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Effect of soaking time on some physiological properties of Melon, Groundnut pod and paddy Rice seeds

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Abstract

Dehulling requires an appropriately designed machine. However, soaking time and moisture content are critical factors for optimal seed processing. Therefore, this study was aimed to determine the optimum soaking time for rice paddy, melon, and groundnut pod suitable for the design of a multi-seeds shelling machine. Seeds were collected from Engr A. A. Kure International market, cleaned, conditioned and soaked for four hours. Seed length, width, thickness, arithmetic and geometric mean diameters were measured using standard procedures every ten minutes. Groundnut pods experienced considerable dimensional changes, with lengths ranging from 24.43 to 32.66 mm, widths from 9.37 to 17.78 mm, and thicknesses from 9.37 to 16.27 mm within 240 minutes of soaking. Notably, groundnut pods width exhibited the greatest increase at 89.6%, followed by thickness at 74%, and length at 34%. Melon seeds demonstrated significant size augmentation, with length, width, and thickness escalating from 8.88 to 18.99 mm, 5.52 to 11.87 mm, and 1.42 to 3.52 mm, respectively, corresponding to moisture content increments from 7.88% to 46.36% (dry basis). This represented remarkable growth rates of 113.85% for length, 114.5% for width, and 142.9% for thickness. Similarly, paddy rice exhibited dimensional expansion, with length increasing from 10.64 to 13.37 mm (20.40%), width from 2.64 to 3.09 mm (17.1%), and thickness from 2.1 to 2.73 mm (3%) over a moisture content range of 6.22% to 32.31%. The study observed that the soaking time of groundnut pod, melon seed and paddy rice affect the physiological change in the seed.

Keywords: Moisture, Groundnut pod, Melon seed, Paddy rice and Soaking time.

Effet du Temps de Trempe Sur Certaines propriétés physiologiques des Graines de Melon, de Grain de Cacahuète et de riz paddy

Résumé

L'égrenage nécessite une machine conçue de manière appropriée. Cependant, le temps de trempe et la teneur en humidité sont des facteurs critiques pour un traitement optimal des graines. Par conséquent, cette étude visait à déterminer le temps de trempe optimal pour le riz paddy, le melon et les gousses de cacahuète, adapté à la conception d'une machine de dépelliculage multi-graines. Les graines ont été collectées au marché international (Engr A. A. Kure International market), nettoyées, conditionnées et trempées pendant quatre heures. La longueur, la largeur, l'épaisseur, les diamètres moyens arithmétique et géométrique ont été mesurés à l'aide de procédures standard toutes les dix minutes. Les gousses de cacahuète ont subi des changements dimensionnels considérables, avec des longueurs allant de 24,43 à 32,66 mm, des largeurs de 9,37 à 17,78 mm et des épaisseurs de 9,37 à 16,27 mm après 240 minutes

de trempage. Il est à noter que la largeur des gousses de cacahuète a montré la plus grande augmentation, soit 89,6 %, suivie de l'épaisseur (74 %) et de la longueur (34 %). Les graines de melon ont montré une augmentation significative de taille, avec des longueurs, largeurs et épaisseurs passant respectivement de 8,88 à 18,99 mm, de 5,52 à 11,87 mm et de 1,42 à 3,52 mm, correspondant à des augmentations de la teneur en humidité de 7,88 % à 46,36 % (en base sèche). Cela a représenté des taux de croissance remarquables de 113,85 % pour la longueur, 114,5 % pour la largeur et 142,9 % pour l'épaisseur. De même, le riz paddy a montré une expansion dimensionnelle, la longueur passant de 10,64 à 13,37 mm (20,40 %), la largeur de 2,64 à 3,09 mm (17,1 %) et l'épaisseur de 2,1 à 2,73 mm (3 %) sur une plage de teneur en humidité de 6,22 % à 32,31 %. L'étude a observé que le temps de trempe des gousses de cacahuète, des graines de melon et du riz paddy affecte le changement physiologique dans la graine.

Mots-clés : Humidité, Gousse de cacahuète, Graine de melon, Riz paddy et Temps de trempe.

ملخص

يتطلب Dehulling آلة مصممة بشكل مناسب. ومع ذلك، فإن نقع الوقت ومحتوى الرطوبة من العوامل الحاسمة للمعالجة المثلى للبذور. لذلك، كانت هذه الدراسة تهدف إلى تحديد وقت النقع الأمثل لأرز الأرز والبطيخ وجراب الفول السوداني المناسب لتصميم آلة قصف متعددة البذور. تم جمع البذور من سوق Engr A. A. Kure الدولي، وتم تنظيفها وتكييفها ونقعها لمدة أربع ساعات. تم قياس طول البذور والعرض والسمك والحساب والأقطار الهندسية باستخدام الإجراءات القياسية كل عشر دقائق. شهدت قرون الفول السوداني تغيرات كبيرة في الأبعاد، حيث تراوحت أطوالها من 24.43 إلى 32.66 ملم، وعرضها من 9.37 إلى 17.78 ملم، وسمك من 9.37 إلى 16.27 ملم في غضون 240 دقيقة من النقع. والجدير بالذكر أن عرض كبسولات الفول السوداني أظهر أكبر زيادة بنسبة 89.6٪، تليها السماكة بنسبة 74٪، والطول بنسبة 34٪. أظهرت بذور البطيخ زيادة كبيرة في الحجم، حيث ارتفع الطول والعرض والسمك من 8.88 إلى 18.99 ملم، و 5.52 إلى 11.87 ملم، و 1.42 إلى 3.52 ملم، على التوالي، وهو ما يقابل زيادات في محتوى الرطوبة من 7.88٪ إلى 46.36٪ (أساس جاف). يمثل هذا معدلات نمو ملحوظة بنسبة 113.85٪ للطول، و 114.5٪ للعرض، و 142.9٪ للسمك. وبالمثل، أظهر الأرز توسعًا أبعادًا، حيث زاد الطول من 10.64 إلى 13.37 ملم (20.40٪)، والعرض من 2.64 إلى 3.09 ملم (17.1٪)، والسمك من 2.1 إلى 2.73 ملم (3٪) على نطاق محتوى الرطوبة من 6.22٪ إلى 32.31٪. لاحظت الدراسة أن وقت نقع جراب الفول السوداني وبذور البطيخ والأرز الأرز يؤثر على التغيير الفسيولوجي في البذور.

الكلمات الرئيسية: الرطوبة، جراب الفول السوداني، بذور البطيخ، أرز الأرز ووقت النقع.

Introduction

Employing mechanisation technology, farmers can enhance their net profit margin by processing agricultural products such as rice, groundnuts, and melons into superior forms, hence extending their usable life (Abhijeet et al., 2016). The design of appropriate equipment becomes important to enable the development of seed processing, given the significance of shelling. Dayou *et al*. (2019) noted that although leguminous crops (groundnuts and melons) are staple foods for most people, they also offer an environmentally safe alternative for managing plant nutrients and enhancing animal and human nutrition with nitrogen, particularly in developing nations where fertiliser use is still quite high. Every region of Nigeria typically cultivates these crops.

Any agricultural product's physical and processing qualities are crucial quality factors to take into account while building processing machinery and

determining its marketability (Danbaba *et al*., 2013; Dayou *et al*., 2019). To get the best outcome in the most cost-effective way possible, these parameters were refined. These factors make studies of these variables crucial to systems engineering, both in the project's early stages of exploration and in its finished design. The machine's examination was conducted based on three parameters: visible seed damage, cleaning, and shelling.

The soaking time of rice has a great potential to influence the moisture content of the seed (Rehaman *et al*., 2021). While short periods of soaking may lead to the crack of the rice grain during milling, more extended periods of soaking could be applied to minimize the crack through the healing of existing cracks. Soaking rice seeds for 12-24 hours brings the seeds to approximately 85% swelling; hence, industrial rice seedling nurseries soak rice seeds for this period to develop germination rates of their planted seeds. Varied factors of the varietal nature of milled rice affect behaviour and initial moisture content, where initially fast water uptake stabilizes at saturation levels during soaking. In the case of parboiling, the time-temperature relationship under soaking conditions affects post-parboiling grain quality, with higher rates of hydration noted at the onset of soaking due to moisture diffusion across the husk layer (Rehaman *et al*., 2021).

Several approaches recommend differing soaking times for the best interest. According to Locali-Pereira et al. (2024), one technique is soaking seeds in hydrochloric acid, treating them with trichoderma, and then drying them till the moisture content is equal to or less than 7%. Another study on egusi melon seeds discovered that the moisture diffusivity of the seeds was impacted by the water absorption kinetics during soaking at temperatures between 30 and 70°C (Wainaina, 2022). Furthermore, soaking watermelon seeds beforehand for several lengths of time—48 and 72 hours, for example—improved the seedlings' growth and development qualities (Rehaman *et al*., 2021).

Studies have indicated that the content of groundnut seeds varies depending on how long they are soaked. When Bambara groundnut seeds were soaked for varying amounts of time, their moisture content varied between 10.2% and 11.2% (Okudu & Ojinnaka, 2017). When seeds were soaked in hot water for four hours, their moisture content was lower than when they were soaked for shorter periods of time (Adebowale *et al*., 2011a). The other is superior water absorption during cooking when pre-soaked seeds are heated infraredly; this suggests that the moisture content of the seeds has changed (Ogundele *et al*., 2021).

The present study is aimed at determining the effect of soaking time on length, width, thickness, arithmetic and geometric mean diameters of groundnut pods, melon seeds and paddy rice with a view to using the results in designing a machine to shell these seeds.

Materials and Methods

The groundnut pod, paddy rice, and melons were bought from Engr. A. A. Kure International Modern Market in Minna, Nigeria (9.64° N, 6.51° E). To get rid of trash and extraneous objects including dirt, stones, and broken seeds, the samples were cleaned. At this point, the samples' engineering characteristics were documented as "dry." Samples that had been cleaned were reconditioned by soaking in water for a maximum of four hours. The seeds were then spread out in a thin layer beneath the shed and allowed to dry naturally in the surrounding air

until appropriate moisture levels. Seed moisture contents were measured using the digital fast moisture metre (Plat I - DrawellDW-110MW Grain Halogen moisture analyser). To provide a consistent and steady moisture content, the seeds with the appropriate moisture levels were sealed in bags made of tagged polythene. as described by Alonge *et al*. (2017) and Idris *et al*. (2021). The seeds were conditioned in triplicate. Seed length, width, and thickness were measured using Digital Vernier Calliper (150 mm at 0.01 mm precision), while arithmetic and geometric mean diameters were calculated using standard procedures.

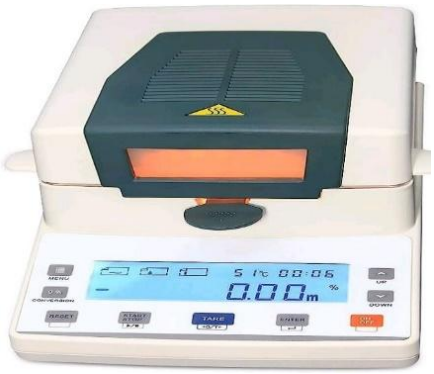

Plate I:I: DrawellDW-110MW Grain Halogen moisture analyser

The quantity of water to be added to get the desired moisture content was computed by Mir et al. (2013) using Equation 1.0 as: described by Mir *et al*. (2013):

$$Q_w = \frac{A(A_f - A_b)}{100 - A_b} \qquad (1.0)$$

Where:

Q_w = Quantity of water to be added, kg

A = Weight of initial sample that is to be fed into the machine, kg

A_f = Final moisture content desired, %

A_b = Moisture content before conditioning, %

Results and Discussion

These measured geometric properties (length, width, and thickness) are important for designing of the hopper, the opening of the concave, shelling drum, and clearance between drum and concave unit as reported by Hassan and Geasa (2021).

Effect of soaking time on geometric properties of groundnut pods

After 240 minutes of soaking, the length, width, and thickness of groundnut pods ranged between 24.43 and 32.66 mm, 9.37 and 17.78 mm, and 9.37 and 16.27 mm, respectively, as shown in Figure 1. The study evaluated and recorded the effects of rising moisture content levels on some geometric properties of groundnut pods. For the period under consideration, a higher rise was discovered to be 89.6% for thickness, 74% for width, and 34% for length. The average measurements of the groundnut pods' length, width, and thickness during the soaking time are displayed in Figure 1. The average values determined corresponded with previous research conducted by Shukla *et al*. (2019) and Krishnappa *et al.* (2017). The results also support the findings of Balami *et al*. (2014), who noted the significance of these parameters in the palm kernel cracker design.

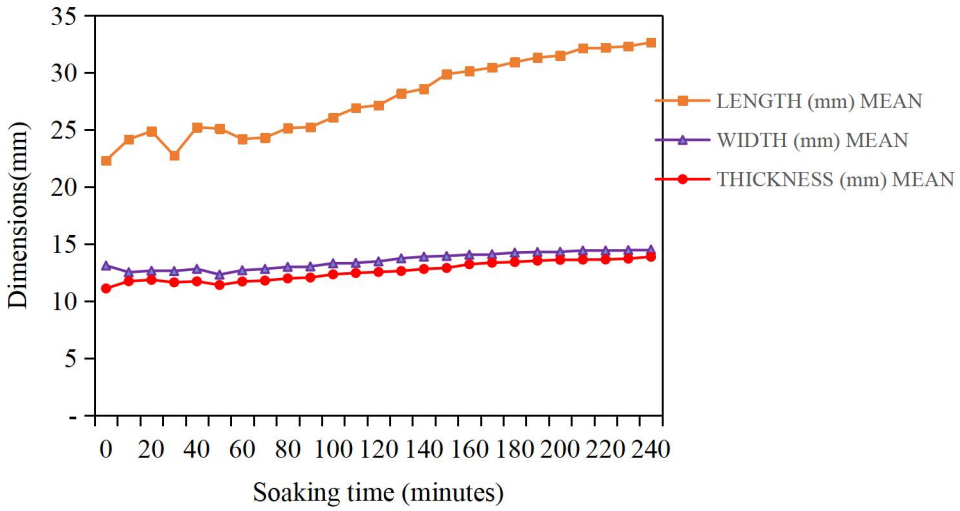

Figure 1: **Effect of soaking time on length, width and thickness of groundnut pods**

The analysis's findings clearly show that as moisture content increased, so did the impact of soaking time on surface area, sphericity, geometric mean diameter, and arithmetic mean diameter. The groundnut pods' mean values for sphericity, projected area, flakiness ratio, elongation ratio, arithmetic mean diameter, and geometric mean diameter were found to be in the range of 0.49 and 0.83, 132 and 67 mm^2, 0.55 and 1.04, and 1.2 and 2.91, 12.20 and 24.46 mm, 11.79 and 23.2 mm, respectively. The direct connection of groundnut pod arithmetic and geometric mean diameter values (Figure 2) on the three principal dimensions of the seed may be the cause of the increase in these values. For moisture range considered, all geometric properties were directly affected by the moisture content of the seed except sphericity as reported by Darfour *et al*. (2022).

The pods' nearly spherical shape and ease of rolling on surfaces, particularly in hoppers and dehulling machinery, are shown by the sphericity values. The sphericity of groundnut pods ranged from 0.49 to 0.83, with an average of 0.65. Sphericity of the seeds within the range of moisture content considered was within the range (0.32–1.00) as stated by Darfour *et al*. (2022) for most agricultural produce.

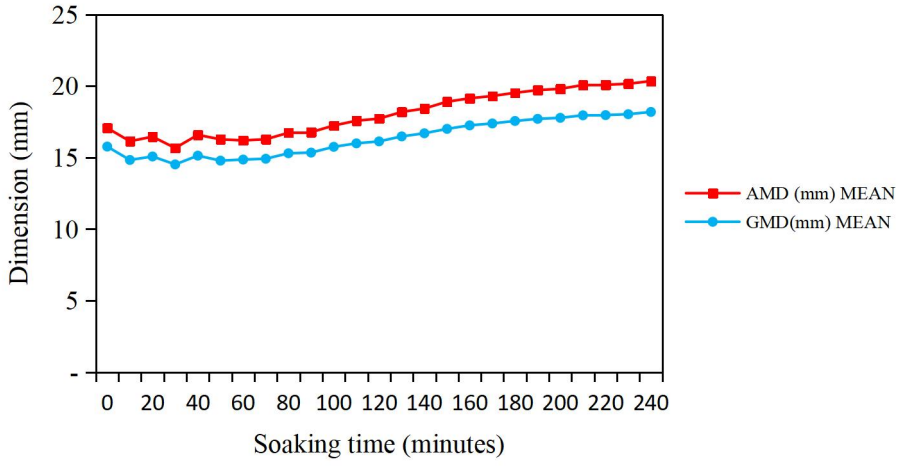

Figure 2: **Arithmetic and geometric mean diameters of groundnut pods at different soaking time**

Effect of soaking time on geometric properties of melon seeds

According to the study of data in (Figure 3), the size of the melon seeds swollen from 7.88 to 46.36% (db) as the moisture content increased. With an increase in moisture content, the melon seeds' length, width, and thickness grew from 8.88 to 18.99 mm, 5.52 to 11.87 mm, and 1.42 to 3.52 mm, respectively. The hygroscopic characteristic of melon seeds may account for their changes in size as moisture content increases. The thickness was the one that increased the most, measuring 142.9%, breadth, 114.5%, and length, 113.85%. This suggests that, in the investigated conditions, the three linear dimensions rely on the moisture content of melon seeds (Figure 3). Satimehin and Akaayar (2017) came to the same conclusion, stating that all of the shelled melon seeds' physical characteristics are linearly correlated with their moisture content, which ranges from 11.04 to 24.78% dry basis.

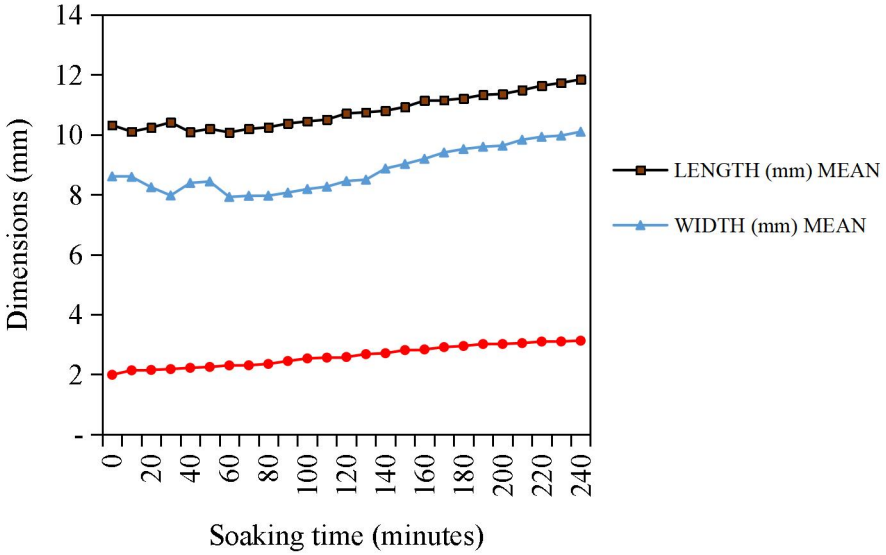

Figure 3: **Effect of soaking time on the length, width and thickness of melon seeds**

Figure 4 shows that the mean values of Melon seeds arithmetic mean diameter (AMD) and geometric mean diameter (GMD) (Figure 4), 0.41 and 0.12, and 2.11 and 6.59, respectively. The mean values obtained by Mansouri et al. (2017) are in agreement because they fall within the range of the values that were determined. The impact of soaking time on the melon seeds (Figure 4) showed that the mean diameters rose more during the period under consideration the longer the soaking time. This is consistent with the findings of Satimehin and Akaayar (2017), who found that the moisture content of egusi melon shelled (hulled) seeds affects all of their physical and frictional characteristics in a linear fashion within the range of 11.04 to 24.78% dry basis

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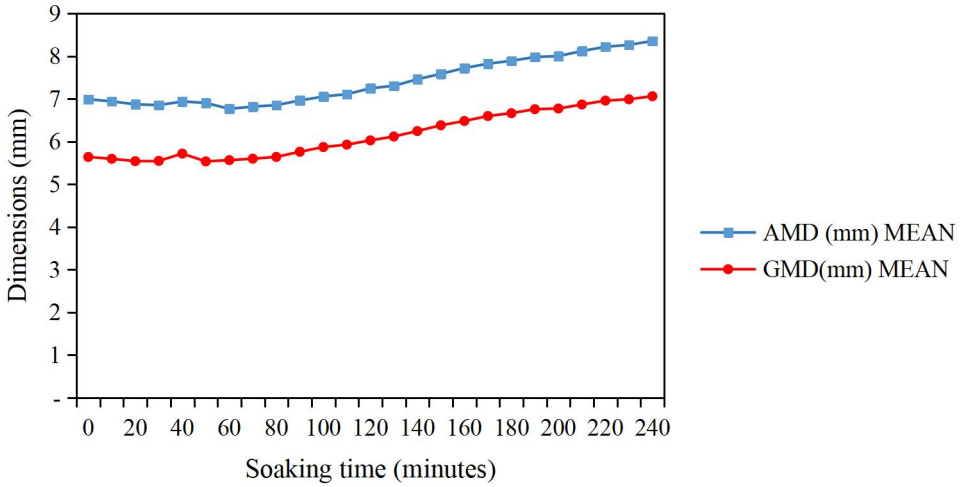

Figure 4: Arithmetic and geometric mean diameter of melon seeds at different soaking time

Effect of soaking time on geometric properties of paddy rice

According to the study, when the moisture content of paddy rice increased from 6.22% to 32.31%, the length increased to 13.37 mm (20.40%), the width to 2.64 mm (17.1%), and the thickness to 2.1 mm (3%) as illustrated in Figure 5. When designing machinery for processing grains or seeds, linear dimensions play a crucial role in establishing the size of the aperture (Adebowale *et al*., 2011a). Pandiselvam et al. (2015) also reported a similar increase in the rice kernel dimensions with increase in moisture content from 11.55 to 26.84 % (db) while a similar result was reported by Adebowale *et al*. (2011b).

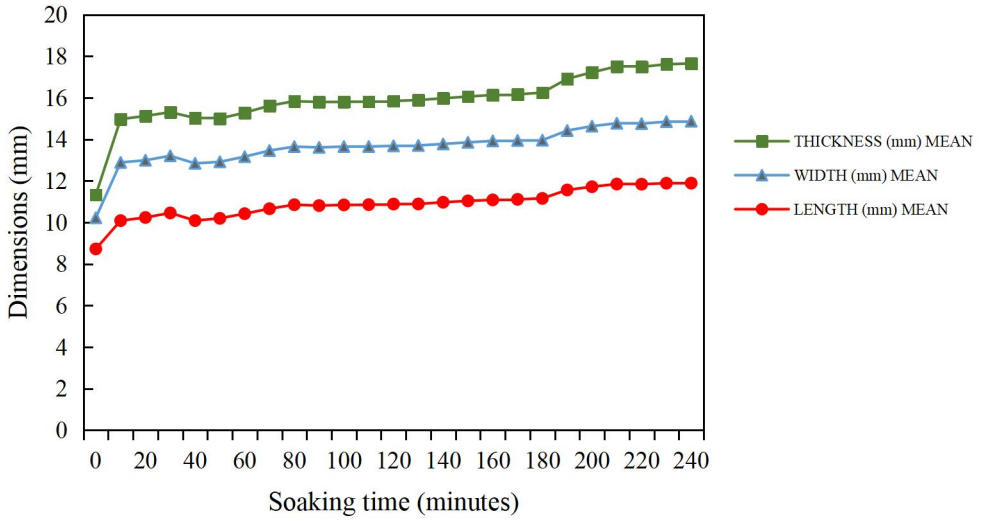

Figure 5: **Effect of soaking time on the length, width and thickness of paddy rice**

As seen in Figure 6, there was a linear and positive association between the mean diameters of paddy rice and the moisture content, as reported by Pandiselvam *et al*. (2015). Paddy rice sphericity mean values were found to be between 0.32 and 0.43. These results were more in line with the similar values published by Mir *et al*. (2013), which were 0.32 and 0.53. The sphericity values indicate that the seeds have a nearly spherical shape and are easily rollable.

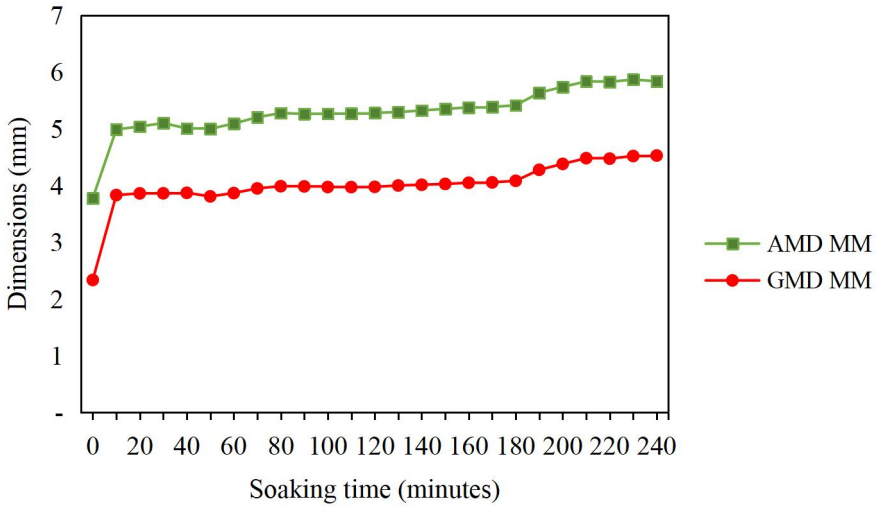

Figure 6: **Arithmetic and geometric mean diameter of paddy rice at different soaking time**

Conclusion

These findings underscore the significant influence of moisture content on seed dimensions, critical for the design and optimization of seed processing equipment. Moreover, the study provides valuable insights into the relationship between soaking time, moisture content, and geometric properties, informing efficient seed processing strategies in agricultural production systems. The study acclaims moisture-induced dimensional changes for optimal performance and efficiency during design of processing machine.

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