Effect of Nixtamalization on the Physicochemical, Nutritional, Anti-Nutritional, and Functional Properties of Maize (Zea Mays) Tortillas

Shamsedin Mahdi Hassan[1,2,*], Sirawdink Fikreyesus Forsido[2], Yetenayet Bekele Tola[2], Adug na Mosissa Bikila[3]

[1]*Jigjiga University, P.O.Box 1020, Jigjiga, Ethiopia*
[2]*Jimma University, P.O.Box 307, Jimma, Ethiopia*
[3] *Wallaga University, P.O.Box 395, Nekemte, Ethiopia*
***Corresponding author:**
Jigjiga University, P.O.Box 1020, Jigjiga, Ethiopia
E-mail: shamsedinmahdi1@gmail.com

ABSTRACT

Nixtamalization is an ancient maize processing technique that improves nutritional quality, functionality, and consumer acceptability of maize-based foods. This paper reviews the effects of nixtamalization on physicochemical, nutritional, anti-nutritional, and functional properties of tortillas produced from quality protein maize (QPM) and enriched with soybean flour. Literature indicates that nixtamalization enhances protein digestibility, reduces anti-nutritional factors, and increases calcium and mineral bioavailability. Functional properties such as water absorption, oil absorption, and rollability are also improved, making tortillas more acceptable to consumers. Optimization of cooking duration, steeping time, and lime concentration is essential to maximize nutritional benefits while minimizing dry matter losses. Nixtamalization of QPM, combined with soybean supplementation, provides a promising approach to address protein-energy malnutrition in developing countries.

Keywords: Nixtamalization, Maize, Functional Properties, Anti-nutrients, Tortillas

INTRODUCTION

The predominant cereal grain consumed by significant portions of the rural and urban populations in Central America and Mexico is maize (*Zea mays*) (Bressani et al., 2004). The crop provides substantial levels of macro- and micro-nutrients, encouraging the food industry to manufacture various products using maize as their primary ingredient (Sánchez-Reséndiz et al., 2019). Each African nation has its own unique maize processing techniques, food items, and eating habits (Mensah et al., 2013). Maize is a significant and strategic grain for Ethiopian farmers' food security and way of life (Balemi et al., 2020). Nixtamalization is a common method that enhances the nutritional content of maize and may also improve the nutritional content of other food types through maize processing (Inyang et al., 2019). The procedure results in considerable physicochemical changes in the pericarp, germ, and endosperm as a result of the lime concentration (calcium hydroxide) and water dispersion into the maize

grain's beneficial nutritional and sensory qualities (Gutiérrez et al., 2013). Tortillas are always flat and round despite coming in a variety of sizes, thicknesses, and textures because they are constructed of maize that has been cooked with calcium hydroxide (Gutiérrez-Cortez et al., 2018). It is an unfermented flat maize bread with a variety of colors based on the maize flour source, and it's soft, flexible, and easy to roll. With 157 grams consumed daily per person in Mexico, tortillas are a vital part of the country's diet (Morales, 2017). Thus, using quality protein maize (QPM) through the process of nixtamalization may aid in nutrient availability, boost protein quality with less nutritional loss, and decrease anti-nutrients. However, there is little information on how different processing techniques affect the physicochemical, functional, mineral, and sensory qualities of cereal and legume blends, which may improve the nutritional value of the finished product. Therefore, this review aims to address and better understand the nixtamalization settings.

MATERIALS AND METHODS

This review was based on peer-reviewed articles, reports, and experimental findings related to maize processing, nixtamalization, and tortilla quality. Key parameters examined include proximate composition, mineral content, anti-nutritional factors, and functional characteristics.

RESULTS AND DISCUSSION

Maize is widely used for food, feed, and industry, but is deficient in lysine and tryptophan, although quality protein maize (QPM) contains 70-100% more of these amino acids than conventional maize (Murdia et al., 2016; Adefris-Teklewold et al., 2015; Mamatha et al., 2017). Nixtamalization, along with dry and wet milling, is a major processing method that affects the proximate composition of maize, where moisture rises from 10-12% to 40-42% during steeping (Serna-Saldívar et al., 1990), protein content ranges between 8.9-11.6% but decreases with longer lime treatment (Almeida et al., 1996; Kadir et al., 2019), and crude fat is reduced by about 20% due to pericarp and germ removal (Pflugfelder et al., 1988; Milán-Carrillo et al., 2004). Crude fiber averages 1.39-2.05% however, it declines during alkali cooking (Reyna Luz, 1993), while ash and calcium increase with higher lime levels (Serna-Saldívar et al., 1991; Salazar et al., 2014). Carbohydrates remain dominant at 74-75%, and energy content is highest when soybean flour is blended due to its fat contribution (Inyang et al., 2019). Nixtamalization also reduces anti-nutritional factors such as phytate (0.61-9.86%), tannins (0.6-1.3%), and oxalates (1.0-4.71%), improving mineral bioavailability (Reddy et al., 1994; Oladapo et al., 2017). Furthermore, functional properties including bulk density, water absorption capacity, water absorption index, and oil absorption capacity are significantly

influenced, with water absorption during cooking and steeping being critical for masa texture and viscoelastic properties (Bedolla and Rooney, 1982; Maskus, 2010).

Table 1: Proximate, Anti-nutritional, and Functional Properties of Maize and Nixtamalized Maize Flour

Parameter	Maize	Nixtamalized Maize Flour
Proximate composition		
Moisture content (%)	9.3-10.2	7.6-10.2
Crude protein (%)	9.7-11.5	7.48-11.6
Crude fat (%)	4.2-6.0	3.36-3.59
Crude fiber (%)	0.2-3.3	1.39-2.05
Ash (%)	1.4-2.9	1.5-2.0
Carbohydrate (%)	68.4-73.1	74.4-75.4
Energy (Kcal/100 g)	361.4-385.7	382.87
Anti-nutritional factors		
Phytate (%)	-	0.61-9.86
Tannin (%)	-	0.6-1.3
Oxalate (%)	-	1.0-4.71
Functional properties		
Bulk density	-	0.61-0.63
WAC (Water absorption capacity)	-	159-163
WAI (Water absorption index)	-	2.27-2.28
OAC (Oil absorption capacity)	-	88.82-88.9

Source: Shamsedin et al. (2023); Serna-Saldar et al. (1990).

CONCLUSIONS AND OUTLOOK

Nixtamalization substantially improves the physicochemical, nutritional, and sensory properties of maize tortillas. It reduces anti-nutrients and increases calcium uptake while enhancing functional qualities important for processing and consumer preference. Combining QPM with soybean flour further enhances protein quality and provides a low-cost intervention against protein-energy malnutrition. Wider application of nixtamalization in Ethiopia and Africa could diversify maize-based diets and improve food and nutrition security.

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