

# Influence of Refrigeration and Freezing Storage on the Instrumental Texture of Corn Dough and Empanadas

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## Abstract

Corn empanadas are a typical Colombian fried food of high consumption; these are stored in refrigeration and freezing to increase their shelf life; however, the impact of these conservation methods on texture is unknown. The selected samples (unfried corn dough, unfried empanada, fried empanada, and pre-fried empanada), were stored in refrigeration, freezing and ultra-freezing pre-treatment, then fried between 4 to 4.5 minutes and evaluated the texture with a durometer. The results show that the texture increases with frying time, with a linear behavior. Freezing, ultra-freezing, and refrigeration have an impact on the texture of corn dough and fried empanada, decreasing with the storage time.

**Keywords:** storage, frying, shelf life, stability, corn

## 1 Introduction

Texture is an essential factor in the quality and sensory acceptability of food, including a set of parameters related to the deformation, disintegration and flow by the application of a force [1], subjecting a product to a double compression relative to its initial height, where a jaw is simulated when biting without breaking the matrix of the food [2], therefore the determination of texture makes it possible to establish the factors that influence the conditions of the food such as composition, process technique, storage conditions among other factors [3], is considering a

critical factor in the quality of crisp foods, such as corn empanada, this sensory property can condition consumer preference, so it is essential to measure it [4].

Corn empanada is a typical food of Colombian culture, is made from a corn dough that is obtained from wet grinding of the grain. Corn mass is a network of solubilized starch molecules and partially gelatinized dispersed starch grains in a continuous phase of free water that supports nongelatinized starch granules, endosperm parts and lipids [5], in addition it consists of a protein or non-protein filler, which undergoes frying processes at high temperatures generating characteristics of texture and palatability desirable by the consumer. This is a highly consumed product in Colombia, therefore it is necessary to use conservation methods that give stability to the food for long periods of time, to improve the marketing, such as refrigeration or freezing, however, these conservation methods can cause significant changes in the appearance or nutritional composition of the food, like humidity, density, which affect the final texture of the product [6].

Currently there are few studies on this typical Colombian food, Acevedo *et al.*, [7] conducted a study to determine the bromatological and sensory properties of corn empanadas stuffed with meat produced on the Colombian Caribbean coast, subjecting it to various time and vacuum frying temperature factors, concluding that the best sensory conditions were obtained at a temperature of 120 °C and bromatological conditions at a temperature of 140 °C. These researchers also evaluated the effect of vacuum frying on the oil absorption of corn empanadas, finding that a longer time (120 s) and lower frying temperature (115 °C) increase oil absorption, impacting food quality [8]. Research has also been carried out on another type product of the Colombian Caribbean coast food, assessing the influence of storage time on the texture and viscoelasticity of white “Cariaco” corn buns, concluding that the storage time influences the texture profile and increased hardness, given the conditions of moisture loss during product refrigeration [9], other studies have been carried out with similar products such as “humitas”, a typical product from Peru and Chile, they assessed the effect of different packages, the modified atmosphere and the storage temperature on humitas taking into account factors such as  $a_w$ , moisture, texture and microorganism count, concluding that the combination of metalized films, vacuum and freezing maintains most of the evaluated characteristics of this food [10].

This work aimed to evaluate the effect of the storage time on refrigeration, freezing, and ultra-freezing pre-treatment on the texture of the unfried corn dough, unfried corn empanada, pre-fried, and fried corn empanadas.

## **2 Methodology**

A quantitative experimental study was developed for the determination of the instrumental texture of unfried corn dough, unfried corn empanada, pre-fried and fried corn empanadas, from the company Maquiempañadas, located in Manizales (Colombia).

## **2.1 Sample Processing and Storage**

Initially, the texture measurement conditions in the unfried and pre-fried empanadas were standardized to determine the frying times that would allow similar texture conditions in the samples. Five refrigerated and frozen sample units were tested per triplicate.

Before the evaluation of the texture the samples (unfried dough, unfried empanada, pre-fried empanada, and fried empanada) were removed from refrigeration for 5 min and from freezing for 15 min, and subsequently subjected to pre-frying and frying in soybean oil to temperature of 180 °C during the times of 4.5 min and 4 min respectively. The samples were packed in low-density polyethylene bags and stored in refrigeration at 5 °C and freezing at -18 °C, some were stored in ultra-freezing (-30 °C) for 12 hours as pre-treatment. Samples were stored for 10 days in refrigeration and 40 days in freezing.

After the time of storage in refrigeration and freezing of the empanadas, the texture was evaluated with a durometer (Wagner FT20 and FT30) to determine the resistance generated by the empanada crust after frying; the measurements were tested per triplicate.

## **2.2 Statistical analysis**

The descriptive statistic was used, and a completely random experimental factorial design was applied, the selected factors were the time and type of storage. The analyses were carried out on days 1, 10, 30, and 40, under refrigeration, freezing, and ultra-freezing conditions. A simple regression analysis was performed to standardize frying times on texture characteristics. Finally, all the data obtained was processed by a variance analysis with a 95% confidence level, using the Statgraphics® plus statistical package.

## **3 Results and discussion**

Figure 1 shows the texture changes after frying the samples (corn dough, fried, and pre-fried empanadas). The texture increases with frying time, with an adjustment to a linear regression model ( $R^2 > 0.98$ ). It is recognized that the high temperatures used in frying processes, have an impact on the texture, generating a crunchy crust on the outside and a soft product inside [11]. From this generated model the texture measurement times for subsequent tests were determined and thus ensure a similar texture in the unfried dough, fried and pre-fried product, and therefore be able to make the comparison during the storage. The selected times were: pre-fried 4.5 min, fried 4 min, and unfried product 5.5 min.

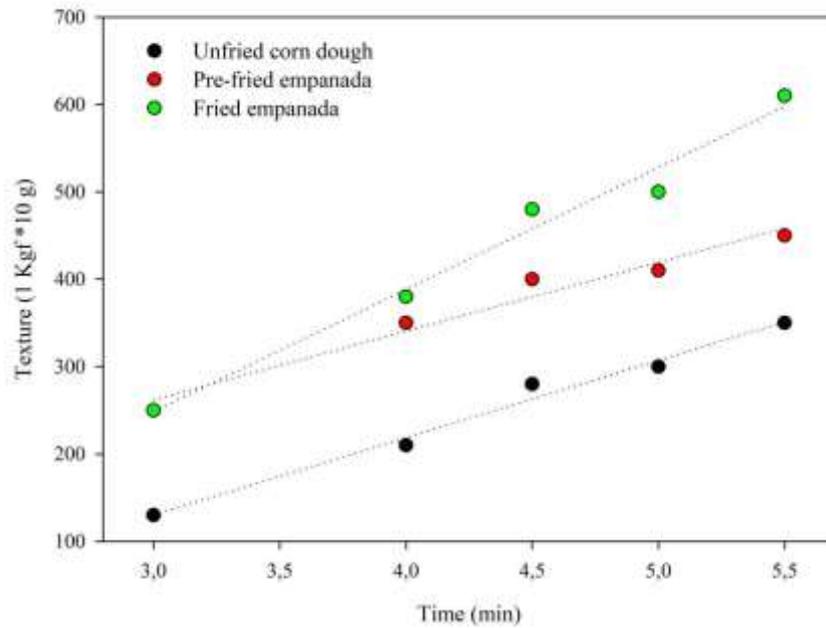


Figure 1. Texture changes over time in corn dough and corn empanadas.

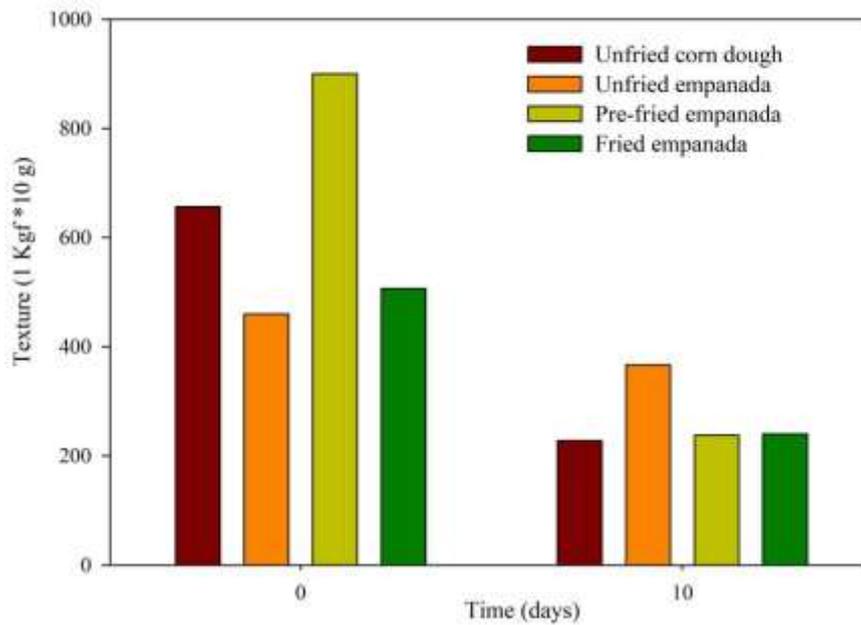


Figure 2. Textural behavior of unfried corn dough, unfried empanada, fried and pre-fried empanada stored in refrigeration.

In Figure 2 the pre-fried empanada has the highest texture values, however, after 10 days of refrigeration storage, the texture decreases by more than half, presenting statistical differences between the time 0 and 10 days ( $p < 0.05$ ). The textural characteristics of the corn dough in refrigeration processes, are influenced by the increase in water retention, related to the type of packaging and relative humidity in refrigeration, this negatively impacts the quality microbiological empanada in this type of storage, because with this method there is a risk that microorganisms continue to grow slowly, on the other hand, it generates a loss of texture, taste and an alteration of the quality [12,13].

Figure 3 and 4 show variations in texture characteristics when products were stored in freezing and ultra-freezing; was observed that texture tend to decrease with storage time. According to the statistical analysis, there are significant differences ( $p < 0.05$ ) between each day of storage for both freezing and ultra-freezing. At 40 days of freezing storage, the highest texture values were presented for the unfried empanada and ultra-freezing pre-treatment, the highest values were for pre-fried and fried empanada. Taking into account the results obtained, the maximum data of texture was achieved in the fried and pre-fried empanada in ultra-freezing, this is consistent with what is established by other studies [14] indicating that at temperatures between 160 and 180 °C, the process generated a thermal shock on the surface crust due to total dehydration in the outer part of the cortex that favors a phenomenon of caramelization and non-enzymatic browning that changes surface color to food, it could also be related to changes in storage temperature, which lead to dehydration resulting in less water retention by the product improving texture conditions. Freezing is based on the physical principles of the water outlet of the mass due to the formation of ice crystals at sub-zero temperatures. The dynamics of water in the frozen dough have indicated that some damage occurs as the ice develops and causes the migration of water from one region to another, impacting the texture [15].

## **4 Conclusion**

Recommended times for texture evaluation on corn dough and empanadas were pre-fried 4.5 min, fried 4 min and unfried product 5.5 min. The texture decreases with the storage time, both in freezing and refrigeration, this associated with the balance between ambient moisture and empanada, generating partial dehydration in the product, during storage. The fresh dough empanada retained the best texture conditions during storage in freezing and refrigeration; however, safety security may be at risk by microbiological deterioration in the unfried dough.

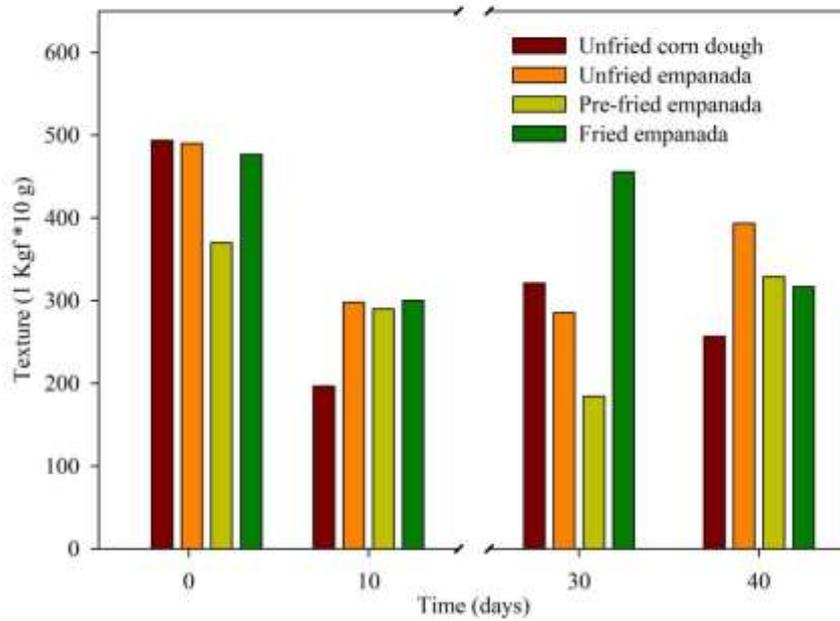


Figure 3. Textural behavior of unfried corn dough, unfried empanada, fried and pre-fried empanada stored in freezing.

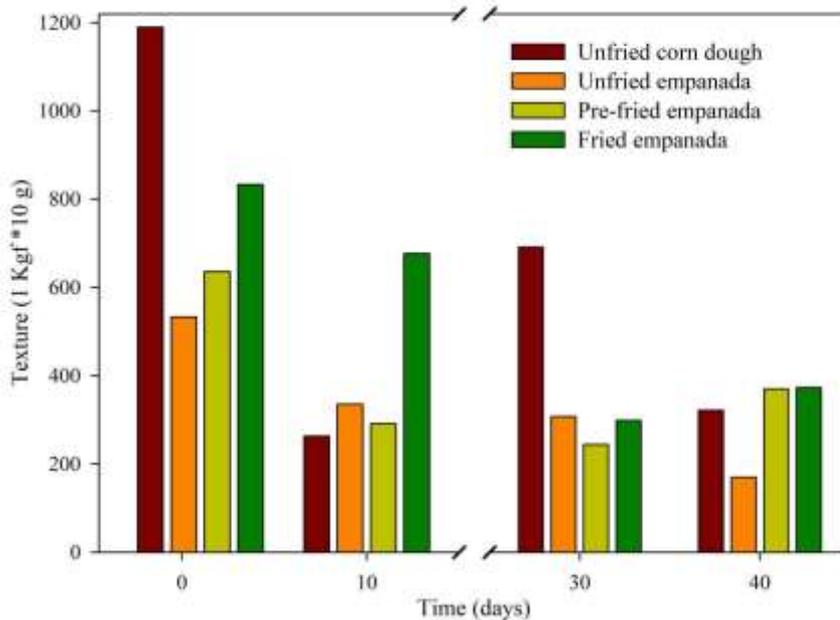


Figure 4. Textural behavior of unfried corn dough, unfried empanada, fried and pre-fried empanada stored in ultra-freezing pre-treatment.

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