

Applying an Ingredient with Antioxidant Activity and its Effect on the Nutritional and Sensory Quality of Cookies

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Abstract

Adding regional flours to the making of crackers is a good alternative to provide more vulnerable population with an affordable and of appropriate nutritional value proposal. The sensorial quality of nutritional foods influences their consumption and this is why knowing the attributes the consumer privileges at the time of their consumption is appropriate. The objectives of this paper were: to evaluate the mesquite flour in nutritional terms and to develop fortified crackers with it, to characterize sensorially the crackers elaborated using the QDA and to evaluate their acceptability. Work was done on sweet crackers formulated out of wheat, mesquite and oat flours for a higher proteinic quality; additionally they were fortified with minerals and chocolate flavored. The mesquite flour brought increased contribution of proteins, fibers and minerals to the formulation of the crackers in addition to that of antioxidant compounds. Using chocolate as the flavoring agent in the production of the crackers resulted in a markedly higher global acceptability punctuation among the infantile population while their sensorial quality was not modified by the addition of mineral fortifiers.

Keywords

Mesquite flour, Cookies, Antioxidant activity, Nutritional quality, Sensory quality

Introduction

The National Plan for Food Security (PNSA) was created in 2003. It is a National Nutrition and Food program, with the aim of making it possible for the population in a situation of social vulnerability to receive complementary food, sufficient and according to the particularities and customs of each region of the country. In this context, it is planned to provide children with school breakfasts and snacks, composed of a dairy base and a solid accompaniment that cover good daily needs of vitamins and minerals. Santiago del Estero, Argentina, has a distinctive diverse flora in which the mesquite (*Prosopis alba*), among others, stands out since its non-timber able produces such as fruits and derivate can be exploited for food aims [1, 2]. Since some years now, utilizing regional products in food manufacturing has gained high impulse [3] due to multiple reasons like the revaluation of cooking traditions, the ressignificance that regional fruits have acquired and the use of low-cost raw materials (RM) that would favor the subsistence and the consumption of nutritive, healthy autochthonic foods. All these become a productive alternative allowing not only to add value to non-

conventional RMs but, based on their consumption features, help facing nutritional difficulties inasmuch their sensorial attributes promote their intake [4].

Baked products made from supplemented flour (i.e. a mixture of wheat and other source flours) show nutritional advantages when compared against those from only wheat flour since functional components and other nutrients are added. In this sense, it should be noted that mesquite flour contains phenolic compounds related to its sensorial and nutritional quality together with a well-known antioxidant activity [5, 6]. In addition, mesquite flour (MF) provides minerals including iron and calcium and fiber [7-10].

The cereal flours and their products are the most suitable for fortifying flours with water-soluble vitamins and minerals [11]. Fortified products are foods markedly supplemented in their natural content of essential nutrients (they must be indicated on the label). Generally, foods such as baked foods, breakfast cereals, dairy products, cookies and potato which value can be added at low additional cost are fortified. They are all authorized by the Argentinean Food Code.

Cookies are a fortifying vehicle showing high degree of acceptability mostly among children since they present features making them appealing and have a long useful life span which allows for large-scale production and distribution. However, the quality and sensorial acceptability of fortified formulations have not always been studied which has an influence on the consumption and success of these developments. The actual consumption of a given nutritive food is influenced by its sensorial quality in such a way that knowing the attributes that the consumer privileges at the time of deciding on consuming it, becomes necessary. This states the importance of characterizing sensorially a new food along all the stages of its development and processing in an attempt for meeting consumer's requirement.

Thus, it should be said that in establishing the key sensorial attributes of a given product, two factors must be considered: determining the sensory indices of high variability and determining the sensory features leading the consumer to hedonic responses [12].

Ultimately, consumers are who decide whether to choose the product or not. This is why affective tests upon representative consumers of the population addressed should be carried out for the level of pleasantness, acceptance and preference for a food product, an important stage within the development of new products, are stated.

The Quantitative Descriptive Analysis (QDA) [13, 14] is a validated, trustworthy and accurate methodology to make a full sensory characterization of a product being studied.

QDA method is a descriptive analysis technique in which a trained sensory panel assess a full range of sensory characteristics by generating an agreed list of attributes and individually rating the received intensity on line scales. This method is based on the principle of a panelist's ability to verbalize perceptions of a product; panelists are screened and trained in attribute recognition and scaling, they use

a common and agreed sensory language, and products are scored on repeated trials to obtain a complete, quantitative description [15, 16]. QDA have been used to characterize the sensory properties of products made with oilseeds such as peanut butter [17] and pistachio products [18] but until now, no study has reported the use of QDA for evaluating cookies made with mesquite flour. The Quantitative Descriptive Test (QDA): measures the intensity of each descriptor by the trained sensory panel. It allows the evaluation of perceptible texture attributes: mechanical, geometric and compositional, and in this way, it is possible to estimate the sensory useful life: taking into account the changes in the sensory characteristics suffered by the food over time.

The objectives of this paper were:

- To evaluate mesquite flour in nutritional terms and develop fortified cookies for Government plans.
- To characterize sensorially chocolate-flavored wheat, mesquite and oat flours using the QDA to achieve a reference profile for controlling the product's quality.
- To evaluate the acceptability of the cookies under study.

Materials and Methods

Test on raw materials

Wheat and oat flour

Label composition verification: Commercial wheat flour enriched (0000 Favorita, registered trademark) with a composition on humid basis stated on the label of 70 mg/kg of iron; 9% of protein; 1% of lipids; 72% of carbohydrates; 3% of fiber and 15% of humidity.

Commercial oat (traditional Quaker, registered trademark) with a composition on humid basis of: 13% of protein, 7.9% of lipids, 68% of carbohydrates, 6.2 of dietary fiber, 4.9% of humidity in order to enhance the protein quality of the flour.

Mesquite flour

In order to use a representative sample from the province of Santiago del Estero, a pool was made with five samples of flour from different locations. This pool was homogenized and determinations were made by triplicate.

Nutritional evaluation of mesquite flour

The proximal composition of the flour was determined by the official methodology [19]: the contents of humidity (method 925.10), protein (method 960.52), lipid (method 922.06), dietary fiber (method 985.29), and ashes (method 923.03); carbohydrates were determined by difference. The quantification of minerals was carried out by atomical absorption and their bioavailability was established using the Wolfgor-modified dialysibility technique [20]. The phenol concentration was determined by the Folin-Ciocalteu's method. The antioxidant activity was evaluated *in vitro* against the DPPH (1,1-diphenyl-1-picrylhydrazyl) radical and given as % of its trapping capacity against a DPPH. The phenolic compounds present in mesquite flour MF were identified and quantified as well by high performance liquid chromatography

(HPLC) by applying the external standard technique.

Formulating government plans-oriented cookies

The cookies were designed to meet school nutritional requirements and supplemented with the minerals detected as critical for this population group in previous studies [21]. The production was carried out first at a pilot-scale at the Processing Pilot Plant of the Agronomy and Agribusiness Faculty, National University of Santiago del Estero. Then it was carried out at industrial scale at Nutrisantiago, a local food manufacturing company with which the Faculty has signed several institutional cooperation agreements. The cookies were elaborated using mesquite (*Prosopis alba*) flour (MF) obtained from milling dry pods collected in various localities of the Province of Santiago del Estero (Argentina).

Sweet cookies were formulated using mixtures of:

1. Commercial wheat flour
2. Commercial oat
3. Mesquite flour

To the adequate amounts of the different flours, the rest of the ingredients were incorporated and kneaded. They were also fortified with minerals: as the core of fortification a 0.2% mixture of ferrous fumarate (33% of Fe) and zinc gluconate (12% of Zn) was used. Table 1 shows the proportion in which the ingredients were used. The fortified cookies were elaborated as chocolate-flavored using a 0.24% chocolate essence.

Table 1: Formulation of the cookies with cores of fortification.

Ingredients amounts in kg	Recipe for the chocolate-flavored cookies	
	%	
Cristal sugar	15	17.67
High oleic sunflower oil	10	11.78
Honey	1	1.18
Soy lecithin	0.15	0.18
Chocolate essence	0.2	0.24
Caramel coloring	1	1.18
Cocoa powder	1.5	1.77
Antioxidant nutrax tq	0.02	0.02
Sodium bicarbonate	0.25	0.29
Ammonium bicarbonate	0.5	0.59
Salt	0.125	0.15
Water	5	5.89
Premix LG1 letritas*	0.1675	0.20
0000 wheat flour	40	47.11
Oat	5	5.89
Mesquite flour	5	5.89

*Premix LG1 Letritas: ferrous fumarate (33% Fe) y zinc gluconate (12% Zn) in a 0.2% concentration.

The dough was laminated and die-cut into 4 cm diameter pieces that were the baked in a continuous cooking oven at 190 °C for 12 minutes. The fortified chocolate-flavored (CF) cookies were cooled at room temperature and stored in pouch

flow pack-type containers. In parallel, a batch of control (C) cookies, same formulation but no fortifying minerals added, was elaborated.

Cookies composition

The proximal composition was determined using the official methodology [19]: the contents of humidity (method 925.10), protein (method 960.52), lipids (method 922.06), dietary fiber (method 985.29), ashes (method 923.03) and that of carbohydrates was determined by subtraction. The caloric contribution was estimated using the Atwater's factors. Additionally, Ca, Fe and Zn were quantified by atomic absorption spectrophotometry AOAC out of humid mineralization. Dialysability and the potential contribution of Ca, Fe and Zn were measured as well.

Sensory tests

The Quantitative and Descriptive Analysis (QDA) [13] was carried out according to [22] as follows: 1) searching for descriptors and 2) measuring the magnitude of the sensory features of the product using the definitive quantifying tests.

In this test, first, a shared and equally understood terminology is sought to be established among the tasters [23]; additionally, it is analytical in character whereby it should be performed by trained judges.

Accordingly, eight judges were trained to carry out the scheduled experiences. These were selected from the pilot plant personnel who on other occasions demonstrated aptitude for this task. Descriptors of the external appearance attribute were studied; odor; evaluated by touch; attributes evaluated through the sense of taste: (taste and texture in the mouth).

Description of the QDA stages

To search for the descriptors, the tests were carried on various own-elaborated and commercial cookies. For six sessions of an hour each and helped by the panel leader and a guiding worksheet, the panelists verbalized their impressions about the cookies following the Norm 20001 [24]. For this purpose, the sessions developed in a room with a round table since the evaluations and discussions occurred in group. (Figure 1).

1. To select the descriptors, the aims of this work were considered: the sensory characterization of the cookies to define a reference profile, aiming at achieving the optimization of their sensorial acceptability and quality. Furthermore, consensus as to the language used by the evaluators was sought; thus, those terms similar in meaning and used with a less than 40% frequency were eliminated [25].

2. Then, the evaluators were trained specifically on the cookies being studied. This stage involves using scales to punctuate the intensity of the various descriptors. Such training demanded four one-hour sessions where they were given a list of the descriptors previously generated along with their definition and mode of evaluation. These sessions were finished at the time the evaluators became familiar to the product and their intensity quantifications became homogeneous for each of the descriptors and among the judges.

Descriptors Search			
Date.....			
Name.....			
Pay close attention to the samples provided and tick the descriptor that best describes your experience for each of the following items. Please, do not forget to write down the sample number beside each of the selected descriptor. You can include your own descriptor.			
External look:			
Appearance:			
Granulosis	Bright	Other.....	
dry	oily		
Colour:			
Yellowish	Orange	Brown	Other.....
Colour uniformity:			
Other.....			
Colour intensity:			
Light	Shiny	Other.....	
Deep	Opaque		
Shape:			
Typical	Conservate	Flat	Other.....
External visual texture:			
Uniform	Granulosis	Gritty	Other.....
Powdery	Dry	Brittle	
Edges:			
Irregular	Cracked	Deformed	Other.....
Regular			
Odour:			
Bitter	Fragrant	Typical	Other.....
Please, try the crackers and remember to rinse your mouth before the other try.			
Flavor:			
Pungent	Spicy	Hot	Other.....
Salty	Bitter	Sweet	
Oral texture:			
Soft	Tender	Pasty	Other.....
Crunchy	Gritty	Gummy	
Granulosis			

Figure 1: Indicative sheet for the search of descriptors for the crackers under study.

3. The definitive tests carried out to measure the intensity attribute used cookies from the same batch of elaboration in individual cabins.

4. To measure descriptor intensities, work was done on 10 cm scales anchored at their ends; four repetitions were made while for the descriptors showing differences, four additional sessions were arranged once the panel were re-trained.

The following descriptors were quantified: appearance: arenosity and shape; odor: chocolate and mesquite; texture: manual, hardness, crunchiness and arenosity; flavor: spicy, sweet, chocolate, mesquit, and astringent; and residual taste, mesquite and astringent.

Statistical analyses

The data obtained were analyzed by the variance analysis of two-factors: sample and evaluators according to the mathematic model below [26] and through the Excel spreadsheet:

$$Y_{ij} = \mu + m_i + v_j + e_{ij} \quad \text{Eq (1)}$$

Where, Y_{ij} = descriptor measure; μ = general average; m_i = sample's effect; v_j = evaluators' effect; e_{ij} = experimental error.

The individual result for each descriptor were expressed as the average of the evaluations performed with its standard deviation.

Evaluation by consumers

To know whether the sensory features of the fortified cookies are accepted by the consumers, an acceptability test was carried out. Since the development of these cookies intended for Government plans benefiting children at school

age, this test was carried in several school facilities for the basic general education of the Province of Santiago del Estero with 102 children of both sexes of ages ranging between 9 and 11, 52 girls and 50 boys.

The enriched cookies were compared to another two made from equivalent commercial products to assess their potential location within the local market [27] and against control cookies made out of the same formulation than those under study but without a mineral fortifying core.

The samples were presented in a balanced order, being each sample served the same number of times in each order of presentation. The cookies under study were served on disposable trays coded with three digits randomly chosen to the participants that received the samples along with the individual testing worksheet. To evaluate their appearance, consistency (manual hardness) and global acceptability, a punctuating scale from 1 to 10, where 1 stands for "I dislike it much" and 10 means "I like it much", was used [27]. A level of significance of 5% was adopted. When significant differences were found, Fisher's minimum significant difference (MSD) method was used.

Bioethical considerations

Prior to commissioning, the present study was reviewed by the Research Committee of the Faculty of the Faculty of Agronomy and Agro industries of the National University of Santiago del Estero. The institutional endorsement for the study it was obtained from the Benjamín Gorostiaga Normal School in the city of La Banda, Santiago del Estero. To each of the Parents of the participating children were explained in detail what the project consisted of, later they signed informed consent. This and other confidential documents are kept under guard.

Results and Discussions

Testson raw materials

The results obtained for both the wheat and oat flours confirm the composition stated on the label. Table 2 shows the percentual composition of the macro-components of the MF of the Province of Santiago del Estero and the standard deviation (SD) of each mean value.

Due to its high fiber content, the mesquite flour is considered as a fiber source food whereby it can be part when

Table 2: Proximal composition of the MF.

MF composition	X (g/100 g)	SD
Protein	7.50	0.80
*Carbohydrates	57.20	-
Lipids	2.90	0.11
Dietary fiber	20.30	1.05
Ashes	3.48	0.10
Humidity	8.62	0.17

*Obtained by subtraction.

formulating diet products [28] and cereal bars [29]. As known, fiber-rich diets imply lower energy contribution and stronger stimulation of satiety signals diminishing in consequence, food intake, something that can be useful when treating overweight and obesity. However, it is known that the dietary fiber diminishes mineral bioavailability whereby knowing the bioavailability of the minerals under study becomes a need to estimate their actual individual contribution [30].

Its mineral nutrient composition indicates that the mesquite tree is a good source of calcium, phosphorous and iron, among others, in important values. The values determined for these minerals are similar to those reported for other species of the *Prosopis* genus [31]. However, variations reflecting the intrinsic biodiversity of the genus are observed.

Calcium and iron are minerals regard as critical nutrients in developing countries. It is thus valuable when they are found in autochthonic products since they are at the reach of the local population and might be incorporated to the diet.

The calcium and iron, present in the MF, have a low bioavailability, mainly because the fiber together with the phytates form insoluble complexes. In addition, both compete with each other for absorption [32, 33].

The total phenol content of the MF was of 156 ± 16.9 mg EAG/100g and the antioxidant activity of 16.4% in preparations with 100 mg/l. The values for the decoloring percentage of the DPPH radical were adjusted regarding the quercetin standard whose antioxidant capacity equals to 100%.

The antioxidant activity of the MF is linked to the existence within itself of phenolic compounds and particularly of phenolic acids [34]. Figure 2 shows the chromatographic profile of the MF analyzed.

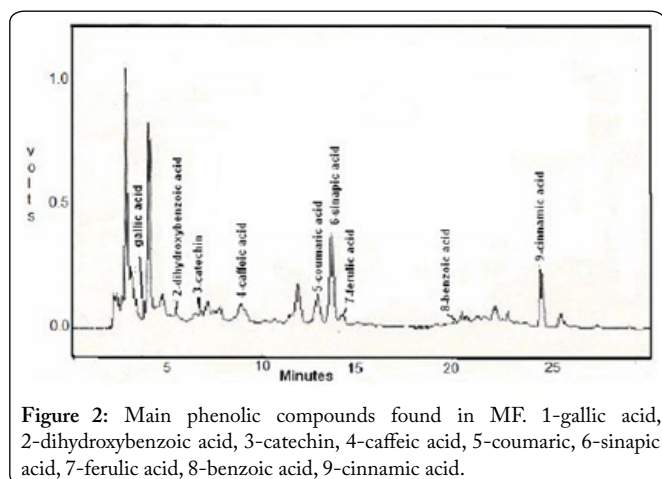


Figure 2: Main phenolic compounds found in MF. 1-gallic acid, 2-dihydroxybenzoic acid, 3-catechin, 4-caffeic acid, 5-coumaric acid, 6-sinapic acid, 7-ferulic acid, 8-benzoic acid, 9-cinnamic acid.

Table 5 presents the average values and standard deviations of the phenolic acids and the catechin identified and quantified using HPLC.

The phenolic compounds identified in the MF are present in quantities comparable to those in other products of vegetal origin. The catechin content (0.47 mg/g), the main responsible for the astringency shown by the mesquite pods and its flour, underscores.

Table 5: Quantification of the phenolic compounds identified by HPLC (mg/g).

Compound (mg/g)	X	SD
Gallic	0.06	0.01
DiOHbenzoic	0.02	0.01
Catechin	0.47	0.07
Caffeic	0.02	0.01
Coumaric	0.01	0.01
Sinapic	0.22	0.01
Ferulic	0.01	0.01
Benzoic	0.29	0.03
Cinnamic	0.02	0.01

The antioxidant activity of the phenolic compounds is usually determined by the number of phenolic groups present in the molecule [35]. The gallic and dihydroxybenzoic acids show both similar activities since two hydroxyl groups are needed for the phenolic acids have antiradical activity; the caffeic acid possesses hydroxyl groups in position 3 and 4 involved in the antiradical activity while the double linkage takes part in the radical stabilization. The ferulic acid shows lower activity than the caffeic because the hydroxyl group in position 3 is blocked.

The sinapic acid presents an interesting activity due to its two methyl groups and as a derivate of the cinnamic acid, demonstrates being more stable than the derivate of the benzoic acid according to [36] who affirm that such a double bound in the molecules of the first (-HC = CH - COOH) group would stabilize the phenoxy radical by resonance of the despaired electron. The latter also applies to the coumaric and cinnamic acids present in the extracts analyzed as well. The catechin presents good antioxidant activity due to its catechol group in ring B which is able to donate either hydrogen atoms or electrons to stabilize radical species and the hydroxyl groups free in positions 3 and 5 in rings A and C [9].

The mesquite flour is a good source of antioxidants and appropriate for formulating functional foods. Even though its polyphenol and fiber contents would account for its low dialysibility of minerals, essentially Fe's, this is not a limiting factor for the MF be used as an ingredient because its antioxidant capacity and its fiber content present result in physiological benefits and, additionally, allows it for being fortified with minerals.

Cookies composition

Determining the proximal composition, minerals and caloric contributions of formulated and elaborated cookies

The elaborated fortified biscuits with chocolate flavor (Cf) showed appropriate values for humidity that is typically varying between 1-5% [37] and is in accordance with the provisions of the Argentine Food Code. It can be said then that the partial substitution did not cause negative effects in this sense. This critical parameter must be strictly controlled when cookies are

produced at an industrial level (before packaging) and during storage to ensure their stability due to their influence on the shelf life and the chemical and microbiological stability of cookies.

Table 6 presents the proximal composition and the caloric contribution of the cookie developed against control (T) without MF and A. The protein content of the cookies was like that of the control cookies. Despite these results, it should be considered that protein quality is determined by the content of essential amino acids.

Table 6: The proximal composition of the cookies.

Composition (g%)	T	DS	Cookie	DS
Proteins	6.9	0.1	7.13	0.3
Lipids	15.45	0.29	15.9	0.17
Fiber	3.85	0.23	5.25	0.06
Humidity	3.87	0.18	4.35	0.21
Ashes	0.42	0.12	0.6	0.05
Carbohydrates	69.51		66.77	
Caloric contribution (Kcal)	444.69		438.7	

The mixture of flours used in formulating the cookies studied here showed the highest punctuation in amino acid content adjusted by the digestibility of the PDCAAS proteins for lysine [38]. The contribution of fatty matter falls in values similar to those informed on the labels of various commercial cookies regularly consumed such as Variedad, Melba and Pepitos produced by KraftFoods, Argentina, containing 16%.

In turn, an important increase in the dietary fiber content was observed in the new formulation as to the control one (with only wheat flour). Incorporating oat contributes with beta glucons and fructan that not only allows to obtain a product with a higher fiber content but also improves the soluble to insoluble fiber ratio [39-41].

Its fiber content higher than 3 g/100 g would allow for its labeling as “fiber source” according to the CMG Common Market Resolution 01/12 [42]. Table 7 presents the mineral content, dialysibility and potential contribution of Fe, Ca and Zn determined in the fortified cookies.

Table 7: Total content, dialysibility and potential contribution of Fe, Zn and Ca of the cookie developed.

Minerals	Cookie		
	Content (mg/100g)	*D%	**AP mg/100g
Fe	3.13	15.05	0.47
Zn	1.26	29.46	0.37
Ca	39	23.45	9.14

Values corresponding to the average of three repetitions. *D: dialysibility; **AP: potential contribution.

The calcium contents of the formulation utilized in this work are higher than those found in equivalent commercial

goods such as Oreo, Chips and Ahoy offered in schools [43]. On the other hand, the calcium content found in bread fortified with mesquite flour was of 85.5 mg/100 g [44] though it should be noted that such formulation was added with skim milk.

If the potential contribution of Fe in the cookies obtained (0.47mg% g) is compared to that of the MF (0.22 mg% g), see table 3, it was greater in cookies as a consequence of their greater dialysibility than It can be attributed to a lower content of components that inhibit the absorption (polyphenols) in cookies. With respect to zinc, there were no variations in the percentage of dialysibility in the samples studied.

Table 3: Mineral contents of the MF.

Minerals in the MF	X (mg%)	SD
Potassium (K)	969.7	12.44
Magnesium (Mg)	54	0.98
Zinc (Zn)	1.76	0.12
Calcium (Ca)	445	3.58
Phosphorus (P)	617	3.77
Iron (Fe)	5.02	0.28

Table 4: Comparison of the Fe, Zn and Ca total content, dialysibility and potential contribution.

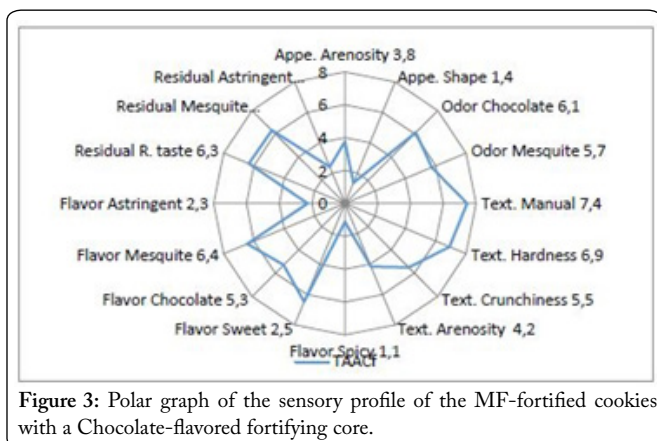
Mineral in the MF	X (mg/100 g)	D (%)	Ap (mg/100g)
Fe (iron)	5.02	4.42	0.22
Zn (zinc)	1.76	29.53	0.52
Ca (calcium)	445	20.33	90.46

Sensory analysis

Out of the opinions given by the panelists, a list of 16 descriptors was obtained. The profile was defined as comprising the following quantified descriptors. Since the frequency distribution of the entire set of observation responds to the normal distribution for each descriptor, they were characterized in terms of the sampling mean. The descriptors selected showed non-significant differences neither for the judge factor ($p \leq 0.05$) nor the sample factor ($p \leq 0.05$).

Figure 3 shows the results of the Quantitative Descriptive Analysis carried out on the chocolate-flavored cookies represented graphically. [29] describe an intense distinctive aroma in the cookies obtained out of mesquite flour that also persists long, even with still high intensity. However, in the cookies under study, the chocolate aroma is perceived with higher intensity, something that leads to affirm that it is a flavoring agent appropriate to attenuate mesquite odor to which, usually, consumers are not used to.

Both the manual texture (hardness) which is the force needed to break the product with the hands and the vocal hardness which is the initial force required to break the product using the incisor teeth are in straight relationship with the quantity of fatty matter contained in the formulation.



The evaluators also verbalized words such as sandiness and crunchiness. The former related to the granulometry of the flours employed and the latter to the amount of fatty matter and is useful to evaluate the conservation status of the product in terms of humidity variations.

According to, Gomez Alvarado [45], Mejía Gallo [46], as much as what ASP [47] affirmed, the attributes of the sense of taste have higher influence on selecting foods and are even more important than those evaluated through the other senses. From the results obtained in this study, it is eight the descriptors evaluated using the sense of taste against the two descriptors used to qualify the external appearance attribute and two were the attributes evaluated using the sense of smell as well.

Even when some of the descriptors coincided with those for cookies published by other authors, some terms specific to products elaborated with regional ingredients from the wild flora were provided by this research. The descriptors for odor, flavor and aftertaste are examples of this; not only do they contribute for a best sensory characterization of this product but are appropriate to describe other foods elaborated out of either mesquite flour or others counting on with similar chemical components in their composition.

The chocolate flavoring raised markedly the punctuation given to the global acceptability within the children population. The acceptability test (Table 8) shows satisfactory results since fortified cookies were given a global acceptance score of 9 (on a scale of 1 to 10), a little lower than for commercial cookies

Table 8: Average values for the sensory variables per formulation type.

Cookies	Average values		
	Appearance	Manual hardness (consistency)	Global Acceptability
C	8.6	8.1	8.7
Cf	8.8	7.8	9
Commercial Chocolate	9.3	8.5	9.3
Commercial Vanilla	9.4	8	9.2

* C: non-fortified control chocolate-flavored cookies; Cf: fortified chocolate-flavored cookies.

(9.3). Cookies C and Cf obtained values greater than 7 of acceptability, being 87% and 89% respectively.

It should be highlighted that the children identified the commercial cookies (because of their external appearance) and this might have favored their global acceptability. This enhances the values given to the cookies tested since they received high punctuations in acceptability and appearance despite being evaluated in such a context.

Significant differences between the C and Cf cookies were not detected as to their global acceptability which would indicate that fortification is not perceived and, consequently, it is not determinant of their acceptability.

Consistency was the feature that the school children liked least. After correlating the results for the three parameters evaluated, Manual Hardness is the attribute punctuated with values lower than those given to appearance in all the cookies studied.

Conclusions

The nutritional composition of the mesquite flour shows appropriate values for fiber, proteins, sugars and minerals. It is believed that its use as food might become an important productive alternative and enhance regional economy since it is a natural resource widely available in Argentine North.

The mesquite flour is an excellent food ingredient which can improve significantly the nutritional quality of the crackers developed in this work because of its important contribution in fiber, proteins and sugars together with that in minerals and phenolic compounds endowed with antioxidant activity.

A quantitative descriptive profile for the chocolate-flavored fortified crackers, valid for controlling the quality of the product under study, was established.

The chocolate flavoring markedly increased the punctuation given to the global acceptance parameter by the child population. Lastly, the sensorial quality of the crackers remained the same despite the addition of minerals as fortifiers. Thus, the crackers designed in this paper become a food good for supplying children with minerals important for their growth.

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