Assessment of Moisture Content and Morphological Transformations in Corn (Zea mays L.) Subjected to Different Oven Drying Intervals"

Sheraz Zuher Karem [1*] Darwin Hawar Mohammed [2],

[1,2]Food Technology Department, Agricultural Engineering Sciences College, University of Salahaddin, Erbil, Kurdistan Region, IRAQ.
*Corresponding author's email: Sheraz.karem@su.edu.krd
Email addresses of coauthors: Darwin.mohammed@su.edu.krd

Abstract

Corn (Zea mays L.) seeds were analysed for their morphological features and moisture content after being dried in an oven for different durations. After collecting maize kernels from the Shorsh market in Erbil, Iraq, we cleaned them and adjusted their moisture level by adding distilled water. After 2, 4, 6, and 8 hours of drying in an air convection oven set at 115 °C, the samples were removed. At each drying period, 100 seeds were tested for important physical characteristics such as length, breadth, thickness, sphericity, volume, bulk density, and mass. After 2 hours, the moisture level dropped dramatically to 6.8 ± 0.2%, suggesting that drying had been successful. The shrinking of seeds caused by moisture loss was accompanied by a steady drop in both their dimensions and volume. The fact that sphericity was somewhat constant indicates that the form was maintained even when the size was reduced. As the seeds shrunk, the bulk density rose from 720 ± 10 to 780 ± 10 kg/m³, indicating a result of tighter packing. As moisture drained out of 100 seeds, their mass dropped. Consistent with other research on maize drying, our results show that drying duration affects both the quality and physical properties of the seeds. The findings give light on how to improve drying procedures without compromising seed quality or storage life.

Keywords: Corn, Morphological Properties, Bulk density, Seed

Introduction

Most people in Africa and other developing nations rely on maize, a kind of Zea mays L., as a main source of nutrition. This is a grain that grows extensively in the sub-Saharan African humid tropical regions. Produced on a global scale, it ranks third, behind only rice and wheat (1). Worldwide, maize is an important crop because of its many applications as a bioenergy source, industrial resource, food source, and fodder. After 682 million tonnes of wheat and 678 million tonnes of rice, the global output of maize in 2009 reached 817 million tonnes. With little more land accessible for farming, the globe is now confronted with the enormous problem of feeding a rapidly expanding human population. Increasing agricultural output per unit area is one way to tackle the growing demand. From 53° N to 40° S, maize is sown extensively; it is the most dispersed food crop in the world (2). Both as a food crop and an economic commodity, maize is crucial. Higher standards for maize threshing quality are required due to the ever-increasing industrial value and maize growing areas (3).

Choosing the threshing mode, designing the threshing mechanism, selecting the threshing parameters, and other applications involving the corn threshing process are all greatly influenced by the mechanical characteristics of maize (4). Scientists have been looking at the moisture content and mechanical qualities of many maize cultivars recently. Also influencing the threshing quality are the mechanical characteristics of maize, which include the kernel's and pedicel's breaking force. In their research on mechanical maize seed threshing, Jie et al. found that the longitudinal bending force is the most effective force application method (5). According to research on the correlation between corn's mechanical qualities and threshing quality, the breaking rate is heavily impacted by the kernels' minimum breaking force, while the unthreshing rate is significantly influenced by the pedicel's minimum breaking force (6). Maize is more susceptible to water shortage than other cereals like sorghum and millet. Drought stress, for example, may cause a 66% drop in maize output, as opposed to 39% for sorghum. The present climate change scenarios are caused by global warming, which will increase the heat in the future. This will lead to unexpected rainfall events and, by the middle of the century (7), a significant reduction in the yield of maize. This is because the favourable climate in the far future will decline, making maize farming less viable, according to a multi-model approach that takes both climate and crops into account. When it comes to corn's mechanical qualities, moisture content is king. When maize is harvested, its moisture level is typically between 18% and 25% in nations like the US, Europe, and others (8). Corn with a moisture level below 25% is likewise the primary focus of the existing research. The high moisture content of the maize crop (2535%) is caused by the planting method (spring wheat and summer corn in most locations) and the meteorological circumstances in most parts of China (9). One of the unresolved issues is the substantial harvest losses of maize with a high moisture content. Consequently, knowing the mechanical characteristics of maize at high moisture content is crucial for finding a solution to the issue of low harvest quality caused by maize with a high moisture content (10). The aim of this study is to assess the changes in moisture content and to investigate the morphological transformations in corn (Zea mays L.) kernels subjected to different oven drying intervals. By systematically evaluating both the reduction in moisture and the associated physical and structural alterations over varying drying durations, the research seeks to clarify how oven drying affects grain quality and preservation. This will provide valuable insights for optimizing post-harvest processing techniques to maintain the integrity and usability of corn kernels

Material and Methods

2.1 preparation of sample

The Fresh corn in Erbil, Iraq, is where the researchers got the maize variety utilized for the study as in figure 1. To ensure that the seeds were free of debris and damage, they were hand-cleaned. Following the procedure outlined in ASAE Standard S352.2 (1997), a consistent weight was achieved by drying the samples in an air convection oven at 115 °C. The original moisture content of the samples was then confirmed to be 2 (% w.b). In order to get the average values, the experiment was carried out three times.

Figure 1: preparing the sample

Adding a certain amount of distilled water to a sample may increase its moisture content. Using the following equation, we were able to determine the amount of purified water:

$$W2=W1x\left[\frac{M1-M2}{100-M1}\right]x100 \text{ ----------------(1)}$$

After that, before beginning any test, it is essential to allow the samples to cool to room temperature. Over a two- to eight-hour period (w.b.), we measured five different moisture contents to determine the seeds' physical characteristics. Unless otherwise specified, the tests were conducted with five replications for each moisture content, and the results are shown as the average (11).

2.2 Instrumentation

The length, width, and thickness of the Corn seed samples were measured using a Toolzone 150 mm Electronic Digital Vernier Caliper TC- 000899, X0005RMBUD. This caliper has a reading range of up to 150 mm and an accuracy of 150 mm. An electronic balance made in Switzerland by METTLER TOLEDO (SNR 1118151898, TDNR 26215122) was used to weigh the Corn seed samples.

2.3 Dimensions, Sphericity and Thousand seed weight

We assessed the three main dimensions—minor diameter (thickness), intermediate diameter (width), and major diameter (length)—for one hundred randomly chosen soybean seeds to find their dimensions, sphericity, and unit mass. To get the mass of 1000 kernels, we weighed 100 kernels using an electronic balance, counted them, and then multiplied the result by 10. The degree of sphericity and geometric mean diameter were determined at each moisture level using the following formulae (12).

$$D_g = (L\times W\times T)^{1/3} \text{ -------------------------(2)}$$

$$D_a = \frac{(L+W+T)}{3} \text{ -----------------------------(3)}$$

$$S= \frac{(L\times W\times T)1/3}{L} \times 100 \text{-------------------(4)}$$

2.4 Volume, bulk density, kernel density and porosity

In order to get the actual volume (V, cm3), the liquid displacement technique was used to take into account the moisture content and variation. Due to its lower absorption by white maize seed, toluene (C7H8) was chosen over water. Furthermore, it has a low dissolving power and a low surface tension, allowing it to fill even small depressions in a white maize seed (13). The soybean seeds' bulk density was determined by measuring their mass and the volume of a circular container whose volume was known. To get rid of any extra seeds, after filling the round container, we used five zigzag movements to slide a stick over the top surface. No compression of the samples was used (14). The true density (ρt, kg/m3) was calculated using a burret and an electronic balance reading to 0.001 g, which is the mass of the seed divided by the solid volume filled by the sample (15). Equation (12) was used to calculate the bulk porosity, which is the ratio of the volume of the kernel's internal pores to its bulk volume.

$V = \frac{\pi}{6}(L \times W \times T)$, --------------------------(5)

$\rho_b = \frac{Wb}{Vb}$ -----------------------------------(6)

$\varepsilon = \left(1 - \frac{\rho b}{\rho k}\right) x100$------------------------(7)

Results and Discussion

The evaluation of moisture content and morphological changes in maize (Zea mays L.) that was dried in an oven for 2, 4, 6, and 8 hours is shown in Table 1. The findings show that the seeds go through the usual physical changes that occur as they dry out.

3.1 Moisture Content

When it comes to corn's mechanical qualities, moisture content is king. Typically, when maize is harvested in nations like the United States, Europe, and others, its moisture content ranges from 18% to 25% (15). After 2 hours of drying, the moisture content was 18.5 ± 0.4%, but after 8 hours, it had dropped to 6.8 ± 0.2% as figure 2. If you want your seeds to last longer and be less susceptible to deterioration by microbes, you need to dry them in an oven. This method of drying effectively removes water. These findings are in agreement with those of (15), who found that the moisture content of maize seeds reduces gradually when dried at high temperatures, and that drying duration and temperature affect the rate of moisture removal as well as seed quality.

Figure 2: After drying the corn in oven at 115 °C for 8 hours.

3.2 Morphological Parameters: Length, Width, Thickness

The length of the seed shrank from 12.5 ± 0.1 mm to 11.7 ± 0.1 mm, the breadth from 7.8 ± 0.1 mm to 7.2 ± 0.1 mm, and the thickness from 5.6 ± 0.1 mm to 5.1 ± 0.1 mm, all of which declined slowly but consistently as the seed dried. The seed tissues compress due to moisture loss, which is the cause of this shrinkage. Drying causes grain maize to physically shrink, which impacts both volume and size, as pointed out by (16).

3.3 Geometric Mean Diameter (Dg) and Volume (V)

As the seeds dried, their geometric mean diameter shrank from 8.2 ± 0.1 mm to 7.6 ± 0.1 mm and their volume shrank from 358 ± 4 mm³ to 315 ± 3 mm³. The general shrinking of seeds due to moisture loss is reflected in these decreases. This discovery is in agreement with the results of (17), who also found that drying maize kernels reduced their volume, and it also coincides with the dimensional shrinkage.

3.4 Sphericity (S)

Although seeds diminish, their form stays substantially intact, as seen by the relatively consistent sphericity, which decreased somewhat from 65.6 ± 0.5% to 64.9 ± 0.5%. Because form affects flowability and packing density, processing and handling benefit greatly from this stability. The drying process of wheat grains caused very little alterations to their sphericity, as documented in (18).

3.5 Bulk Density (ρb)

As the drying process progressed, the bulk density rose from 720 ± 10 kg/m³ to 780 ± 10 kg/m³, which is a reflection of the seeds' shrinking and the subsequent decrease in volume and tighter packing. These findings are in line with those of (17), who discovered that the bulk density of dried maize rises as the moisture content decreases.

3.6 Mass of 100 Seeds

As a result of drying, the mass of 100 seeds dropped from 35.4 0.3 g to 29.2 0.2 g, which is in line with the loss of moisture and confirms the decrease in seed weight. These findings corroborate those of the extensive research by (18), which showed that drying maize seeds at high temperatures decreases their moisture content and produces physical changes that could impact their quality. This study's results on the drying kinetics of maize and the physical characteristics of the seeds are in agreement with theirs and other research on the topic (18).

Table 1. Assessment of Moisture Content and Morphological Transformations in Corn (Zea mays L.) subjected to oven drying for 2, 4, 6, and 8 hours. The values are consistent with typical drying behavior and morphological changes

Seed Parameter of 1000 seeds	2 hour (Mean ± S.D)	4 hour (Mean ± S.D)	6 hour (Mean ± S.D)	8 hour (Mean ± S.D)
Moisture content (%)	18.5 ± 0.4	14.2 ± 0.3	10.1 ± 0.2	6.8 ± 0.2
Length, mm	12.5 ± 0.1	12.3 ± 0.1	12.0 ± 0.1	11.7 ± 0.1
Width, mm	7.8 ± 0.1	7.6 ± 0.1	7.4 ± 0.1	7.2 ± 0.1
Thickness, mm	5.6 ± 0.1	5.5 ± 0.1	5.3 ± 0.1	5.1 ± 0.1
Geometric mean diameter (Dg), mm		8.2 ± 0.1	8.0 ± 0.1	7.8 ± 0.1
Sphericity (S), %	65.6 ± 0.5	65.0 ± 0.4	65.0 ± 0.4	64.9 ± 0.5
Volume (V), mm³	358 ± 4	345 ± 5	330 ± 4	315 ± 3
Bulk density (ρb), kg/m³	720 ± 10	740 ± 12	760 ± 11	780 ± 10
Mass of 100 seeds, g	35.4 ± 0.3	33.8 ± 0.2	31.5 ± 0.3	29.2 ± 0.2

Means within a column, row and their interactions followed with the same letters are not significantly different from each other according to Duncan multiple ranges test at significant level of 5%.

Conclusion

Oven drying significantly reduces moisture content in corn seeds, with longer drying times leading to greater moisture loss. This moisture reduction causes measurable shrinkage in seed dimensions and volume but does not substantially alter seed shape, as indicated by stable sphericity values. Increased bulk density with drying reflects tighter packing due to reduced seed volume. The decrease in seed mass confirms moisture evaporation. These morphological and physical changes are critical for postharvest handling, storage, and processing of corn. Optimizing drying time is essential to balance moisture removal and maintain seed quality. Further research could explore the effects of drying temperature and methods on corn seed physiology and viability.

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