Variation of the nutritional composition of quinoa according to the processing used

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SUMMARY: In Mendoza, Argentina, quinoa is grown with a very good yield, and its consumption is becoming widespread. It is consumed as a seed, flour, expanded, sprout (germinated) and activated (hydrated). The popular belief is that all these forms have the same nutritional contribution. Taking into account this belief, the objective of this work was to determine the nutritional composition of the different preparations. The same batch of quinoa seeds was processed as flour, expanded, hydrated and sprout. It was analyzed by triplicate, applying conventional laboratory techniques. For the statistical analysis, a multiple comparison test was applied, and to discriminate between the means, the honestly significant difference procedure (HSD) of Tukey was applied. It showed that there is statistically significant difference of nutrients between all groups, with a level of 95.0% confidence. For proteins, it varies from 12.78±0.02 g/100g in whole seed to 5.25±0.01 g/100g in the hydrated seed. In total fats, it varies from 7.80±0.02 g/100g in flour to 0.72±0.01 g/100g in sprouts. For fiber, the germinated quinoa provides the highest content (23.50±0.01 g/100g), whereas the hydrated quinoa the lowest content (8.71±0.02 g/100 g). The energy value in 100 g was as follows: whole seed 1299 kcal, flour 1430 kcal, germinated 291 kcal, hydrated 594 kcal and expanded 1368 kcal. This shows how different preparations influence the nutritional contribution of quinoa. With this information, one can recommend different types of preparations depending on the type of nutrient which is wanted for consumption.

KEYWORDS*: expanded seed, flour, germinated seed, hydrated seed, quinoa*

RESUMEN: ***Variación de la composición centesimal de quinua según procesamiento empleado.*** En Mendoza, Argentina se puede cultivar quinua, con un muy buen rendimiento, por ello su consumo se está generalizando. Se la consume como semilla, harina, expandida, brote (germinada) y activada (hidratada). La creencia popular es que todas poseen el mismo aporte nutricional, por ello el objetivo fue determinar la composición nutricional de las diferentes preparaciones. Se tomó el mismo lote de semillas de quinua y se lo procesó como harina, expandida, hidratada y brote. Se analizó por triplicado, aplicando técnicas convencionales de laboratorio. Para el análisis estadístico se aplicó una prueba de comparaciones múltiples y para discriminar entre las medias el procedimiento de diferencia honestamente significativa (HSD) de Tukey. Se demostró que hay diferencia estadísticamente significativa de nutrientes entre todos los grupos. Para proteínas varía de 12,78±0,02 g/100 g en semillas enteras a 5,25±0,01 g/100 g en la semilla hidratada. En grasas totales varía de 7,80±0,02 g/100 g en harina a 0,72±0,01 g/100 g en brotes. Para fibra la germinada aporta el mayor contenido (23,50±0,01 g/100 g) y la hidratada el menor contenido (8,71±0,02 g/100 g). El valor energético fue: semilla entera 1299 kcal/100 g, harina 1430 kcal, germinada 291 kcal, hidratada 594 kcal y expandida 1368 kcal. Con esto queda demostrado como las diferentes preparaciones influyen en el aporte nutricional de la quinua. Con estos datos se puede recomendar diferentes tipos de preparaciones según el tipo de nutriente que se desea ingerir.

PALABRAS CLAVE*: harina, quinua, semilla expandida, semilla germinada, semilla hidratada.*

1. INTRODUCTION

According to FAO (2011), quinoa (*Chenopodium quinoa* Willd.) is a millenary crop that contributes to world food security. The protein content varies from 13 to 21 g% depending on the variety, with its amino acid profile being one of the most complete in the vegetable kingdom. This adequate supply of proteins makes it an ideal food for populations with protein malnutrition (FAO, 2011). The saponins found in the unwashed grain decrease the bioavailability of its amino acids (Ahumada, 2016). Quinoa has an adequate content of dietary fiber, which decreases grain digestibility. The fiber contributes to grant satiety. It provides omega 6 polyunsaturated fatty acids (50% of their fat content) and omega 9 monounsaturated fatty acids (25% of their fat content) (Delatorre-Herrera, 2013). It has been shown that the fatty acids of quinoa maintain quality due to the high natural value of vitamin E, which acts as a natural antioxidant (Su-Chuen, 2007).

In Argentina, it is cultivated especially in the northwest; however in the area of Mendoza, the crop shows good yields. Due to the type of harvest, it is ideal for small-scale production, benefiting small producers. In this context, Juan A. Maza University, the Provincial Legislature and the Family Agriculture Secretary of National Government are working on a project of the agronomist engineer Amanda Di Fabio (Di Fabio, 2018).

In a global context with a strong demand for natural and nutritious products, quinoa is one of the andean and ancestral crops most requested by consumers and with better economic prospects in recent years (INTA, 2012).

It is consumed as a seed, flour, expanded, sprout (germinated) and activated (hydrated). The popular belief is that all these forms have the same nutritional contribution. Taking into account this belief, the objective of this work was to determine the nutritional composition of the different forms of this grain.

2. MATERIALS AND METHODS

This study was based on the same lot of quinoa, which was washed, dryed and free of saponins.

2.1. Ways of preparation

Quinoa seed. It was washed and dried. This form of consumption is common.

Quinoa flour. The seed was grounded until a granulometry of 60 mesh (0.25 mm) was reached. In the present study, a laboratory mill was used and sieved prior to its analysis.

Activated quinoa (hydrated). Quinoa seeds were placed in water, in a ratio of 1 part of seeds to 3 parts of water. They were left for 5 hours. Then they were drained, cooked and used in different preparations. This method is common among vegans and vegetarians.

Sprouts of quinoa (germinated). Moisture the quinoa all night, drain and place in a glass jar upside down with a canvas as a lid to breathe. The next day moisten, drain and leave face down again. The bottle was placed in the light and within 3 days they began to sprout.

Expanded quinoa. A frying pan was heated over direct heat, with a small amount of oil. Quinoa seeds were added and after 5 minutes, they began to expand. The pan was removed from heat and the rest of the grains expanded.

2.2. Laboratory analysis

To determine the nutritional composition of the different preparations of quinoa, the following laboratory determinations were made:

Humidity: Method of A.O.A.C 950.46 B. Indirect method by drying in an oven at 100-105ºC, until constant weight is achieved.

Total fat: Direct method by extraction with ethyl ether (crude fat) (A.O.A.C. 960.39, 1990). By extraction with ethyl ether, by Soxhlet gravimetric method.

Fibers: Insoluble fiber method in neutral detergent (NDF) (AOAC, 50 (1): 50-55. (1967)

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 ºC), until constant ash weight.

Carbohydrates: by difference

Energy value: by calculation

Statistical analysis

The same batch of quinoa was taken and processed (treatment) as flour, expanded, hydrated and sprout. It was analyzed in triplicate, applying the laboratory techniques listed above. For the statistical analysis, a multiple comparison test was applied and to discriminate between the means the honestly significant difference procedure (HSD) of Tukey.

3. RESULTS

Nutrient content for each type of preparation

There are statistically significant differences (a <0.05) between the nutrients of each type of preparation (seeds, sprouts, expanded, hydrated and flour).

A statistically significant difference was shown between all groups of nutrients. For proteins, it varies from 12.78±0.02 g / 100 g in whole seeds to 5.25±0.01 g / 100 g in the hydrated seed (Figure 1). In total fats, it varies from 7.80±0.02 g / 100 g in flour to 0.72±0.01 g / 100 g in sprout (Figure 2). For fiber, the germinated quinoa provides the highest content (23.50±0.01 g / 100 g) and the hydrated the lowest content (8.71 ± 0.02 g / 100 g) (Figure 3). The energy value was as follows: whole seed 1299 kcal / 100 g, flour 1430 kcal, germinated 291 kcal, hydrated 594 kcal and expanded 1368 kcal (See Table 1).

4. DISCUSSION

The values found, for the whole seeds, are similar to those of the bibliography (INTA, 2013), except the fat content which showed to be lower, since the grain was not ground for its determination. The determination of lipids was done in this way to simulate what would happen at the digestive level if the cuticles of the seed were not to be destroyed in the stomach. In the case of flour, the values are similar to those in the literature (FAO, 2011), (INTA, 2013). By making the lipid fraction more bioavailable, the energy contribution increases.

During the germination process, (quinoa sprout) nutrients diminish and the proportion of fiber increases, which makes it ideal to grant satiety**.**

When the quinoa seed is placed in water (activated quinoa) it is hydrated by 205%, which means that the content of all nutrients is reduced.

Finally, expanded quinoa increases its carbohydrate content, decreasing the protein and lipid value, maintaining fiber intake.

5. CONCLUSIONS

This shows how different preparations influence the nutritional contribution of quinoa. With this information, one can recommend different types of preparations depending on the type of nutrient that is wanted for consumption.

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TABLES

Table 1

Centesimal composition of quinoa, for different forms of preparation

	Seed		Flour		Sprout		Hydrated		Expanded	
	Averange	Standard deviation	Averange	Standard deviation	Averange	Standard deviation	Averange	Standard deviation	Averange	Standard deviation
Proteins	12,78[a]	0,02	12,15	0,02	6,04	0,01	5,25[b]	0,01	7,49	0,01
Carbohydrates	59,36	0,05	55,42	0,01	9,64[b]	0,04	27,94	0,03	69,86[a]	0,02
Total fats	2,32	0,02	7,80[a]	0,02	0,72[b]	0,01	0,97	0,02	1,80	0,01
Saturated fats	0,26	0,01	0,86[a]	0,02	0,08[b]	0,00	0,11	0,00	0,19	0,01
Trans fat	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Ashes	2,23	0,02	2,29[a]	0,01	0,93[b]	0,01	1,22	0,01	1,22	0,01
Humidity	10,64	0,02	10,63	0,01	59,16[a]	0,01	55,91	0,01	7,00[b]	0,01
Dietary fiber	12,68	0,01	11,71	0,02	23,50[a]	0,01	8,71[b]	0,02	12,63	0,01
Energy value kcal	309	0,58	341[a]	0,58	69[b]	0,00	141	0,58	326	0,58
Energy value kJ	1299	0,58	1430[a]	0,00	291[b]	0,58	594	0,58	1368	0,58

[a] Indicates the highest value

[b] Indicates the lowest value

FIGURE CAPTIONS

Figure 1. Content of proteins in quinoa for each of the treatments

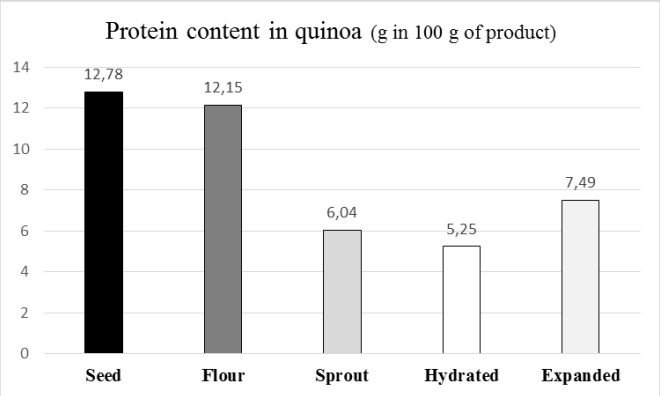

Figure 2. Content of total fat in quinoa for each of the treatments

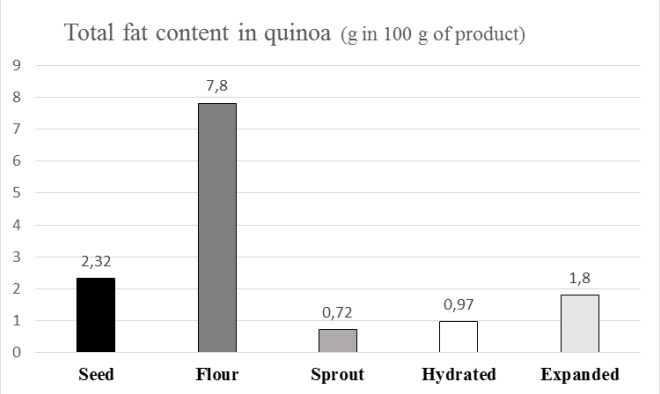

Figure 3: Content of fiber in quinoa for each of the treatments