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GERMINATION AND MOISTURE LEVEL RESPONSE OF SOME SELECTED LEGUMINOUS SEEDS TO VARIOUS STORAGE METHODS

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ABSTRACT

Leguminous crops such as cowpea (Vigna unguiculata), groundnut (Arachis hypogaea), and soybean (Glycine max) play critical roles in food security, soil fertility, and economic sustainability due to their high protein content, nutritional value, and ability to fix atmospheric nitrogen. However, the viability of legume seeds during storage is significantly influenced by storage conditions. This study evaluated the effects of five storage using jute bags, cotton bags, plastic containers, hermetic storage, and underground storage on the germination rate and moisture level of these crops. Seeds were stored for three months under each method, and viability tests including germination rate, and moisture content were conducted. The results revealed significant differences among storage methods; Underground storage was the most effective, yielding the highest germination rates (82.67% for cowpea, 76.33% for groundnut, and 71.00% for soybean) and maintaining optimal moisture levels. Hermetic storage also performed well, with comparable germination rates and excellent moisture retention. The Hermatic storage system promoted germination across the three crops with cowpea recording the highest percentage of 82.33% followed by groundnut (72.33%) and Soybeans (63.00%). Plastic container gave 75.67% for Soybean and 65.67% for Cowpea but only 51% for groundnut. Cotton bag system of storage gave marginal germination of the three crops from 47.33% to 53.33%. In contrast, seeds stored in jute bags exhibited the lowest germination rates (14.00% for groundnut, 49.67% for cowpea, and 42.33% for soybean) due to high moisture absorption, pest infestations, and membrane damage, as indicated by low germination rate values. The study underscores the importance of proper storage techniques in preserving seed viability and highlights underground and hermetic methods as superior options.

KEYWORDS: Germination, Legumes, Moisture, Seed viability and Storage methods

INTRODUCTION

Leguminous crops such as cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogaea*), and soybean (*Glycine max*) are essential to global agriculture due to their significant contributions to food security, soil fertility enhancement, and economic sustainability. These crops are renowned for their high protein content, ranging from 20% to 45%, along with essential amino acids, dietary fiber, and complex carbohydrates, making them crucial in regions with limited access to animal protein (Maphosa & Jideani, 2017; Ekwere & Efretuei, 2021).

Additionally, legumes enhance soil fertility through biological nitrogen fixation, reducing reliance on synthetic fertilizers and promoting sustainable agricultural practices (Kebede, 2021). Their versatility, adaptability to various climates, and increasing demand in the plant-based food market further underscore their importance in global agricultural systems (Ferreira *et al*., 2021; Ekwere *et al*., 2023). Seed storage is vital for preserving the viability and quality of leguminous crops, particularly in regions prone to post-harvest losses. Several studies have highlighted the impacts of different storage methods on seed viability and quality;

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hermetic storage methods, such as the Purdue Improved Crop Storage (PICS) bags, have been shown to effectively maintain seed quality by minimizing oxygen levels and reducing pest infestations (Baributsa *et al*., 2017). Similarly, underground storage which is common in low water table zones of Nigeria offers insulation against temperature fluctuations and moisture loss (Gilman & Boxall, 1974). In contrast, traditional methods in South-Eastern Nigeria which include jute and cotton bags have proven less effective in a previous study, often leading to moisture absorption, pest infestations, and nutrient degradation (Lindemann *et al*., 2019). Despite these findings, comprehensive evaluations comparing the effects of various storage methods on germination rates and moisture retention for staple leguminous crops in South-South, Nigeria remain limited.

The loss of seed viability during storage is a major concern for farmers, especially in Sub-Saharan Africa, where suboptimal storage methods are prevalent. Poor storage practices result in reduced germination rates, lower crop yields, and increased vulnerability to pests and diseases (Mangena, 2021). Addressing these challenges is critical for enhancing agricultural productivity and ensuring food security in resource-poor settings. Although research has identified factors such as temperature, humidity, and seed coat characteristics as critical determinants of seed viability, the specific impacts of traditional storage methods compared with hermetic and underground storage on the germination and moisture % of three largely consumed legumes in South South, Nigeria remains underexplored. Therefore, the purpose of this study is to assess the germination rates and moisture retention level of cowpea, groundnut, and soybean seeds stored using jute bags, cotton bags, plastic containers, hermetic methods, and underground storage. By identifying the most effective storage method, this research seeks to provide actionable insights for improving seed viability, minimizing post-harvest losses, and supporting sustainable agricultural practices for smallholder farmers.

MATERIALS AND METHODS

This study was conducted at the Department of Crop Science Research Laboratory, Akwa Ibom State University, Obio Akpa Campus, between the rainy season months of May and August 2024. The research location is situated at latitude 5°17’ S and longitude 7°58’ E, with an annual rainfall of approximately 488 mm and a mean annual relative humidity of 82% (AKSU-MET, 2019).

The seed samples used in the study Cowpea (*Vigna unguiculata*), Groundnut (*Arachis hypogaea*), and Soybean (*Glycine max*) were obtained from a local market in Abak Local Government Area, Akwa Ibom State, Nigeria. Seeds of good quality were selected to ensure reliable results during the experiment.

The experimental design was Complete Randomize Design (CRD), with three replications. Five different storage methods were evaluated: Jute Bag Storage (Control), Cotton Bag Storage, Plastic Container Storage, Hermetic Storage, and Underground Storage (Seeds were stored in a pit 2 meters deep and 1 meter in diameter, insulated with a rubber mat (Gilman & Boxall, 1974). Each storage method was applied to 15 kg of seeds for each crop, with a total of 45 experimental units (15 units per replicate). The seeds were stored for three months, after which they were subjected to two viability tests:

i. Moisture Content Test

The moisture content of the seeds was measured before and after storage. Small seed samples randomly selected were dried in an oven at 140°C for one hour (ISTA, 1993). The moisture content was calculated using the formula:

MC (%) =Weight before drying - Weight after drying x100

Weight before drying

ii. Germination Test

After the storage period, seed germination was tested. Random samples of seeds were placed on non-toxic paper towels, moistened with distilled water, and placed in seed boxes. Germination was observed over seven days (AOSA, 2001), with germination percentage calculated as:

Germination (%) = Number of germinated seeds x 100

Total seeds tested

The data collected were analyzed using the analysis of variance (ANOVA) procedure in the Minitab Software Package Version 21.2. Treatment means were compared using the Fishers Least Significant Difference (LSD) method at a 0.05 probability level.

RESULTS AND DISCUSSION

The germination rates of cowpea, groundnut, and soybean seeds stored using various methods are presented in Table 1. A significant difference (P<0.05P < 0.05) was observed across the different storage methods. The underground storage method yielded the highest germination percentages across all three crops. Cowpea recorded 82.67% followed by groundnut (76.33%) and Soybeans (71%). Another method of storage with significant improvement on percentage germination is the Hermatic method of storage. The Hermatic storage system promoted germination across the three crops with cowpea recording the highest percentage of 82.33% followed by groundnut (72.33%) and Soybeans (63.00%). Plastic container gave 75.67% for Soybean and 65.67% for Cowpea but only 51% for groundnut.

Cotton bag system of storage gave marginal germination of the three crops from 47.33% to 53.33%. Jute bag storage gave the lowest percentage value for germination test across the three crops with only 14% in groundnut, soybean 42% and Cowpea 49.67%.

The moisture retention capacity of the seeds varied significantly across storage methods. Hermatic storage maintained optimal moisture levels for groundnut (0.83%), cowpea (0.95%), and soybeans (0.67%) minimizing seed deterioration by limiting gas and moisture exchange. Also, seeds stored in jute bags (groundnut 2.89%, cowpea 2.97% and Soybeans 1.86%) exhibited the highest moisture absorption which contributed to reduced germination rates and seed viability (Figure 1).

Table 1: Germination Rate as Influenced by Storage Methods at 3 Months after Storage

	GERMINATION %		
STORAGE METHODS	GROUNDNUT	COWPEA	SOYBEANS
JUTE BAG (Control)	14.00	49.67	42.33
UNDERGROUND	76.33	82.67	71.00
COTTON BAG	53.33	51.67	47.33
PLASTIC CONT.	51.00	65.67	75.67
HERMATIC	72.33	82.33	63.00
MEAN	**53.40**	**66.40**	**59.87**
S. E±	**4.266**	**4.786**	**4.389**
L.S.D (P= 0.05)	**9.50**	**10.66**	**9.780**

S.E = Standard error Mean
L.S.D= least significant difference

Table 2: Initial Moisture Level of Groundnut, Cowpea and Soybeans before Storage

SEED TYPE	**MOISTURE CONTENT (%)**
GROUNDNUT	**2.31**
COWPEA	**1.47**
SOYBEANS	**1.06**

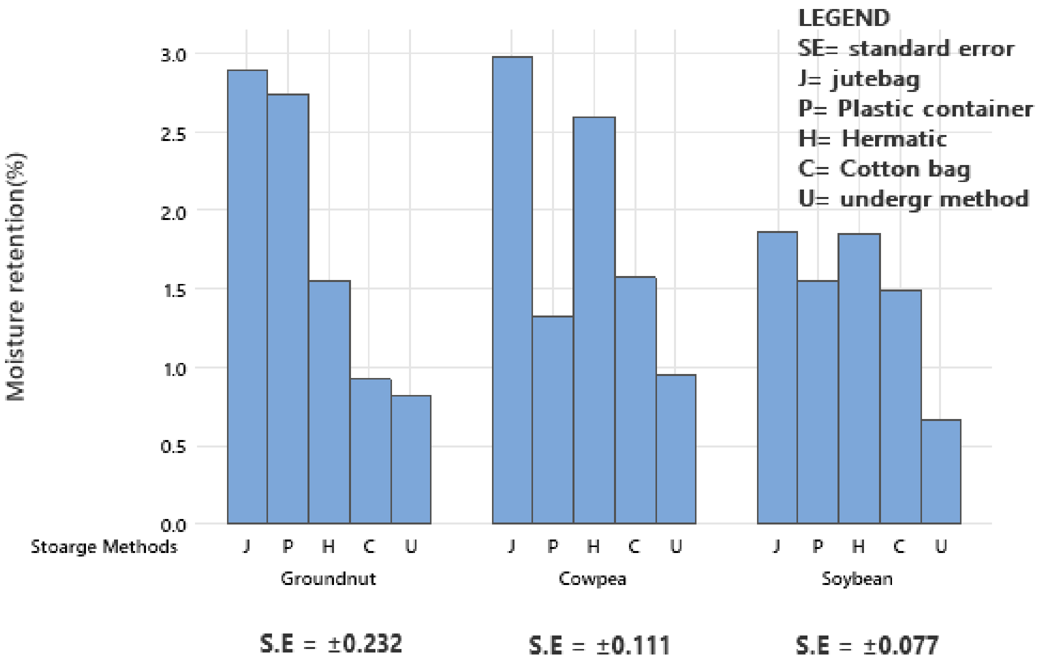

Figure 1. Effect of storage methods on Moisture level of Groundnut, Cowpea and Soybeans at 3 months after storage

DISCUSSION

The germination test results for the three leguminous crops; groundnut, cowpea, and soybeans conformed with previous research that emphasizes the importance of storage conditions on seed viability. For instance, Berhe (2023) highlighted that effective storage technologies can significantly reduce post-harvest losses and maintain seed quality, which is crucial for enhancing germination rates. In addition to underground storage, the hermatic storage method also demonstrated substantial improvements in germination rates. The effectiveness of hermetic storage in preserving seed viability has been well-documented. Studies have shown that hermetic bags create an airtight environment that minimizes moisture and pest infiltration, thereby enhancing seed longevity and germination potential (Baributsa *et al*., 2020, Aboagye *et al*., 2017). For instance, Aboagye *et al*. (2017) concluded that hermetic storage offers a superior method for preserving cowpea quality compared to non-hermetic systems. The results also indicated that while plastic containers can be beneficial, their effectiveness may vary by seed type. The findings are consistent with the literature, which notes that moisture-proof containers can significantly influence seed viability by maintaining lower relative humidity levels around the seeds (Ali *et al*., 2018). Conversely, cotton bags yielded marginal germination rates, and jute bags provided the lowest germination percentages, this agrees with the observations of Waheed *et al*. (2022), who noted that the permeability of jute bags allows for moisture ingress, adversely affecting seed quality. Overall, the data underscore the critical role of storage methods in influencing seed germination rates across different leguminous crops. The underground and hermetic storage methods emerged as the most effective, while traditional storage methods like jute and cotton bags proved inadequate for maintaining seed viability. These findings are supported by a body of research emphasizing the need for improved storage technologies to enhance agricultural productivity and food security (Berhe, 2023; Baributsa *et al*., 2020; Aboagye *et al*., 2017).

The findings also suggest that the storage methods employed have a substantial impact on the moisture retention capabilities of the seeds, which is critical for their viability during storage. The observed differences in moisture retention can be attributed to the inherent characteristics of the seeds and the storage conditions. According to Agarwal (2024), the initial moisture content of seeds (Table 2) is a crucial factor influencing their deterioration during storage. High moisture content can lead to increased respiration rates and microbial growth, which ultimately compromises seed viability, this is particularly relevant for groundnut and cowpea, which retained higher moisture levels compared to soybeans. The moisture content in seeds is known to affect their physiological processes, including germination and longevity (Widajati, 2023). Moreover, the results conformed with the findings of Emam (*et al*., 2010), who noted that moisture retention is directly related to seed viability. Their research indicated that seeds with lower moisture content tend to exhibit better longevity and reduced deterioration rates. This is supported by the work of (Angaine *et al*., 2020), which highlighted that lower seed moisture content is advantageous for maintaining seed viability by minimizing lipid peroxidation and enhancing antioxidant enzyme activity. The significant moisture retention in groundnut and cowpea compared to soybeans may also reflect differences in their physiological adaptations to storage conditions. For instance, Widajati (2023) noted that cowpea seeds have been shown to tolerate higher moisture levels while still maintaining viability. However, the lower moisture retention in soybeans suggests a more sensitive response to storage conditions, which could be detrimental to their viability if not managed properly. The moisture retention test results underscore the importance of storage methods in influencing the moisture content of leguminous seeds, which in turn affects their viability. Groundnut and cowpea demonstrated higher moisture retention, which may pose risks for seed longevity, while soybeans exhibited lower moisture retention, indicating a potentially more stable storage profile. These findings highlight the need for careful consideration of storage conditions to optimize seed viability across different leguminous crops.

CONCLUSION

This study has shown that between the months of May and August the underground and hermatic storage methods are the most effective in preserving the viability and quality of cowpea and groundnut, except for soybean seeds which performed better in plastic container storage. These methods are recommended for farmers seeking to minimize post-harvest losses and improve crop yields. Future research should explore the long-term effects of these storage methods and evaluate their economic feasibility for widespread adoption.

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