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Effect of nixtamalization on nutritional composition of corn (*Zea mays*)

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Abstract
"Nixtamalization" is the process of cooking maize grains in a lime solution, soaking and washing them, to obtain "nixtamal". The nixtamalization process enhance the bioavilability of minerals as well as vitamin. Then it is stone-ground to obtain nixtamal dough or masa. A variety of products are obtained from it and tortilla (flat pancakes cooked in a griddle) is the most popular one. In conclusion, the nutritional qualities of Nixtamalized Quality Protein Maize (QPM) tortillas were enhanced by the cooking duration, steeping time, and lime concentration. This study aimed to evaluate the effect nixtamalization on the nutritional quality of corn.

Keywords: Nixtamalization, nutritional, corn, niacin, masa

Introduction

Maize (*Zea mays*) is popular crop over the world and it serves as a food source for both humans and animals. It is stable food 400 million people whom from of Africa and Asia. (Olajide & Nsakpuma, 2019) [11]. Maize variants can be classified as dent, flint, floury, waxy, amylase, pop, and sweet depending on the kind of endosperm. (Govind *et al*., 2018) [4]. Maize has several nutritional limitations, especially the quantity and quality of its essential amino acids and niacin (Katz *et al*., 1974) [6]. A typical maize kernel is composed of 70-75% starch, 8-10% protein, 4-5% lipid, 1-3% sugar and 1-4% ash. One of the most widely grown cereal grain crops worldwide, along with rice and wheat, is maize (*Zea mays* L.), which is an essential source of food, feed, fuel, and fiber (Tenaillon & Charcosset, 2011) [15]. It is thought that unless it is prepared by specific techniques, its nutritional value is marginal and any human population that depends on it as a major staple would suffer some degree of malnutrition. Alkali cooking was the main technique used to improve its nutritional value (Mertz *et al*., 1970) [8]. Maize is used multi-purposely as food, fodder, feed, and seed, it's also a source of industrial primary raw material products, such as starch, protein, oil, food, alcoholic beverages, cosmetics, biofuel, sweeteners, etc. The immediate use of maize in the world is for feed for about 64%, human food for 16%, starch and beverage as industrial beverage products for 19%, and about 1% for seed (Malhotra 2017) [7]. Maize is the primary supplier of proteins and carbs after rice, it has the potential to become one of the cereals with the highest economic value. Corn has good potential as a raw resource for industry and food based on its nutritional value and chemical makeup. Corn flour is one of the semi-finished products that can be made from corn.

The nixtamalization method is frequently used to produce tortillas and other food items made from maize. After being cooked with alkali (such as lime), the maize kernels are steeped in the cooking water and then washed at least twice to remove any leftover organic material and extra alkali. Nixtamalization is an ancient cooking method that dates back thousands of years to the Meso-American period. By immersing them in an alkaline solution, dried grains are treated with alkaline agents. Lime, wood ash, and lye are the most common alkaline agents employed in the therapy. Grain, particularly maize, is treated using this method extensively in Mexico and Central America. Anti-nutritional elements like phytic acid and condensed tannins, which are present in cereals, are reduced throughout the treatment process, and physical and chemical changes take place that contribute to the end product's increased nutritional value. This causes the bound niacin, which is present in maize harvests, to break free.

2. Materials and Methods
2.1. Procurement of raw materials
The research unfolded its insights in the Department of Food Process Technology at College of Food Technology, VNMKV, Parbhani. Essential ingredients, such as corn were sourced from the regional markets of Parbhani.

2.2 Processing treatment of corn
The nixtamalization conditions of cooking for 20 - 85 min, steeping for 8 - 16 h, and optimizing the alkaline solution with 1.5 - 2% of $Ca(OH)_2$.

2.3 Proximate analysis
The experimental nixtamalized corn flours were analyzed in triplicate, and the protein content, total fat, ash and pH values were determined using standard methods of the American Association of Cereal Chemists (AACC, 1995) [1]. Dietary fiber and calcium content were evaluated by the 991.43 and 985.35 methods of AOAC (2000) [2], respectively.

3. Result and Discussion
3.1 Effect of nixtamalization on nutritional composition of corn

Table 1: Effect of alkaline treatment on nutritional composition of corn

Parameters (%)	Raw	Alkaline
Moisture	12.70±0.37	12.92±0.04
Protein	11.30±0.20	9.46±0.03
Fat	3.33±0.18	2.47±0.01
Fibre	2.66±0.02	3.48±0.25
Carbohydrate	68.96±0.77	70.08±0.03
Ash	1.05±0.01	1.59±0.14

*Each value is an average of three determinations

3.2 Moisture content
For the best masa texture, however, there is typically a critical level of water absorption during the nixtamalization process of boiling with steeping for maize kernels. During the nixtamalization process, the moisture content of grain rises from 2.70±0.37% to 12.92±0.04%. According to Serna-Saldivar *et al*., steeping the lime-cooked grains also raises their moisture content and more evenly distributes the water throughout the kernel.

3.3 Protein
The protein content of raw maize was 11.30±0.20%, of cooked maize was 9.46±0.03%. The protein content was slightly decreased due to loss of water-soluble amino acid. Regarding lysine and tryptophan, which are the two most limiting amino acids in maize, the same authors reported that lysine content does not change significantly due to processing (158-166 mg/g N in raw maize to 152-165 mg/g N in cooked maize, to 145 175 mg/ g N in tortilla), but lime cooking and tortilla baking decrease tryptophan content in maize from an average value of 38 mg/g of nitrogen in raw maize to 26 mg/g of N in tortillas. Another report2, indicates that there are considerable losses of total nitrogen during the cooking process, but the relative amount of lysine in nixtamal is increased 2.8 times, tryptophan is increased slightly and the isoleucine/leucine ratio increases 1.8 times (Bressani., 1990) [3]. Nixtamalization alters the solubility patterns of maize proteins. Lime cooking and tortilla baking decrease the solubility of albumins and globulins.

3.4 Fat
The same authors reported that total fat content decreases from 3.33±0.18% (w/w) in raw maize to 2.47±0.01% (w/w) in nixtamalized corn, but the lime cooking process does not cause changes in fatty acid distributions (Bressani). According to Pflugfelder *et al*., the nixtamalization of grains results in a 20% loss in lipid content. Nixtamalization lowers the lipid content of QPM from 6.1 to 5.0%, according to Milan-Carrillo *et al*.

3.5 Fibre
The crude fibre content in raw corn was 2.66±0.02% to increase in alkaline corn was 3.48±0.25%. The nixtamalization process helps to eliminate the pericarp, so insoluble dietary fiber decreases from raw to nixtamalized maize; however, the relatively high levels that remain in the dough are of nutritional significance. According to Bressani *et al*., who studied chemical changes during rural tortilla production in Guatemala, dietary fiber of nixtamal dough (9.3 - 9.6%) is lower than that of raw maize (12.2 - 12.8%); however total dietary fiber content of tortillas is higher (10.3 - 11.7%), possibly due to the development of insoluble compounds when the maize dough is placed in the hot plate to bake tortilla (Bressani *et al*., 1990) [3].

3.6 Carbohydrate
The first dominant chemical component of maize is carbohydrates (Ullah, 2010) [17]. According to Kadir *et al*., the carbohydrate content for nixtamalization treatments ranged from 74.44 to 75.36%. For each lime concentration, boiling maize for (30 or 60 min) results in a different percentage of carbohydrates. In this study carbohydrates increases from 68.96±0.77% to 70.08±0.03% due to composition of protein and fat was decrease.

3.7 Ash
The proximate composition of meals includes ash content, which contains several minerals. The result found that the ash content increased in raw to nixtamalized corn was 1.05±0.01% to 1.59±0.14%. According to Tsegay *et al*., the value of ash content is a combination of inorganic components in the dietary samples. According to Salazar *et al*., whereas flours processed with 1.5 and 2.0 g/100 g had greater ash contents (20.09 and 21.35 g/kg, respectively), those processed with 0.5 and 1.0 g/100 g calcium hydroxide had ash contents that ranged from 15.98 to 17.82 g/kg. Nixtamalized maize flour contains more calcium as a result of the nixtamalization process.

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