# New Products from Traditional South American Grains

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## Summary

Popped amaranth grain can be the main ingredient in food snacks such as breakfast cereal and crunchy bar. The objective of this study was to obtain products based on popped amaranth grain that would be easy to produce, nutritive and well-accepted among consumers. Mixtures, including complementary ingredients were prepared with reference to commercial foodstuff identified by market survey. The mixtures were evaluated by sensory analysis with semi-trained judges and potential consumers. The temperature effect on the moisture sorption isotherms and kinetic deterioration were determined for the amaranth products. Several macro and micro components were analyzed to determine the nutritional quality of breakfast cereals and crunchy bars.

## Introduction

New products with desirable properties are always required for the food industry (Gonzáles et al., 2007). Traditionally, the food industry has supplemented the nutritional attributes of several products like breakfast cereals or infant foods with non-conventional cereal and legume grains (Chavéz-Jáuregui et al., 2003). Research and development also aims to improve sensory characteristics in ancient or aboriginal food products to revalorize them (Lara 1999). Concerning traditional grains, Amaranth is believed to have originated in America. For Centuries, amaranth grain had great importance in pre-Colombian American diets. After being almost extinguished, this crop has been rediscovered because it is one of the most promising grains, with high protein and minerals contents. The amaranth seed is nearly spherical, around 1 mm in diameter and yellowish-white in colour (González et al., 2007).

The amaranth can be popped with high yield by rapid evaporation of moisture contained within the grain when it is heated by hot air (Lara and Ruales 2002; Iyota et al., 2005). The popped grain has a crunchy texture (Lara and Ruales, 2002) and tastes like nutty flavoured popcorn (Tovar et al., 1994), two attributes that characterize popped amaranth grain as an high quality ingredient for use in breakfast cereal and crunchy bars (Lara, 1999).

## Experimental Methods

INIAP-Alegía (*Amaranthus caudatus*), an Ecuadorian variety, was used. A dry hot air popcorn popper was used according to selected conditions of Lara and Ruales (2002).

*Products from popped amaranth grain*

Popped amaranth grain based-products were obtained after a sequential process, which included a market survey, evaluation of sensory profiles using semi-trained judges (Anzaldúa-Morales, 1994) and acceptability 150 children, 10-12 years old (Lara 1999).

*Texture*

Force of compression (TA-XT2i) was measured during storage (90 days) and sensory scale discriminating five categories (1 not crunchy, 2 a little crunchy, 3 crunchy, 4 quite crunchy, 5 extremely crunchy) was used for crunchiness intensity (Lara and Mejía, 2004).

*Moisture sorption isotherms*

Moisture adsorption isotherms for amaranth products were determined at 14, 20, 26, 32°C (Lara and Cangás 2004). The Guggenheim-Anderson-de Boer (GAB) equation, reported by Bell and Labuza (2000), was used to adjust the isotherms and determine the monolayer values.

*Kinetics of deterioration*

Arrhenius model was used to determine the kinetic deterioration of popped amaranth products, based on rates of water absorption (Lara and Mejía, 2007).

*Macro and micro nutrients*

Content and nutrition quality was determined (Lara and Mejia, 2004b).

## Results and Discussion

*Products from popped amaranth grain*

A market survey in two large Ecuadorian cities showed that the main ingredients of commercial products like breakfast cereals were cereals and maize. Only a few products contained quinoa flour and none contained amaranth. The breakfast cereals were fortified with powdered milk, vitamins and minerals to compensate for lack of those compounds in the raw ingredients. Breakfast cereals and granola had a protein content of 6 to 10%, and iron and zinc levels were between 0.01 and 0.03%.

The hedonic score of judges (10 persons) of breakfast cereal and crunchy bars were similar ($p > 0.05$) for satisfaction level, equivalent to «like moderately» on a scale of seven points (Table 1), but were different ($p < 0.05$) for preference as analyzed from Fisher and Yates values (Anzaldúa-Morales 1994).

*Table 1. Judges score for level of satisfaction and preference of amaranth products**

| Products | Satisfaction level | Preference |
|---|---|---|
| Breakfast cereal | 6.5 ± 1.0 a | 0,66 a |
| Crunchy bars. | 6.4 ± 0.7 a | 0.12 b |

* Average (n=10), Different letter in the same column shows significantly differences by Duncan test at 5 %.

*Mixture defined by sensory judges:*

- Breakfast cereal.- 45% popped grain, 15% raisins, 9% grated coconut, less than 1% amaranth starch , brown sugar syrup 62°Brix and honey 65°Brix.
- Crunchy bars.- 60% popped grain, 1.5% amaranth starch , brown sugar syrup 62°Brix and honey 65°Brix.

The average score 4±1 for consumer satisfaction level was similar for both breakfast cereals and crunchy bars, which corresponded to the category «like a little» on the 5 point hedonic scale. The median 5 was also similar for both and equivalent to the highest category «like a lot».

The amaranth products had high preference among potential consumers. However, total purchase intention was significantly different between products, proving that crunchy bar has a better chance ($\alpha$ 5%) than the breakfast cereal (Table 2).

*Table 2. Acceptance (%) and purchase intention (%) of products based on popped amaranth grain**

| Products | Acceptance | Purchase intent. |
|---|---|---|
| Breakfast cereal | 78 ± 5 a | 58 a |
| Crunchy bars. | 84 ± 6 a | 42 b |

* The different letter in the same column shows significantly differences, (n = 150).

### *Texture*

Crunchiness sensory against maximum force of compression (Figure 1) showed a high linear correlation. The R-Squared value indicated that the model explained more than 99% of the variability of sensory responses. The correlation coefficients (-0.99) showed a relatively strong inverse relationship between crunchiness sensory score against maximum force of compression. Instead of sensory response, the maximum force of compression can be use to control the shelf life testing and basic stability of amaranth products.

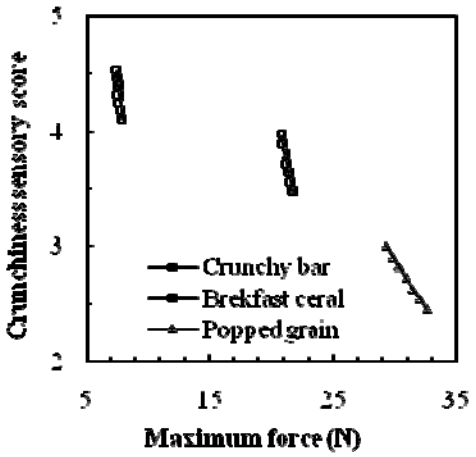


*Figure 1. Texture correlation for amaranth products stored by 90 days at 30°C and 75% relative humidity*

### *Moisture sorption isotherms*

A type II sigmoid shape characterized the moisture adsorption isotherms of popped amaranth grain and its breakfast cereal product and crunchy bars (Figure 2). At the monolayer level, the equilibrium moisture content was from 0.046 to 0.063 g $H_2O$/g db and the water activity was from 0.26 to 0.32 (Lara and Cangás 2004). For maximum stability of breakfast cereal and crunchy bars, it is important to consider the critical limit of water activity, which is related to the water monolayer value.

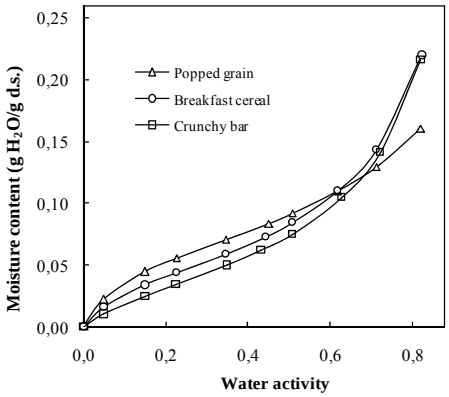


*Figure 2. Moisture adsorption isotherms of amaranth products for the temperature range of 14 to 32°C)*

### *Kinetic of deterioration*

The relation of water absorption rates (Figure 3) versus temperature (25, 30 and 35°C, corresponding to normal, accelerated and extreme storage conditions) showed the kinetics of deterioration in amaranth products through the Arrhenius model (Lara and Mejía, 2007).

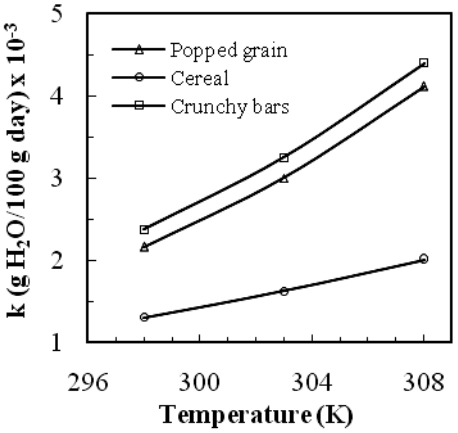


*Figure 3. Incremental rate k of water absorption in amaranth products by effect of temperature*

The R-Squared value indicated that the Arrhenius model as was fitted explained between 78.9 to 86.3% of the variability of water absorption rates by temperature effect. The kinetics of deterioration by water absorption was higher in crunchy bars than in breakfast cereal (Figure 3).

*Macro and micro-components*

A comparison of nutritional and antinutritional values showed that popped amaranth grain is a potential source of nutrients for breakfast cereal and crunchy bars (Lara et al., 2007). For both, protein content is around 8.5% and within protein range indicated in the market survey (Lara, 1999). Also, among macro and micro elements (Table 3), the contents of potassium, iron and zinc are important. The iron content in breakfast cereal and crunchy bars was 51.8 and 50.7 µg/g, respectively, even without fortification.

*Table 3. Mineral composition of amaranth products*

| **Minerals** | **B. cereal** | **C. bar** |
|---|---|---|
| Calcium (mg/g) | 1.0 ± 0.3 | 0.9 ± 0.3 |
| Phosphorous (mg/g) | 3.4 ± 0.3 | 2.5 ± 0.7 |
| Magnesium (mg/g) | 1.6 ± 0.1 | 1.3 ± 0.1 |
| Potassium (mg/g) | 7.6 ± 0.5 | 8.4 ± 0.1 |
| Sodium (mg/g) | 0.6 ± 0.4 | 0.6 ± 0.4 |
| Copper (µ/g) | 5.5 ± 0.7 | 4.7 ± 0.4 |
| Iron (µ/g) | 51.8 ± 3.1 | 50.7± 0.4 |
| Manganese (µ/g) | 12.7 ± 0.4 | 10.5 ± 0.7 |
| Zinc (µ/g) | 19.0 ± 1.4 | 16.7 ± 2.4 |

Average (n = 3)

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