Literature Review of Treatments for the Preservation of Corn Flours

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Abstract: This study was conducted at the Faculty of Agricultural Sciences in Huambo Province to investigate the nutritional quality of corn flour and identify treatments that can preserve the product without compromising its quality. Nutritionally, the formed grain is composed of approximately 73% starch, 10% protein, and 5% oil, with the remainder (12%) beting fiber, vitamins, and minerals. 100g of flour contains approximately 365 kcal, 75-82g of carbohydrates, 6-9g of protein, and 3-5g of total fat. Regarding treatmetnts and preservation, a literature search was conducted to identify the application of eight (5) treatments: ionizing radiation, thermal drying, infrared, heating, and freeze-drying, which are expected to preserve the product in better nutritional conditions. The methodology used in this study is the product of a research project whose objective was to group together studies already conducted in this area to facilitate the search for knowledge. The treatments proposed were for the following products: corn, flour, and starch.

Keywords: *Corn; Cornmeal; Treatment, Preservation, and Nutritional Value.*

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I. INTRODUCTION

Due to its rich nutritional composition, corn, when stored improperly, becomes vulnerable to the development of fungi, mites, and insects, compromising its quality and safety (Porto et al., 2022). Corn flour treatment focuses on drying and humidity control to prevent mold, while heat treatment can be used to gelatinize the starch, facilitating cooking and digestion. To preserve the flour, store it in a cool, dry place away from light and heat. Use airtight containers to protect it from moisture and insects, and check the expiration date to ensure product quality (Giacomelli et al., 2012).

➢ *General Objective:*

To investigate the nutritional quality of corn flour and identify the types of treatments aimed at preserving the product without altering its quality. Specific objectives:

- To determine the types of corn treatment;
- To identify methods of treatment and preservation of corn flour and starch.

➢ *Specific Objectives:*

- Determine the types of corn processing;
- Identify methods for processing and preserving corn flour and starch.

II. METHODOLOGY

This work is the product of an investigation whose objective was to group the studies already carried out in this area, to facilitate the search for knowledge. In order to gather information on general aspects of corn cultivation, flour processing and possible treatment and preservation methods, which according to Carvalho and Alves (2012) "is developed from material already produced, consisting mainly of books and scientific articles" and is characterized as "an in-depth analysis of the subject". The possible methods used in the treatment of corn, flour and starch will be based on studies done with ionization, drying, infrared, thermal heating and lyophilization.

III. RESULT AND DISCUSSION

The treatment of corn flour focuses on drying and moisture control to prevent mold, while heat treatment can be used to gelatinize the starch, making cooking and digestion easier. To preserve the flour, store it in a cool, dry place away from light and heat. Use airtight containers to protect it from moisture and insects, and check the expiration date to ensure the product's quality. (Giacomelli et al., 2012). (table 1).

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- *Corn Flour Treatment*

- *Drying:*

After the corn is ground, the flour goes through a drying process to reduce its moisture content to low levels (ideally below 13%). This step is crucial to prevent mold growth and extend the shelf life of the flour.

- *Heat Treatment (Gelatinization):*

Some corn flours undergo a heat or hydrothermal treatment. This process causes the starch to gelatinize, changing its crystalline structure, which makes it more soluble in cold water and easier to digest. The temperature used in the heat treatment is controlled to reach this state without harming the nutritional value.

- *Storing Corn Flour*

- *Environment:*

Keep corn flour in a cool, dry, and dark place, away from excessive heat and direct sunlight.

After grinding the corn, the flour goes through a drying process to reduce its moisture content to low levels (ideally below 13%). This step is crucial to prevent fungus growth and to extend the flour's shelf life.

- *Heat Treatment (Gelatinization):*

- *Environment:*

Keep cornmeal in a cool, dry, and dark place, away from excessive heat and direct sunlight.

- *Container:*

Store the flour in a well-sealed container, such as an airtight jar. This helps protect the flour from moisture and prevents insects, like cockroaches, from spoiling the product.

- *Check the Expiration Date:*

Write the expiration date on the container and do not consume the flour after this date, as its quality and safety may have been compromised.

- *Pest Control:*

In areas where corn and flour are stored, it's important to control rodents and other pests that could contaminate the product.

- *Notes*

- Cornmeal should not be eaten raw; it is recommended to consume it in foods that go through heat treatment.
- The quality of the flour is linked to strict moisture control during the production process, as excess moisture can lead to fungal growth.

- *Non-Thermal By Ionizing Radiation*

Due to its rich nutritional composition, corn, when stored improperly, becomes vulnerable to the development of fungi, mites, and insects, compromising its quality and safety. Ozone can reduce corn contamination by microorganisms and also degrade mycotoxins (Porto et al., 2022).

- *Thermal Drying*

The corn was harvested with 35, 25, 18, 15.3, and 14.3% moisture and subjected to drying at 100°C, 70°C, and 40°C. The 15.3 and 14.3% moisture levels at harvest were not dried, with the last value referring to the batch that stayed in the field for 60 days.

(Post-harvest corn). The chemical composition was determined according to AOAC (1995) and the AMEn by the total excreta collection method. When considering the AMEn values expressed on a natural matter basis, significant differences were found between the undried corn (15.3% moisture) and the other treatments. The difference with the highest AMEn value obtained in this case was 11.8% (2864 vs 3247 kcal/kg). This is due to the fact that the grain harvested at 15.3% moisture reached values close to 24%, possibly due to a rehydration process. When considering the AMEn values on a dry matter basis, there were no differences between treatments. The nutritional value of corn harvested at different moisture levels and subjected to drying at different temperatures remained within the standard tabulated values. Mazzuco et al., (2002).

- *Infrared*

Freshly harvested corn with high moisture content should be dried in a short period of time to about 12–14% (w. b.) to prevent mold growth and preserve the overall quality of the corn. This research presents the following practical applications:

Expanded infrared (IR) treatment of corn is effective in significantly reducing drying time (9 to 22 minutes depending on the infrared intensity and the duration of intermittent IR drying to dry freshly harvested corn with moisture content from 23 to 13% on a wet basis). Ability to use intermittent infrared heating to combine drying and decontamination of corn in a single step, while maintaining the quality of the finished product.

Potential of IR heating to inactivate heat-resistant mold spores that produce mycotoxins, which are likely to survive conventional drying methods, according to Wilson (2017).

- *Heating*

In order to investigate the impact of continuous dry heat treatment (CDHT) and repeated dry heat treatment (RDHT) on the structural and physicochemical properties of waxy corn starch, the starch was prepared at 140°C for 20 continuous hours or for 5 heating cycles, respectively. Each cycle lasted 4 hours, with a 1-hour cooling period at room temperature between each cycle. It was found that RDHT and CDHT caused the starch to aggregate into large chunks. The crystalline type of CDHT and RDHT starches remained type A, while the relative crystallinity and short-range molecular

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order of the starch, characterized by 1040cm−1/1018cm−1, increased during the first 2 RDHT cycles and the first 8 hours of CDHT, then decreased with longer treatment. After heat treatment, the water absorption index, swelling volume, viscosity, and thermal parameters of CDHT and RDHT starches decreased, but the solubility,, The paste clarity and the temperature of the starch paste increased compared to the native starch. Taken together, RDHT has a greater impact on decreasing the starch paste's transmittance, weakening shear strength and increasing the degree of retrogradation of the starch paste compared to CDHT for the same duration. Zou et al. (2019).

➢ *Lyophilization*

In this study, the effects of lyophilization on the functional properties of acid-modified and autoclaved corn starch preparations were investigated. The RS content and the pasting properties of these starch preparations were also determined. Significant increases in solubility were observed as the hydrolysis level of the lyophilized samples increased. All acid-modified, gelatinized-autoclaved-lyophilized samples showed higher water-binding values than native starch and oven-dried, thermally treated native starch. Acid-modified, gelatinized-autoclaved-lyophilized samples (with storage at 95°C: GASL or without storage: GAL, before lyophilization) significantly improved the emulsion properties of the soy protein solution. Acid modification seems to be a prerequisite for achieving the enhanced effect of lyophilization. Although native starch contained no In AR, the level increased to 8.1% due to gelatinization, autoclaving, and oven drying (Control 2). The RS content of Control 2 was higher than that of the native gelatinized-autoclaved-lyophilized starch (N-GAL, 2.9%). Samples stored before lyophilization had higher RS contents compared to the corresponding non-stored samples. The highest RS content (12.4%) was observed in the 2h-GASL sample. Cold viscosity was observed in the RVA curves of the N-GASL, 2h-GASL, N-GAL, and 2h-GAL samples. A possible mechanism/model is suggested to explain the lack or presence of cold viscosity. Koksel et al, (2008).

IV. FINAL CONSIDERATIONS

Through the results, we can say that corn is primarily an energy food, since its kernels are mainly made up of carbohydrates. This cereal is also considered a source of protein, as the nutrient accounts for about 10% of the kernel.

Regarding the treatment and preservation of corn, flour, and starch, it can be done using five (5) treatments, namely: Non-thermal by ionizing radiation, thermal by drying, infrared, heating, and freeze-drying.

Treating corn flour with high doses of ionizing radiation harms its aroma and color.

Treating cornmeal with low-dose ionizing radiation helps preserve its quality, whereas high doses do not.

Treating corn with infrared, even under non-accelerated conditions, doesn't affect quality and can actually improve yield and energy efficiency.

Starch treated with freeze-drying is more soluble in water.

Starch that was treated in a batch process had lower crystallinity, worse short-range molecular order, lower transmittance, solubility, and swelling power than starch treated continuously.

The nutritional values of corn harvested at different moisture levels and then dried match the tabulated values, whereas corn harvested post-harvest does not.

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Table 1 Summary of Five Treatments and Storage Methods for Corn, Flour, and Starch

Product	Type of treatment/ preservation	Treatment/ storage conditions	Main Conclusions	Reference
Corn	Drying	%Humidity and drying temperature	Allows keeping nutritional values within the standard listed	Mazzuco *et al.*,(2002).
Flour	Ionizing radiation	Ozonation of 40 mg of O3/L for 300 minutes (using 3 kg of sample)	Under these conditions, it helps maintain quality. In high concentrations, it harms the aroma and color.	Porto *et al.*, (2022).
Corn	Infravermelho	Harvested with 24% moisture It was intermittently dried with infrared at different intensities until it reached a safe storage moisture content of 13%.	Drying and decontamination through accelerated and enhanced infrared were achieved without affecting the quality of the corn; optimized treatments could potentially improve yield and energy efficiency.	Wilson, (2017)
Starch (flour)	Warm-up	Impact of continuous dry heating treatment (CDHT) and repeated dry heating treatment (RDHT) on the structural and physicochemical properties of waxy corn flour, the starch was prepared at 140°C for 20 hours continuous or for 5 cycles.	After RDHT and CDHT, the waxy corn starch granules clumped into large chunks, and the surfaces of the aggregated granules were visibly damaged. The RDHT samples had lower crystallinity, worse short-range molecular order of starch, and lower transmittance, solubility, and swelling power than the CDHT ones.	Zou et al, (2019).
Starch	Freeze-drying	The effects of freeze-drying on the functional properties of acid-modified and autoclaved corn starch preparations.	Significant increases in solubility were observed as the level of hydrolysis of the freeze-dried samples increased. All the acid-modified gelatinized-autoclaved-freeze-dried samples had higher water-binding values than those of native starch and heat-treated dry native starch.	Koksel et al, (2008).