined by official analytical techniques, including carbohydrates by difference, energy value by calculation, and fatty acid profile by gas chromatography. From the analytical results, it appears that protein increased from 7.76 g% (F) to 10.87 g% (FS), carbohydrates decreased from 51.68 g% (F) to 39.87 g% (FS), and fiber increased from 3.19 g% (F) to 8.68 g% (FS). Total fats increased from 13.18 g% (F) to 18.68 g% (FS), of which omega-3 fatty acids increased from 0.67 g% (F) to 4.03 g% (FS). Energy value varies from 356 kcal/100 g (F) to 369 kcal/100 g (F). With the partial substitution of wheat flour with chia and amaranth, it was possible to improve the nutritional profile of the noodles, making them a feasible option for both industrial and home use.

Keywords: amaranth; chia; fresh noodles; lipidic profile; nutritional profile; vegetable protein

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1. Introduction

Due to the current regulations on the front of package warning seals, the food production industry needs to reformulate foods so that the products that reach the market do so with a better nutritional profile. On the other hand, the consumption of fresh pasta is frequent in Argentina, as well as in several countries of the region and in Europe [1].

According to Argentine legislation, the generic term "pasta or noodles" refers to non-fermented products obtained with mechanical mixing and kneading of baking flours or their mixtures with drinking water, with or without the addition of coloring substances authorized for this purpose, and with or without the addition of other permitted ingredients for this type of products. A mixture of mono- and diglycerides and monoglycerides of high concentration may be used in noodle products, alone or in a mixture, and in the technologically necessary quantity, without declaring it on the label [1].

To improve the nutritional profile of these pastas, ancestral seed flours such as amaranth (*Amaranthus caudatus*), which has a very good crop yield in Mendoza, Argentina, especially in the northwest of the country, and chia (*Salvia hispanica* L.) were chosen. Amaranth was chosen for its protein content of 16 to 18 g% [2], with a complete amino acid profile, resulting in a protein of high biological value [3]. "The Food and Agriculture Organization of the United Nations (FAO) recognizes this grain as a 'pseudocereal', with a higher protein content for human consumption, itis considered 'the food of the future' and recommended its intake in families, mainly in those with scarce resources" [4].

Chia seeds (*Salvia hispanica* L.) mainly provide omega-3 fatty acids (linolenic acid and its long chain derivatives), being the vegetable source with the highest content of this type of essential fatty acids, with the consequent benefit in human cardiovascular health. It also provides omega-6 fatty acids, its precursor being linoleic acid. The seeds are ground to obtain fine flour with an intense flavor, called "pinole" in Mexico, which is mixed with cereal flour to prepare different baked goods. This represents how these seed flours are used in this current work [5,6].

For all the above, the objective of this work was to determine the variation of the nutritional profile of fresh noodles by partially replacing wheat flour by chia and amaranth flour.

2. Materials and Methods

Fresh noodles were prepared in triplicate, partially substituting wheat flour 000 with 15% chia flour and 11% amaranth flour, respecting the proportions of the rest of the ingredients (this preparation was called FS) and fresh noodles with unsubstituted wheat flour, which was taken as the standard (called F).

2.1. Ways of Preparation

At the Applied Nutrition Research Laboratory of the Juan Agustín Maza University, Mendoza, Argentina, noodles were prepared on a pilot scale. For this purpose, two doughs were prepared in triplicate, one in which the 000 wheat flour was partially replaced by 15% chia flour and 11% amaranth flour, to which 17% fresh eggs were added so as not to add water, 10% high oleic sunflower oil, 0.3% salt, and 0.3% turmeric, which was called FS. And dough with 72% exclusively of 000 wheat flour, with the same proportion of the rest of the ingredients, this preparation was used as a standard, called F. A manual machine was used to perform the lamination and cutting of the dough. The centesimal composition analyses were performed in duplicate on the raw dough. In order to perform the sensory evaluation, the noodles were cooked in boiling water at 98 °C with Mendoza atmospheric pressure, in a ratio of one part noodles to three parts water for 3 minutes, starting from boiling. The noodles hydrate twice their weight; that is, from 100 g of noodles a 300 g dish is obtained. As such, it can be considered that the nutrients analyzed correspond to the ready to eat dish, taking into account that the fraction that leaches to the cooking water would correspond to the mineral fraction, not analysed in this study.

2.2. Laboratory Analysis

To determine the nutritional composition of both types of noodles (FS) and (F), the following methods were applied:

- *Humidity*: Method of AOAC 950.46 B. [7] Indirect method by drying in an oven at 100–105 °C, until constant weight is achieved.
- *Total fat*: Direct method by extraction with ethyl ether (crude fat), Soxhlet gravimetric method (A.O.A.C. 960.39, 1990) was used.
- *Cholesterol and Acid profile* by gas chromatography
- *Fibers*: Acid alkaline attack (AOAC, 15th edition 1990) was used.
- *Crude protein*: Kjeldahl method, (A.O.A.C. 928.08, 1990), determining nitrogen, using 6.25 as a protein conversion factor.
- *Ashes*: Direct Method (A.O.A.C. 923.03, 1990): by incineration in muffle (at 500 ± 10 °C), until constant ash weight.
- *Carbohydrates*: determined by difference, by the following formula:

$$100 - (\text{weight in grams [protein + fat + water + ash + fibers]}), \text{ in 100 g of food.}$$

- *Energy value*: by calculation

Energy value (kcal) = (protein *4) + (carbohydrates* 4) + (fat * 9). The conversion is 2000 kcal = 8400 kJ

2.3. Statistical Analysis

To analyze the assumption of normality, the Shapiro–Wilk test was applied. To analyze differences in means, the Student's *t*-test for independent samples was used. The analysis was carried out with the SPSS® statistical package.

2.4. Sensory Analysis

In order to evaluate the acceptability of the noodles, an acceptance test was carried out with 30 untrained judges.

3. Results

3.1. Noodles with and without Added Seed Flour

For all nutrients analyzed, the Shapiro–Wilk normality assumption $p = 0.526$ was met.

3.1.1. Protein

The addition of chia and amaranth flours increased the protein content from 7.76 ± 0.14 g% (F) to 10.87 ± 0.85 g% (FS). When applying the Student's t-test for independent samples, a statistically significant difference can be observed in protein $p = 0.003$.

3.1.2. Lipid Profile

Total fat increased from 13.18 ± 0.19 g% (F) to 18.66 ± 0.51 g% (FS). When applying the student's t-test, statistically significant differences p = 0.001 were found. If we analyze the different fractions that make up this lipid profile, we observe that saturated fats increase from 1.97 ± 0.12 g% (F) to 2.62 ± 0.23 g% (FS), with statistically significant differences between the two, p = 0.013. Monounsaturated fats practically do not vary from 9.14 ± 0.15 g% (F) to 9.62 ± 0.40 g% (FS), with no statistically significant differences between the two types of noodles. Cholesterol, provided by egg, is the same in both preparations 68.85 ± 0.73 mg% (F) and 68.85 ± 0.60 mg% (FS). Polyunsaturated fats increase from 2.07 ± 0.08 g% (F) to 6.44 ± 0.06 g% (FS), with statistically significant differences p = 0.001. If we analyze how these polyunsaturated fats are constituted, we observe that the contribution of omega 6 increases from 1.41 ± 0.80 g% (F) to 2.43 ± 0.05 g% (FS), with statistically significant differences p = 0.001. And the omega 3 intake increases from 0.67 ± 0.70 g% (F) to 4.02 ± 0.05 g% (FS), with statistically significant differences p = 0.001.

3.1.3. Carbohydrate Profile

Total carbohydrates decreased from 51.68 ± 0.99 g% (F) to 39.24 ± 0.23 g% (FS), with statistically significant differences $p = 0.001$. With a consequent increase in fiber content from 3.19 ± 0.04 g% (F) to 8.68 ± 0.39 g% (FS), with statistically significant differences $p = 0.001$.

3.1.4. Ash, Moisture, and Sodium Content

For these three nutrients there are no statistically significant differences when applying the Student's *t*-test for independent samples.

The ash content was 1.25 ± 0.04 g% (F) and 1.20 ± 0.03 g% (FS). Moisture was 22.94 ± 1.23 g% (F) and 21.35 ± 1.84 g% (FS).

The sodium content was 162 ± 6.25 g% (F) and 166 ± 5.29 g% (FS), which represents 7% of the daily sodium requirement.

3.1.5. Energy Value

The energy value of the noodles varied from 356 kcal/100 g for the common noodles to 369 kcal/100 g for the noodles with the addition of seeds. The increase in energy intake is not significant compared to the nutritional improvements obtained.

Table 1 shows all the values obtained for both noodles, allowing for ease of comparison.

Table 1. Composition of both noodles.

	Noodles (F)	Noodles with Seeds (FS)
Proteins g%	7.76 ± 0.14	10.87 ± 0.85
Total fats g%	13.18 ± 0.19	18.66 ± 0.51
Saturated fat g%	1.97 ± 0.12	2.62 ± 0.23
Monounsaturated fats g%	9.14 ± 0.15	9.62 ± 0.40
Polyunsaturated fats g% of which	2.07 ± 0.08	6.44 ± 0.06
Omega 6 g%	1.41 ± 0.80	2.43 ± 0.05
Omega 3 g%	0.67 ± 0.70	4.02 ± 0.05
Cholesterol g%	68.85 ± 0.73	68.85 ± 0.60
Carbohydrates g%	51.68 ± 0.99	39.24 ± 0.23
Dietary Fiber g%	3.19 ± 0.04	8.68 ± 0.39
Ash g%	1.25 ± 0.04	1.20 ± 0.03
Moisture g%	22.94 ± 1.23	21.35 ± 1.84
Sodium mg%	162 ± 6.25	166 ± 5.29
Energy Value kcal	356 ± 5	369 ± 8
Energetic Value kJ	1497 ± 22	1547 ± 34

4. Discussion

The addition of amaranth and chia flours improves the protein content. Taking into account that wheat has a protein of low biological value, the addition of amaranth improves the nutritional value of the noodles, making them ideal for low-income communities. In addition, fresh eggs provide protein of very high biological value.

The increase in total fat content is especially due to the lipid content of the chia seed, which is demonstrated by looking at the different lipid fractions. The almost constant contribution of monounsaturated fatty acids is due to the high oleic sunflower oil, which has a similar contribution to olive oil, but a more neutral taste, which facilitates the acceptability of the product. If the fatty acid profile is analyzed, noodles with seed flour are greatly improved because of the contribution of omega 9, which is beneficial to health, added to the increase in omega 3, which is extremely deficient in the population's diet, and necessary to improve the cardiovascular system, among other effects [7,8].

The decrease in total carbohydrate content, with a consequent increase in fiber, provided by seed flours, contributes to increased satiety [9].

Sodium content can be decreased by not adding salt at the time of preparation and replacing it with seasonings [10].

5. Conclusions

The addition of amaranth and chia seed flour to a noodle base dough improves the nutritional profile of the noodles and is a simple practice to apply in small-scale producers. The use of these additions increases the supply of healthier foods and revalue ancestral seeds, as well as being easy to use at home.

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