# Quality and acceptance of corn tortillas from the Sierra of Manantlán, Jalisco

Diana Laura Valdez-Reyes[1]
Yolanda Salinas-Moreno[2]
Edgardo Bautista-Ramírez[2][§]
Patricia Severiano-Pérez[3]
Mario Antonio Vega-Loera[4]

[1]Department of Agroindustries-Chapingo Autonomous University. Mexico-Texcoco Highway km 38.5, Texcoco, State of Mexico. CP. 56230. [2]Experimental Center Altos of Jalisco-INIFAP. Tepatitlán-Lagos de Moreno highway km 8, Tepatitlán, Jalisco. CP. 47600. [3]Department of Food and Biotechnology-Faculty of Chemistry-UNAM. Fourth floor of building A, Ciudad Universitaria school circuit, Mexico City. [4]Jalisco Coast Experimental Site-INIFAP. Highway Guadalajara-Barra de Navidad km 204, La Huerta, Jalisco, Mexico. CP. 48930.

[§]Corresponding author: bautista.edgardo@inifap.gob.mx.

## Abstract

Tortillas of native corns are well accepted among consumers due to their ancient origin and artisanal transformation. The objective of the work was to determine variables of nixtamalization and tortilla, as well as the sensory quality and acceptance of tortillas made with corns of the Reventador, Complejo Serrano de Jalisco and Elotero de Sinaloa races from the Sierra de Manantlán Biosphere Reserve. Two accessions per race were collected, H-155 (white grain) and one accession of the Elotes Cónicos race (blue-purple grain) were used as references. Between races, there were no statistically significant differences in moisture of nixtamal, dough and tortilla. The yield of the corns was greater than or equal to 1.54 kg of tortilla per kg of corn. The mean overall acceptability of the tortillas ranged from 6.4 to 7.67. Tortillas of the Reventador race had the lowest acceptance, rated with 'I like it a little'. The CSJ race was the one that obtained the lowest scores on the attributes evaluated on the JAR test. The native corns from the SMBR have the necessary quality for making tortillas. However, their acceptance and organoleptic attributes can be improved.

Currently, there is a revaluation of native corns by urban consumers, who appreciate their ancient origin and their artisanal transformation. In addition to the above, in most households in Mexico, it is considered that native corns are the best for the preparation of rural cuisine dishes due to their color, flavor and aroma (Aragón-Cuevas *et al*., 2012). These tastes favor their consumption in Mexican households, so characterizing them from different approaches can contribute to the generation of new forms of use.

The native corns present in the Sierra de Manantlán Biosphere Reserve (SMBR), due to the cultural, biological and genetic importance they represent, must be enhanced for their specific uses for their commercial use by the Indigenous groups that grow them. Within this series of activities, it is necessary to determine their potential for the making of tortillas and their possible commercialization in differentiated markets. Therefore, the objective of the work was to determine variables of nixtamalization and tortilla, as well as the sensory quality and acceptance of tortillas made with corns of the representative races from the SMBR.

## Collection site and study material

The collections were carried out in January 2021 at different sites of the SMBR, so the cobs from which the grain was obtained for the study correspond to the spring-summer 2020 harvest. Six collections of corn were obtained, two of the Reventador race, two of the CSJ race, both of white grain, and two of ES of blue-purple grain (BLP). The selection of races to be collected was made based on the richness of native corns from the SMBR. The hybrid H-155 and an accession of the Elotes Cónicos (EC) race were used as reference materials, the latter to contrast with the tortillas of ES. There was a sample size of approximately 5 kg for each of the collections.

## Experimentation site

The accessions were analyzed in the Laboratory of Quality of Crops for Human and Livestock Use of the National Institute of Forestry, Agricultural and Livestock Research (INIFAP, for its acronym in Spanish). Located in the Centro Altos de Jalisco Experimental Field.

## Nixtamalization and making of tortillas

The nixtamalization of the samples was done according to the method described by Salinas and Vázquez (2006). The nixtamalization time was determined with the formula N= 49.131-0.267 (IF). Where: IF= grain hardness (Salinas and Vázquez, 2006). The nixtamalized grain was left to stand for 16 h in coolers, covering each glass with aluminum foil to conserve heat for as long as possible.

The nixtamalized grains were washed with water to remove excess lime and solubilized pericarp, the nixtamal was ground in a volcanic stone mill to obtain the dough. To make the tortillas, the dough was kneaded with drinking water until the desired consistency was obtained. Portions of 20 g of dough were separated to make the tortillas, which were molded in a manual press to obtain discs of 11 cm in diameter and an approximate thickness of 1.5 mm that were cooked in a hot metal plate (270 °C approx.) for 15 s, alternating between both sides until the formation of the blister, which is the final point of cooking the tortilla.

**Parameters of nixtamal, dough and tortilla**

Moisture of nixtamal, dough and tortilla. From the nixtamalized and rinsed corn, 10 grains were taken and split longitudinally to obtain an approximate sample of 2 g. While the sample of 2 g of dough was obtained since it was prepared to have the desired consistency for making tortillas. In the case of the tortilla, the 2 g sample was obtained from a representative fraction (from the edge to the center). The oven dehydration method was applied according to what Salinas and Vázquez (2006) described. The analyses were done in duplicate, and the calculations were performed by gravimetric analysis, expressing the moisture in percentage.

Corn-dough-tortilla yield. To calculate the yields, in the case of dough, the weight of prepared dough obtained from a sample of 100 g of nixtamalized grain was recorded, for the tortilla, the weight of cold tortilla obtained from 100 g of grain was considered. Using rules of three, the yields of corn:dough and corn:tortilla that would be obtained from one kilogram of corn were estimated. To make a valid comparison between genotypes, it was tried that that the difference in grain moisture was not greater than 1%.

**Overall acceptability and Just About Right (JAR) test**

The test was carried out on 70 people from Ayotitlán, Cuatitlán de García Barragán and 30 from Tepatitlán de Morelos, Jalisco. Tortillas were made from the accessions studied, as well as from the two reference materials. Consumers received the tortillas one by one and assessed the overall acceptability using a 9-point scale, where 1 corresponds to 'I dislike it very much' and 9 to 'I like it very much'. The attributes of color, lime flavor, corn flavor and rollability were evaluated based on the JAR test proposed by Rothman and Parker (2009), where each attribute was evaluated from 1 to 5, 1 corresponds to 'too little intense', 2 'very little intense', 3 'just right', 4 'very intense' and 5 to 'too intense'.

The samples were presented hot on a white plate, coded with a three-digit number. The white grain tortillas were the first to be presented, concluding with the tortillas of BLP corn. Each evaluator was provided with water as a rinse.

**Information analysis**

With the results obtained, an analysis of variance (Anova) and Tukey tests were performed in SAS V.9.1. (SAS Institute, 2002) in a completely randomized design. However, only mean comparisons with Tukey's test ($p \leq 0.05$) were reported. The source of variation was race, so each of the two accessions per race was considered as a repetition, even though each accession was analyzed in duplicate.

No statistically significant differences were found in the moisture content of nixtamal, dough and tortilla between races and reference materials (Table 1). Contrary to the results of Mauricio *et al*. (2004), grain hardness had no influence on water absorption in nixtamalization. The moistures of the doughs varied from 56.1 to 59.2%, similar to those obtained by López-Espíndola *et al*. (2020) in doughs of mill-tortillerías of Córdoba, Veracruz Mexico. As for the moisture of the tortilla, all exceeded the highest value reported by López-Morales *et al*. (2019), which was 43% in tortillas made with Tuxpeño corn.

**Table 1. Comparison of means of moisture in nixtamal, dough and tortilla and corn-dough and corn-tortilla yields.**

| Race and control | Average moisture in | | | Yield from corn to | |
|---|---|---|---|---|---|
| | Nixtamal | Dough | Tortilla | Dough | Tortilla |
| Reventador | 48.34 a | 57.65 a | 46.82 a | 1.92 bc | 1.59 a |
| CSJ | 46.98 a | 59.19 a | 46.8 a | 2.07 a | 1.54 a |
| ES | 45.9 a | 56.7 1 a | 48.56 a | 2 ab | 1.66 a |
| H-155 | 47.62 a | 58.03 a | 47.3 a | 1.82 c | 1.45 a |
| EC | 47.51 a | 56.13 a | 48.39 a | 2.1 a | 1.73 a |
| HSD | 4.29 | 4.57 | 5.13 | 0.11 | 0.39 |

Means with equal letters in columns are not statistically different (Tukey≤ 0.05). HSD= honest significant difference.

The CSJ race had the highest yield of corn:dough, a trend that is not maintained in the yield of corn:tortilla (Table 1). The possible cause is the accelerated loss of moisture in the dough of this race, during the cooking of the tortilla, which was slightly superior to the rest of the races studied. The corn:tortilla yield of all samples was ≥1.54 kg of tortilla per kg of corn, a value that Guzmán-Maldonado *et al*. (2015) considered the minimum for a native corn to be considered outstanding in this variable.

Regarding the acceptance of the tortillas of the different races, the mean of the overall acceptability ranged from 6.4 to 7.67, with respect to a hedonic scale, where 9 corresponds to 'I like it very much'. In the evaluation, tortillas of the H-155 corn achieved a score of 8, which means that they were liked more than those of native corns.

This result was surprising, especially in the evaluation conducted among individuals from the locality of Ayotitlán, where the corn populations were obtained, who failed to identify the tortillas made with their corns as the best. The tortillas of the Reventador race were the ones that the evaluators liked the least since they were rated in the category 'I like it a little' (Cuadro 2). It is possible that this result is due to the fact that it was not processed properly, since, in rural communities, each housewife processes her corn in a particular way, which impacts the quality of the tortilla (Rangel-Meza *et al*., 2004).

**Table 2. Comparison of means of overall acceptability by means of the JAR test for tortilla quality attributes.**

| Race and control | Overall acceptability | Color | Flavor | | Rollability | Average of attributes |
|---|---|---|---|---|---|---|
| | | | corn | lime | | |
| Reventador | 6.4 c | 3.15 ab | 2.55 bc | 2.34 a | 3.05 ab | 2.77 |
| CSJ | 6.71 bc | 2.33 d | 2.5 c | 2.17 a | 3.37 a | 2.59 |
| ES | 6.94 bc | 2.83 bc | 2.86 ab | 2.38 a | 2.72 b | 2.7 |
| H-155 | 7.67 a | 2.72 cd | 2.93 a | 2.25 a | 3.31 a | 2.8 |
| EC | 7.17 ab | 3.43 a | 2.96 a | 2.27 a | 2.67 b | 2.83 |
| HSD | 0.58 | 0.4 | 0.34 | 0.37 | 0.42 | |

Means with equal letters in columns are not statistically different (Tukey≤ 0.05). HSD= honest significant difference.

In the JAR test, significant statistical differences were observed in each attribute, however, the means ranged from 'very little intense (2)' and 'just right (3)'. In the average of the means of each attribute, the tortillas of the H-155 and EC corns had values of 2.8 and 2.83, respectively, so they were the closest to 3, which would be equivalent to 'just right'. While the lowest average of the means (2.59) was obtained in the tortillas of the CSJ race, which does not correspond to the overall acceptability, where the tortillas of Reventador were the ones with the lowest acceptance. Possibly in the overall acceptability test, the evaluators rated other attributes that were not included in the JAR test, such as smell, lumpiness and dryness sensation when chewing, which are considered quality attributes (Vázquez-Carrillo *et al*., 2011).

## Conclusions

The native corns from the Sierra de Manantlán Biosphere Reserve have the technical quality for the making of tortillas. However, their acceptance and organoleptic attributes were not outstanding in relation to the controls included in the study.

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