Bima Journal of Science and Technology, Vol. 8(3) Sept, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i3.768

Effectiveness of Chemical Scarification Methods on the Early Germination of Different Varieties of Date Palm in Kashere, Gombe State, Nigeria

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ABSTRACT

Date palm is one of the most important trees in semi-arid and dry areas of the world. Dates are rich in carbohydrates, vitamins and minerals, they have immense importance as a healthy food as well as a desert fruit. The fruit contains fructose and glucose as the major sugar components which make it an important source of sugar to persons who cannot tolerate sucrose. The tree provides food, fuel, shelter and is used in manufacturing of different handicrafts. The primary cause of datepalm seed (*Phoenix dactylifera* L.) dormancy is its hard seed coat structure, which makes it difficult for the seed to absorb water during germination. This study aimed to examine the effect of chemical scarification treatments which could effectively enhance and reduce datepalm (*Phoenix dactylifera* L.) number of days to seed germination in Kashere, Gombe State. The experiment consisted of ten different varieties of datepalm sourced from Nigerian Institute for Oil Palm Research, Jigawa State and two chemical treatments (H_2SO_4 and NaOH) together with a control (water) laid out in a Randomized Complete Block Design in two replications. It was significantly observed that the varieties differ in their rate of germination with Shiwarin (25.83 days) germinating earlier than the other varieties studied. Similarly, chemical treatment was found effective in promoting germination rate and germination percentage of the studied datepalm varieties. Furthermore, the varieties were categorized based on the number of days to germination and germination percentage with Galamawa and Shiwarin varieties showing potential for early germination and high germination percentage. According to the findings reported here, date palm seed exhibited exogenous dormancy that is entirely enforced by the hard seed coat. Chemical scarification is a viable method that can enhance early germination of date palm seeds.

Keywords: Date Palm; dormancy; chemical scarification; Kashere; sulphuric acid; sodium hydroxide

INTRODUCTION

Date palm (*Phoenix dactylifera*) is an economically important fruit crop cultivated in various regions around the world, including Kashere, Gombe State, Nigeria. Date palms are valued for their sweet, nutritious fruits, which have been consumed for centuries and play a significant role in the local economy

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(Al-Khayri and Al-Bahrany, 2015). As a source of food and fiber, they are extremely important to the majority of people on the planet (Ellison and Ellison, 2001). Native to tropical or subtropical parts of Africa or Southern Asia, *Phoenix dactylifera* L. is a monocotyledonous angiosperm belonging to the Palmaceae (Arecacea) family (Al-Alawi *et al*., 2017). It is the most prized fruit crop, grown in several Arab countries, the Middle East, and semi-arid regions of North Africa. Due to its well-known effects on the economy, nutrition, aesthetics, history, and society, it is extremely important (Khierallah and Bader, 2007). Among woody plants, palms are well-known in the nursery industry for their uneven and time-consuming seed germination (Balslev, 1991).

Breaking and implantation offshoots are two ways in which this condition limits the activity of the normal propagation strategy. There are several reasons why this behavior occurs: First off, the date palm is primarily a diploid, dioecious tree species with distinct male and female plants (2n = 2x = 36). Fertilization of the female flowers, which frequently involves manual or mechanical pollination, is required for fruit setting. Also, according to Al-Khalifah *et al*. (2012), the date fruit is an oblong, single-seeded berry with a fleshy mesocarp, a membrane endocarp around the seed, and a pericarp, or fruit skin. Moreover, at 27°C, it takes more than a week for the embryo to emerge from the seed coat, indicating that date palm seed germination is rather slow (Hodel, 1977; Said, 1989). In the nursery condition, irregular and belated seed germination is typical. Date palm seeds, on the other hand, have an impermeable, hard seed coat that may prevent germination and the emergence of seedlings. A characteristic known as "seed dormancy" keeps seeds from germinating even under ideal circumstances.

Germination is a crucial stage in the life cycle of plants, and successful seedling establishment is essential for achieving high yields in date palm cultivation. The hard seed coat of date palm seeds acts as a protective barrier, preventing water absorption and inhibiting the germination process. This can lead to prolonged germination times, low germination rates, and inconsistent seedling emergence, all of which can limit the productivity of date palm orchards. (Brown and Johnson, 2020). There might be a lack of comprehensive studies examining the optimal scarification methods for specific date palm cultivars, especially those unique to certain regions. Identifying the most effective scarification techniques for various cultivars could significantly enhance date palm propagation.

The primary cause of date palm seeds' (*Phoenix dactylifera* L.) dormancy is their hard seed coat structure, which makes it difficult for the seeds to absorb water during germination. To overcome the challenges posed by the hard seed coat, various methods have been employed, including mechanical scarification, hot water treatment, and chemical scarification. Chemical scarification involves the use of chemical agents to weaken or break down the seed coat, allowing for better water absorption and enhancing the germination process. Understanding the effects of chemical scarification on germination and seedling emergence of date palm seeds can have practical implications for farmers and researchers in Kashere, Gombe State. If chemical scarification proves to be effective, it could offer a viable technique for enhancing seedling establishment, improving yield potential, and promoting uniform growth within date palm orchards (Teixeira da Silva and Al-Khayri, 2017).

The purpose of this study is to investigate the effects of chemical scarification on the

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germination and seedling emergence of ten varieties of date palm in Kashere, Gombe State, Nigeria. By evaluating the impact of chemical scarification on these varieties, we aim to provide valuable insights into optimizing germination and seedling establishment in date palm cultivation. This will further contribute to the knowledge base of date palm cultivation, provide practical recommendations for farmers, and facilitate the sustainable development of date palm production in Nigeria.

MATERIALS AND METHODS

Site and Location

The experiment was carried out at the Agronomy Laboratory, Faculty of Agriculture, Federal University of Kashere, Gombe. It is located on latitude 9°46”0” N and longitude at 10°57”0”E, 431 meters above sea level in the Sudan Savannah agro-ecological zone of Nigeria.

Planting Material

Galamawa, Magorawa, Takanda, Kargo, Limawa, Sinasir, DanMali, Shiwarin, Tirgal and Deglenoor varieties of date palm were selected for this study. The five seeds of the 10 different varieties of date palm were collected from Nigerian Institute for Oil Palm Research, Datepalm station, Dutse, Jigawa state. After carefully removing the seeds from the fruits, they were properly cleaned with distilled water. By cleaning, any leftovers from the date pit were eliminated. After that, the seeds were kept in plastic bags at room temperature until needed for the study, after being visually chosen based on size uniformity. Different scarification treatments were applied to the stratified stony seeds.

Treatment and Experimental Design

The study consists of a chemical treatment (Sulphuric acid, H_2SO_4 and Sodium hydroxide, NaOH) and control (water). The chemicals are sourced from the Agronomy laboratory, Faculty of Agriculture, Federal University of Kashere. In separate small bottles, the seeds were placed and submersed in 50 ml solution of $1NH_2SO_4$ (Normal acid), 1NNaOH (Normal Base) and water treatments for 12hrs soaking period. $1NH_2SO_4$ and 1NNaOH were prepared using the molarity formula ($C_1V_1 = C_2V_2$) from the concentrated stock solution (97% Sulphuric acid, H_2SO_4 and 99% Sodium hydroxide, NaOH). To make $1NH_2SO_4$, 27.0ml of H_2SO_4 was diluted carefully in water to make 1000ml and to make 1NNaOH, 40.00g of NaOH pellet was dissolved in water to make 1000ml. Then, the seeds were rinsed few times with sterilized distilled water.

Polystyrene containers were filled with mixed sterilized sand and manure as media for germination and sprouting. The treated and untreated seeds were then transferred into black polystyrene container. This was laid out in a Completely Randomized Design (CRD) in two replications. Six (6) polystyrene containers were used for each variety, making a total of 60 containers. In the containers, 1-2 treated seeds were sown and tagged according to the recommended germination conditions for the specific seed species and treatment applied. The containers are randomly spaced 5cm × 5cm to avoid buildup of disease. All other recommended agronomic practices for date palm sowing were adhered to. Periodically, the soaked seeds were checked to ensure uniform scarification.

Data Collection and Data Analysis

The data collected after germinated seeds were counted for number of seeds germinated, germination percentage and number of days to germination after sowing (Table 1). All data were subjected to analysis of variance to test significance among the treatments using SAS 9.4v. Significant means were separated using Tukey test. Cluster analysis was carried out to determine the relation among the studied date

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palm seeds with respect to days to germination after sowing.

Table 1: Description of Data Collection

Parameter	Description
Number of days to germination	Counting the number of days it takes the seeds to germinate from the day of sowing
Total number of seed germination	Counting the number of seeds that germinate after every treatment
Germination Percentage	Number of seeds germinated divided by the total number of seeds sown, multiplied by 100

RESULTS AND DISCUSSION

Genetic variability of different date palm varieties and chemical scarification treatment on the number of days to germination and germination percentage

In this study, 10 different varieties of date palm sown appeared to germinate at different times. This could be due to the genetic heterozygosity of date palm seeds, which resulted in a wide range of germination percentages for each type. Shiwarin variety took significantly ($P<0.05$) lesser days (25.83) to germinate than Tirgal which took 30.67 days to germinate (Table 2). This indicated that Shiwarin had early germination rate than the other studied varieties. This was similar with Sinasir (26.50), Limawa (27.00), Takanda (27.50) and Kargo (27.50) as shown in Table 2. However, there was no significant ($P<0.05$) different on the number of seeds germinated among the different varieties of date palm studied (Table 2). The germination percentages ranges from 68.33 to 81.67% which was found significantly similar ($P<0.05$). Shiwarin and Takanda gave the lowest germination while Degletnoor and Magorawa gave the highest germination percentage (Figure 1). This appears that the germination efficiency is uniform among the studied date palm varieties but differs in their rate of germination as observed in this study. This is on conformity with the findings of Al Zoubi (2020) who reported significant difference among the germination rate of different date palm varieties.

Table 2: Effect of varieties and chemical treatment on the number of days to germination and number of seeds germinated after treatment of date palm seeds during the period of the experiment

	Number of days to germination	Number of seed germinated
Variety		
Galamawa	29.67ab	16.00
Takanda	27.50cd	13.67
Degletnoor	29.33ab	16.33
Magorawa	29.17bc	16.33
Kargo	27.50cd	16.17
Limawa	27.00cd	13.50
Sinasir	26.50cd	15.17
DanMali	29.67ab	14.83
Shiwarin	25.83d	13.67
Tirgal	30.67a	15.50
Sig. ($P<0.05$)	**	NS
LSD	2.7881	4.7864
Chemical Treatment		
Control (Water)	40.70a	14.85

DOI: 10.56892/bima.v8i3.768

NaOH	22.60b	15.60
H_2SO_4	22.15b	14.90
Sig. (P<0.05)	**	NS
LSD	1.5271	2.6216
Interaction		
Variety × Treat	**	NS

Means followed by same letters are not significantly different. NS = Not Significant, ** = Significance at 1% level of probability. LSD = Least Significant Difference

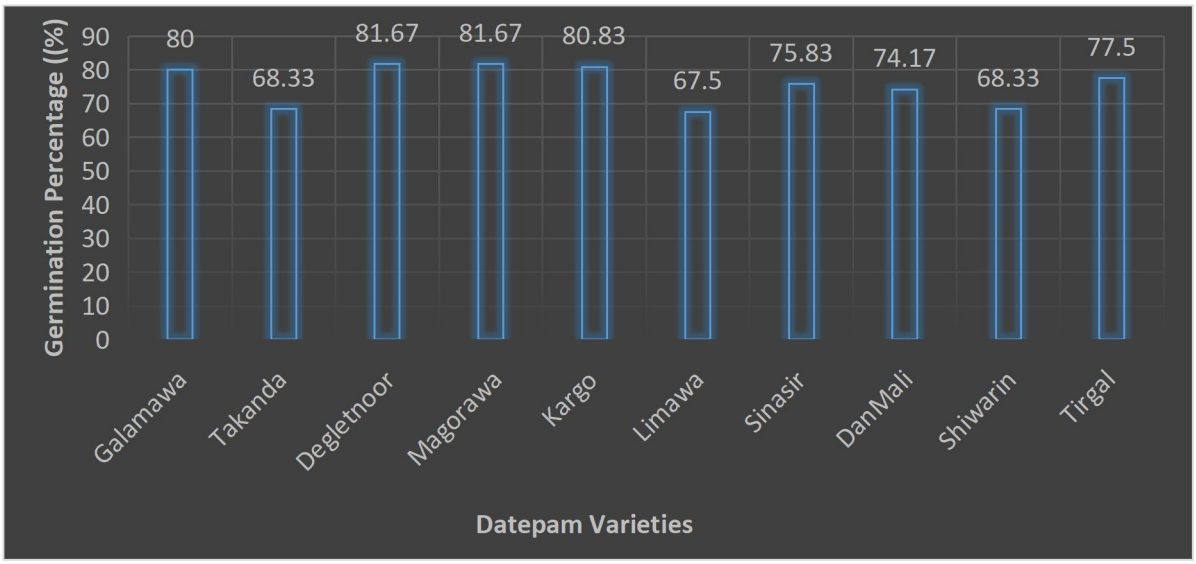

Figure 1: Germination percentage of the studied different varieties of date palm seeds.

There were significant (P<0.05) disparities in response between the chemical treatments for the number of days to germination among the studied varieties. The seeds soaked in H_2SO_4 (22.15 days) and NaOH (22.60 days) significantly (P<0.05) germinated earlier than the control (40.70 days) during the period of the experiment (Table 2). This shows that chemical treatment of date palm seeds enhances the time of germination than when treated with water only. The amount of seed to germination did not differ significantly (P<0.05) between the chemical treatment of the studied date palm (Table 2). However, seed response competence to water and chemical soaking decreased as the concentration of chemical increases. That is, water treatment took date palm seeds more time to germinate followed by NaOH and then H_2SO_4. However, the effectiveness of the chemical treatments on the germination percentage of the date palm seeds was observed in NaOH (Figure 2). NaOH gave 78% germination percentage followed by H_2SO_4 which gave approximately 74%. The outcomes resulting from this study suggest that the different treatments used had substantial effect on germination of date palm seeds. But this reaction was not uniform with all treatments even though not significantly different (P<0.05). The difference in the response may be owed to variant in the effect of sulfuric acid and sodium hydroxide scarification on removing and/or cracking of the test surface and consequently raising the permeability of the seeds to water germination. Similar observations were reported by Khadijah *et al.* (2020) who reported the effect of pre-sowing treatment on germination of date palm seeds.

Bima Journal of Science and Technology, Vol. 8(3) Sept, 2024 ISSN: 2536-6041

DOI: 10.56892/bima.v8i3.768

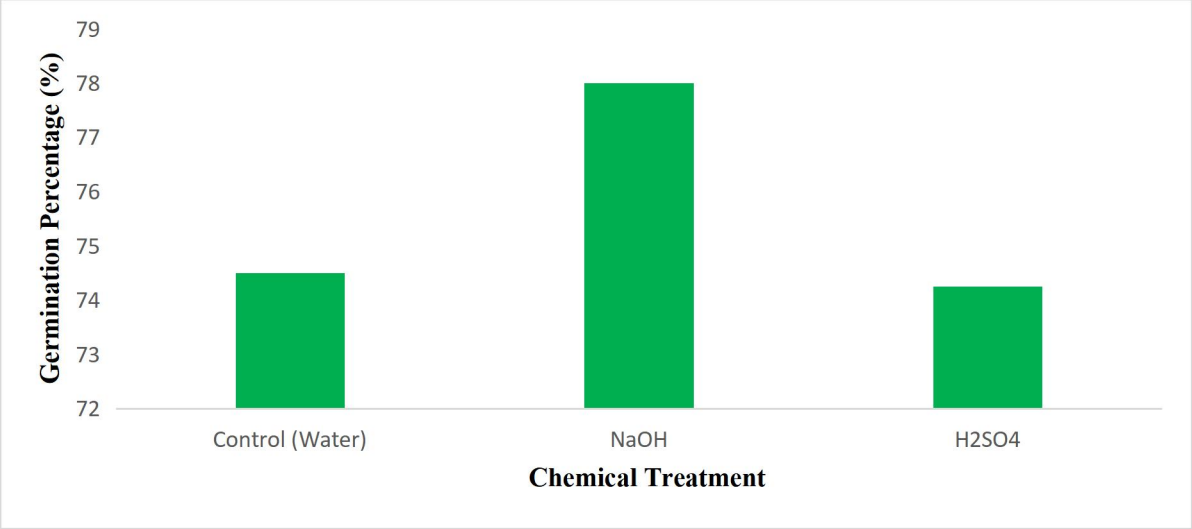

Figure 2: Effectiveness of different chemical treatments on the germination of different varieties of date palm seeds.

This study demonstrated the value of chemical scarification treatments in boosting seedling germination rates and early growth. Several pretreatments, including mechanical and chemical scarification, are used to enhance the germination of seeds in the various hard-seeded palm species (Dewir *et al*., 2011). Numerous species' seeds (palmease) responded favorably to a number of pretreatments, including scarification and exposure to chemicals like sulfuric acid (Arteca, 2013). Date palm growers on a big scale may find it more cost-effective to use sulfuric acid or sodium hydroxide to break the dormant date palm seed, however this is not always the case for local farmers who want to reduce production costs. Due to its simplicity, speed, economy, effectiveness, and repeatability, this process may provide a foundation for the advancement of a generalizable seed germination method for additional plant species. However, more study is required to maximize overall germination rates and minimize the number of germination days required for commercial application.

The interaction between chemical treatments and different varieties of datepalm was found significant during the period the experiment in Kashere (Table 2). Table 3 shows that the combination of NaoH and Sinasir (17.50 days) gave the least number of days to germination after treatment compared with the control Trigal variety (49.50 days). Obviously, as observed in this study the combination of water treatment which is the control and any of the studied varieties took longer days to germination significantly ($P<0.05$) than the treated datepalm seeds (Table 3). Datepalm seeds treated chemically produced the highest percentage of germination in the shortest amount of time. Additionally, the chemical treatment increased the pace of seed germination, enabling a final germination percentage of 50% in the shortest amount of time. Similar results were reported by Najwa and Abdel (2018), who found that date palm seeds treated for six days sprouted significantly faster and had a greater germination rate. The day's duration promoted the highest overall germination (88%) and fewer days (45) to 50% of final germination in comparison to other water-soaking treatments.

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Knowledge about the conditions for seed germination and efficient methods for breaking dormancy could be helpful in date palm seed propagation endeavors. Numerous endeavors have been undertaken to accelerate the germination of date palm seeds and increase the overall germination percentage (Najwa and Abdel, 2018). This study's results are consistent with those of Muhammad *et al*. (2017), who found a correlation between the hardness of the seed coat and the dormancy of *P. dactylifera* seeds. The various pre-treatment techniques examined for thawing Phoenix dactylifera's dormancy may have removed the cuticule and softened the seed coat, which resulted in an increase in the date palm seed's germination rate.

Table 3: Interaction between Different Chemical Treatment and Varieties of Datepalm on the Number of Days to Germination after sowing.

Source of Variation	Galamawa	Takanda	Degletnoor	Magorawa	Kargo	Limawa	Sinasir	DanMali	Shiwarin	Tirgal
Control (Water)	46.5ab	42.00bc	40.00bc	42.50bc	38.00bc	36.50c	37.00bc	40.00bc	35.00cd	49.50a
NaOH	22.00e	22.50e	22.00e	25.00de	26.00de	23.50e	17.50e	24.50e	19.00e	23.00e
H_2SO_4	20.50e	21.00e	26.00de	19.00e	21.50e	21.00e	25.00e	24.50e	23.50e	19.50e
Sig (P<0.05)					**					
SE±					1.685					

Means followed by same letters are not significantly different. SE = Standard Error. Sig. = Level of Significance

** = Significance at 1% level of probability

Genetic Distance-Based analysis for Number of Days to Germination and Germination Percentage

The standardized data was employed to calculate the Euclidean distances among the 10 datepalm varieties and an UPGMA dendrogram was constructed (Figure 3). The dendrograms of the 10 datepalm varieties were grouped into 5 major groups based on the number of days to germination and germination percentage at 0.02 dissimilarity coefficients (Figure 3). The cutoff at this point was for the convenience of discussion. Group II and group IV gave the highest with 3 varieties each (Magorawa, Kargo, Sinasir and Limawa, DanMali, Tirgal) respectively followed by group I with 2 varieties (Galamawa, and Shiwarin) and then group III and group V recorded only one variety each (Degletnoor and Takanda) respectively (Figure 3). Varieties in the same group appeared to have the similar number of days to germination and germination percentage together. Group V which has only one variety (Degletnoor), recorded the highest number of days to germination and germination percentage values and this proved that this variety might have dissimilar genes as compared to the other varieties for controlling these characters. However, Galamawa and Shiwarin have less number of days to germination and high germination percentage.

One of the factors used in parent selection is genetic divergence. A breeder's ability to select suitable parents for a breeding program is typically aided by their understanding of genetic variety within plant populations and how to quantify it. This is because selecting parents based on divergence analysis will likely yield better results (Usman *et al*., 2014). Six clusters were identified by Amarul Junior *et al.* (2005) among the 45 genotypes that were analyzed, and Farhad *et al.* (2008)

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reported eight unique groups in 50 accessions based on genetic diversity.

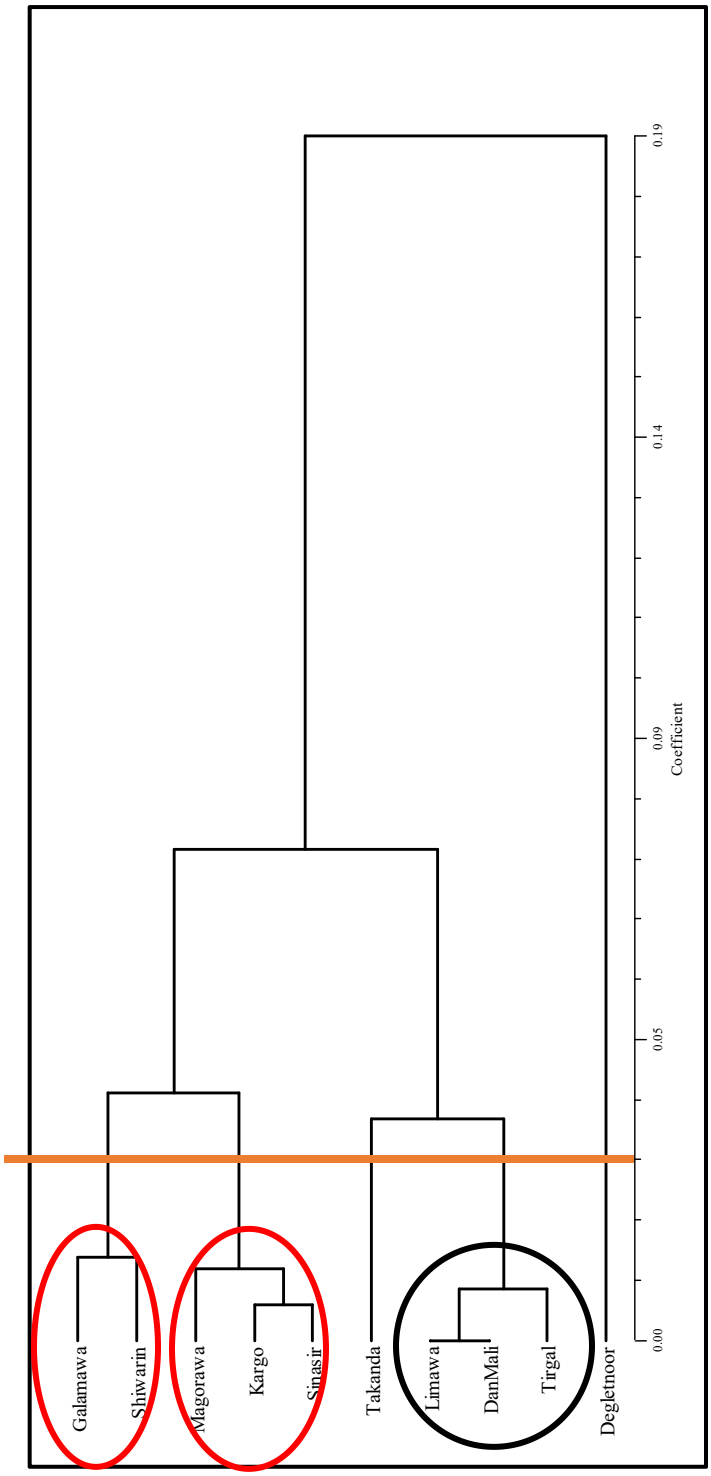

Figure 3: Relationship among the 10 datepalm varieties based on number of days to germination using SAHN clustering on UPGMA method.

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CONCLUSION

Therefore, it is reasonable to believe that date palm seeds' natural dormancy was overcome by soaking them in H_2SO_4 or NaOH. One possible way to improve and expedite entire germination of date palm seeds is to soak them for a brief period of time prior to seeding. The method could be applied to the development of a broadly applicable seed germination strategy for other plant species. It turned out to be easy, fast, inexpensive, clear-cut, reproducible, and suitable for year-round use. To create a system that can be produced economically, more research is necessary, particularly on the timing of exposure and various concentration levels, in order to increase overall germination percentages and shorten the germination period.

Acknowledgement

The authors are grateful to the Tertiary Education Trust Fund (TETFund), Nigeria for adequate funding of the research through the National Research Fund (TETF/DR&D-CE/NRF2021). The authors also express their gratitude to Department of Agronomy, Faculty of Agriculture, Federal University of Kashere, Gombe, Gombe State, Nigeria for providing research facilities.

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