EFFECT OF SOME NATURAL DORMANCY OVERCOMING TREATMENTS ON THE GERMINATION AND EARLY VIGOROUS GROWTH OF BAMBARA GROUNDNUT (*Vigna subterranean* L. Verdc)

Aim: To investigate the effect of some natural dormancy overcoming treatments on the germination and early vigorous growth of three varieties of Bambara nut.
Study design: Randomized block design.
Place and Duration of Study: Department of Plant Science and biotechnology University of Jos and Nursery of the Federal College of Forestry Jos, between August 2019 and February 2020.
Methodology: Three varieties of Bambara nut seeds were subjected to the following treatments; mechanical scarification, soaking in fresh cow milk, soaking in coconut milk, scarification plus fresh cow milk, scarification plus coconut milk and no treatment (control). These combinations were replicated three times and soaked for three different durations (24, 27 and 30 hours). The seeds treated in the above combinations were planted in designated nursery bags.
Results: The differences in the mean number of days after planting for germination to occur were not statistically significant for any of the varieties and preceding treatments including the control, for all the durations. The means number of shoots per plant were also not significantly different for the three durations with their respective varieties and treatments. Furthermore, the differences in the mean number of leaves at seven weeks after planting were not significantly different within all varieties and treatments, when compared to the control group for all three durations.
Conclusion: It is concluded in this study that; no significant benefit will be derived in pretreating Bambara nut seeds with mechanical scarification, fresh cow milk, or coconut milk treatment before sowing.

ABSTRACT

1. INTRODUCTION

The Bambara groundnut (Vigna subterranea (L.) Verdc.) is an underappreciated African Fabaceae species. It's known for its excellent nutritional value, resilience to poor soils, drought, and salt stress, as well as its capacity to produce peanuts [1]. It, unfortunately, remains less cultivated and poorly known in tropical Africa. Seed legumes, particularly Bambara groundnut, play a vital socioeconomic significance in tropical Africa, where they are a part of the culinary tradition [2]. Northeastern Nigeria and northern Cameroon are home to the

Bambara groundnut [3]. It is currently found in various parts of South America, Asia, and Oceania, in addition to Sub-Saharan Africa [4]. The wild Bambara groundnut's range now extends from Nigeria's Jos and Yola plateau to Cameroon's Garoua, and most likely beyond [5].

Bambara groundnut seeds are consumed raw, boiling, or roasted, and are also used to make cakes (koki, dough, pounded/crushed, etc.), stews, couscous, soups, and porridge, as well as a snack. Its seeds are utilised as pig and poultry feed, while its leafy stalks are used for livestock and traditional medicine [6]. Bambara groundnut is an important crop to consider for food security because of its high nutritional value and high level of vital amino acids [7].

The poor seed quality of most legumes is attributed to physical seed dormancy due to their characteristic hard seed coats. Albeit all types of dormancy involve metabolism suppression, physical dormancy commonly found in legumes is also characterized by a palisade or radially elongated cells in seeds causing hardness of seeds and impermeability. This hampers the passage of water to the embryo which is necessary for germination [8].

Seed dormancy occurs when viable seeds fail to germinate under ideal conditions, resulting in a temporary halt in growth and a reduction in metabolic activity. Most pre-sowing treatment procedures, including as physical, chemical, and mechanical scarification, degrade the seed coat for germination without always impacting the physiology of the seeds and seedlings in a consistent and quick manner, and without overcoming physiological dormancy of seeds [9]. There is a plethora of information concerning the effect of natural sources of hormones such as fresh cow milk and coconut milk on the germination of legume seeds compared to synthetic sources. Hormones are known to speed up the rate of germination of plant seeds. Major plant growth regulators (PGRs) significantly enhanced plant seed germination rate [10] and other growth parameters in different plants. Hormones help to relieve photo, thermo-, and physiological dormancy in seeds and also encourage mass production of seedlings for agroforestry programs [11]. Adelani et al. [12] reported that Coconut milk had 1.52 µg/ml, 0.023 µg/ml, and 0.092 µg/ml of (IAA) Indole Acetic Acid, (GA3) Gibberellic acid, and (ABA) Abscisic acid, respectively. Fresh cow milk had 0.012 µg/ml and 0.006 µg/ml for IAA and ABA, respectively.

However, there are significant obstacles to successful Bambara groundnut production, such as poor crop establishment due to physical seed dormancy. Hormones found in fresh cow milk and coconut milk have been reported to speed up the germination of plant seeds [12Although Bambara groundnut seeds are not marketed on international markets, they are an essential part of most people's diets in various West African countries, where they rank third after cowpea and groundnut in national production and consumption figures [13]. As the demand for this crop increases, there is the need for an increase in its production. therefore, overcoming the dormancy of Bambara groundnut using cheap natural means will go a long way because it possesses great potential for global food security as a drought-tolerant crop that is adapted to low-input agriculture. This research aims to find the most effective natural way(s) of breaking the seed coat dormancy of Bambara groundnut and the specific objectives are as follows:

1. To determine if mechanical scarification, fresh cow milk, coconut milk, scarification plus cow milk, or scarification plus coconut milk treatments will result in the fastest germination rate of Bambara nut.

2. To also determine which of the aforementioned treatments will give an early vigorous growth of Bambara nut.

2. MATERIAL AND METHODS

2.1 Experimental Site

A potted experiment was carried out during the early dry season (November) of 2019 at the nursery site of Federal College of Forestry Jos, Plateau State. This is located at the altitude of 1,159 m above sea level on latitude 09^0 57'N and longitude 08^0 53'E.

2.2 Source of Experimental Materials

Three varieties of Bambara nut seeds (cream, brown, and black) were obtained from the Newmarket at Jos North, Nigeria. The three varieties are among the seven established varieties of Bambara nut [14].

Fresh cow milk was procured from cattle breeders in Naraguta village Jos North Local Government Area, Plateau State. Fresh coconut balls, from which the coconut milk was produced, were purchased from coconut sellers in the Newmarket Jos north.

2.3 Measurement of Seed Size and Weight

Seed size: The circumferences of ten seeds of each of the three varieties of Bambara nut were measured and the average of each of them was computed. The measurement of the circumference around the middle of each seed was done using a micrometer screw gauge.

Seed weight: The weights of ten seeds of each of the three varieties of Bambara nut were measured and the average of each of them was computed. The measurement of the weight was done using a digital weighing balance.

2.3 Preparation of Experimental Materials and Experimental Design

Best looking Bambara nut seeds varieties (162) were selected and sorted out in three categories as cream, brown, and black colored. These three varieties each consisting of 54 seeds were labeled as V1, V2, and V3 respectively. The control and treatments groups were prepared as follows:

1. Control group: These are set of seeds with no treatment at all, and they were designated as T0.

2. Mechanical scarified group (immersed in water): These are set of seeds that were scarified and were designated as T1. Mechanical scarification was carried out using a sharp razor blade. A scar was made on two sides of each seed using a sharp razor blade carefully.

3. Cow milk treatment group: These are set of seeds that were treated with a 100 % concentration of 500 ml undiluted cow milk and were designated as T2.

4. Coconut milk treatment group: These are set of seeds that were treated with a 100 % concentration of 500 ml undiluted coconut milk, designated as T3. The preparation of coconut milk involved an equal mixture of coconut water and the liquid extract from crushed white fleshy coconut using an electric blender and a mesh.

5. Scarified and cow milk treatment group: This group includes seeds that were mechanically scarified and treated with fresh and undiluted cow milk, designated as T4.

6. Scarified and coconut milk treatment group. These are set of seeds that were mechanically scarified and treated with fresh and undiluted coconut milk and was designated as T5.

The three varieties were separately exposed to all treatments at three different durations (24, 27, and 30-hour) before planting. After treatment for the given durations, seeds were washed with distilled water and air-dried for 1 hour, and treated with fungicides (Dress force) to prevent seed from fungi contamination. In addition, treated seeds were sown in 4cm depth [15] in designated nursery bags, and these bags were laid out in the field applying the randomized block design method [16].

2.5 Observations and Data Collection

Field observations and data collection were carried out on the following parameters:

1. The germination rate: Seedling emergence was obtained by visual counting of the number of germinated seedlings from the first day of seedling emergence up to the fourth week.
2. The number of shoots: This was determined by counting the total number of shoots of each plant at 4, 5, 6 and 7 weeks after planting (WAP).
3. The number of leaves Per Plant: The number of leaves per plant was determined by physically counting the total number of leaves on each plant at 7 WAP.

2.6 Cultural Practice

An adequate amount of water was sprinkled on the pots regularly at two days' intervals every morning [16]. Proper weeding was done manually to remove the weeds spotted on the pots.

2.7 Analysis of Data

Data collected were analyzed using a two-way analysis of variance (ANOVA) test to check significant differences among the means. The differences between the means were compared and all results were considered statistically significant at $P < 0.05$.

3. RESULTS

3.1 Seed Size and Weight of Bambara Nut Varieties

The average sizes and weights of three varieties of Bambara nut seeds are given in Table 1.

Cream-colored variety is the largest and heaviest of all the varieties, followed by the brown-colored variety and black-colored variety in that order. The black color variety was the smallest and lightest of them all.

Table 1. Sizes and weights of three varieties of Bambara nut (*Vigna subterranea*) seeds.

VARIETY	SIZE (mm)	WEIGHT (g)
Cream color	11.06	1.31
Brown color	9.67	0.63
Black color	8.31	0.44

3.2 Germination Rate

There were no significant differences in the germination rate of all combined treatments when compared to the control group. Figures 1, 2, and 3 depict the combined effect of the germination of Bambara nut varieties with the different preceding treatments, for 24, 27, and 30-hour duration respectively. For the 24-hour duration, V1T4 (Cream-colored variety & scarification + cow milk treatment) took the highest number of days to germinate. The result of the 27 and 30-hour duration showed that V1T5 and V1T2 treatment combinations displayed the the highest number of emerged shoots. However, there were no actual significant differences ($P < 0.05$) in the number of emerged shoots from the different treatments groups, when compared with the control.

highest number of days before germination respectively.

3.3 Number of Shoots Per Plant

The combined effect of the pre-treated Bambara nut varieties on the number of emerged shoots for 24, 27, and 30-hour duration at seven weeks after planting are shown in figures 4, 5, and 6 respectively. The combined varieties and treatments V3T0, V3T5, and V2T3 from 24, 27, and 30-hour respectively showed

3.4 Number of Leaves Per Plant

The differences in the mean number of leaves for the three pre-treated varieties were not statistically significant ($P < 0.05$) for the three durations. Figures 7,8, and 9 display the mean number of leaves of Bambara nut varieties at seven weeks after planting, affected by different treatments and a 24, 27, and 30-hour duration respectively. The combined effects of V3TO, V3T5, V2T3 from 24, 27, and 30-hour duration respectively, showed the highest number of leaves. The other treatment combinations differ in the number of leaves from one duration to the other.

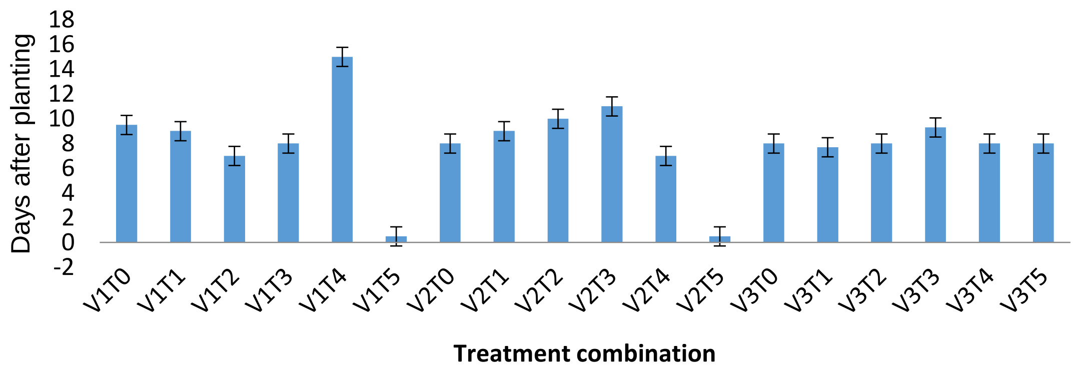

Fig. 1. The Days-After-Planting germination rate of the combined effects of pre-treated Bambara nut varieties at a 24-hour duration.

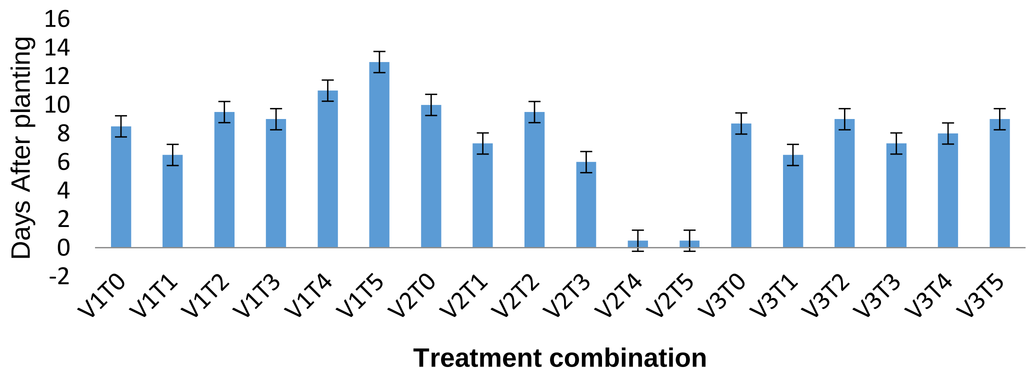

Fig. 2. The Days-After-Planting germination rate of the combined effects of pre-treated Bambara nut varieties at a 27-hour duration.

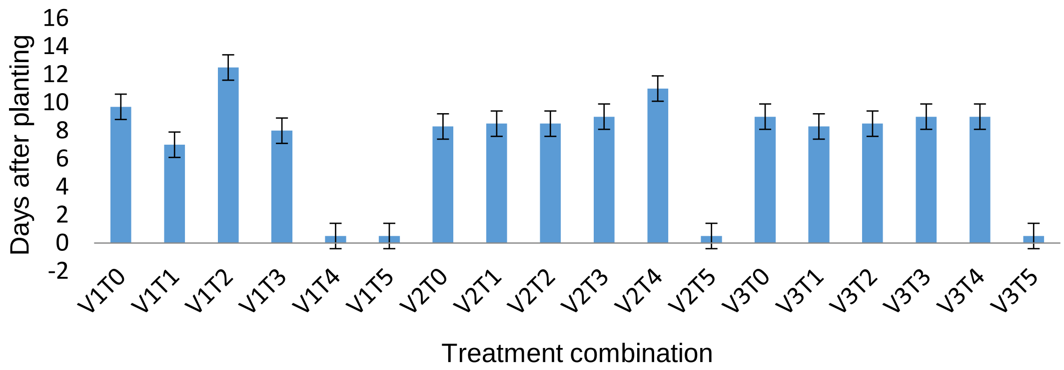

Fig. 3. The Days-After-Planting germination rate of the combined effects of pre-treated Bambara nut varieties at a 30-hour duration.

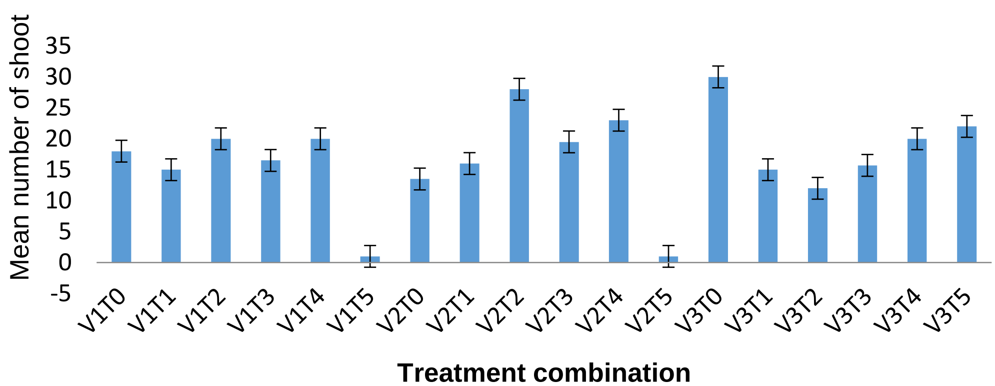

Fig. 4. Seven Week After Planting (WAP) combined effects of the pre-treated Bambara nut varieties on the number of emerged shoots for the 24-hour duration**.**

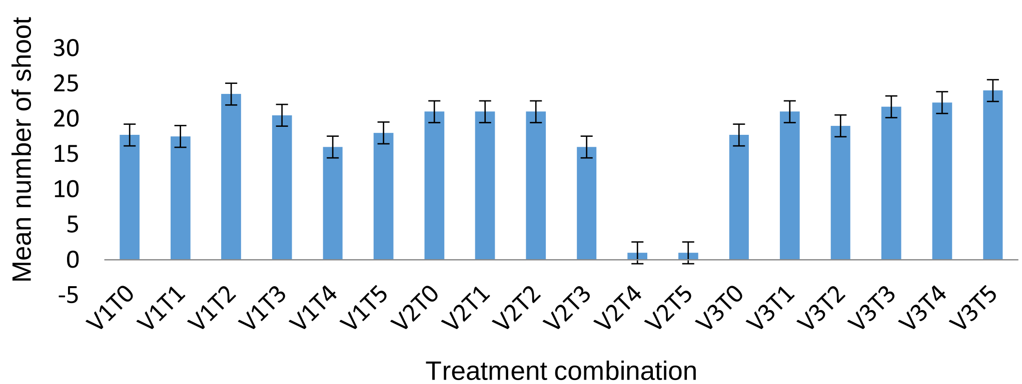

Fig. 5. Seven Week After Planting (WAP) combined effects of the pre-treated Bambara nut varieties on the number of emerged shoots for the 27-hour duration**.**

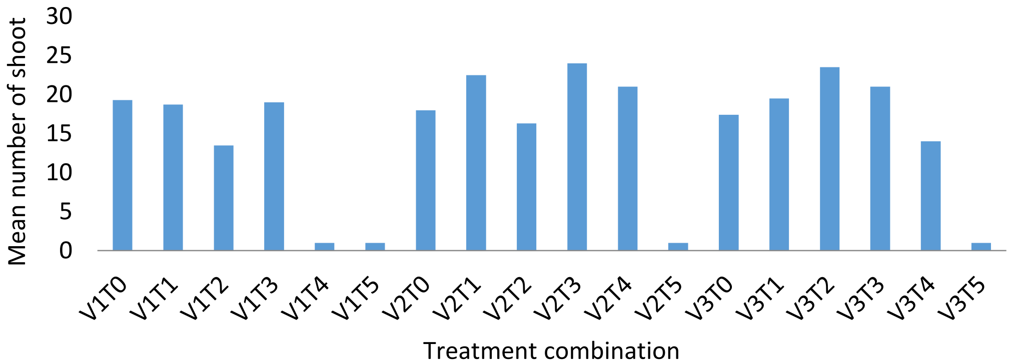

Fig. 6. Seven Week-After-Planting (WAP) combined effects of the pre-treated Bambara nut varieties on the number of emerged shoots for the 30-hour duration**.**

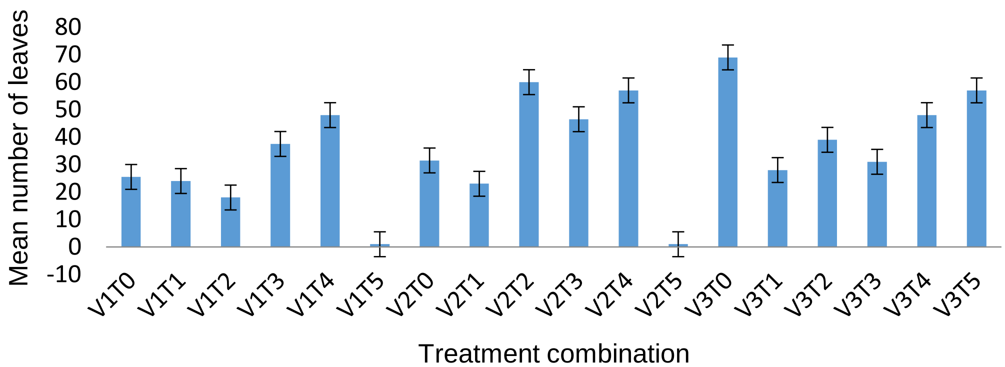

Fig. 7. The combined effects of the pre-treated Bambara nut varieties on the number of leaves at 7 Week-After-Planting, for a 24-hour duration.

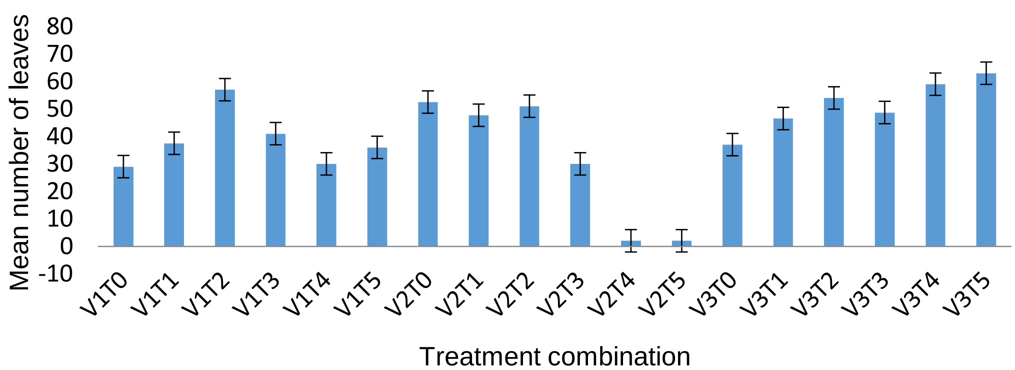

Fig. 8. The combined effects of the pre-treated Bambara nut varieties on the number of leaves at 7 Week-After-Planting, for a 27-hour duration

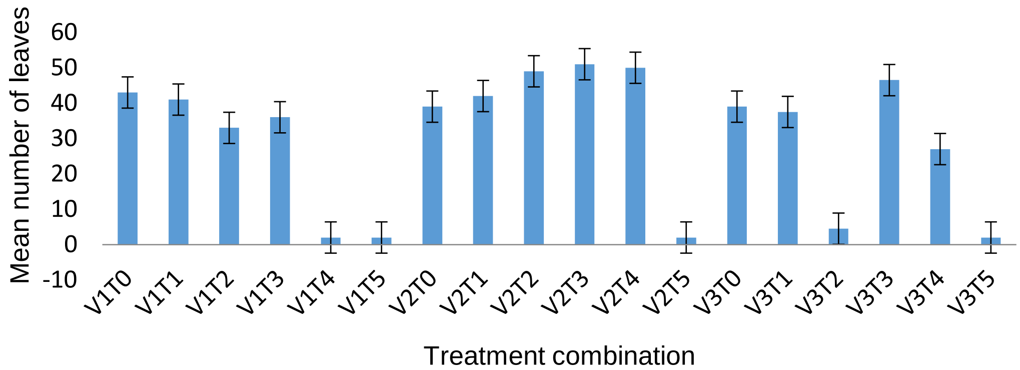

Fig. 9. The combined effects of the pre-treated Bambara nut varieties on the number of leaves at 7 Week-After-Planting, for a 30-hour duration

KEY

V1T0- Cream colored variety + no treatment (control)

V1T1- Cream colored variety + scarification

V1T2- Cream colored variety + fresh cow milk treatment

V1T3- Cream colored variety + coconut milk treatment

V1T4- Cream colored variety + scarification & cow milk treatment

V1T5- Cream colored variety + scarification & coconut milk treament

V2T0- Brown colored variety + no treatment (control)

V2T1- Brown colored variety + scarification

V2T2- Brown colored variety + fresh cow milk treatment

V2T3- Brown colored variety + coconut milk treatment

V2T4- Brown colored variety + scarification & cow milk treatment

V2T5- Brown colored variety + scarification & coconut milk treatment

V3T0- Black colored variety + no treatment (control)

V3T1- Black colored variety + scarification

V3T2- Black colored variety + fresh cow milk treatment

V3T3- Black colored variety + coconut milk treatment

V3T4- Black colored variety + scarification & cow milk

V3T5- Black colored variety + scarification & coconut milk

4. DISCUSSION

Since there were no significant differences in the recorded treatments for all the durations, it can be postulated that these factors did not influence the rate of germination, mean number of shoots, and the mean number of leaves in all the varieties of Bambara nut seeds used. This result is contrary to the report of Adelani et al., [12] who reported that the germination percentage value of *Balanites aegyptiaca* seeds increased with increasing hydro-priming hours. It is possible that there were no differences in performance of various parameters as par soaking durations because the minimum time of 24 hours used in this experiment was too long.

The non-significant differences in all pre-treated varieties affecting the germination rate, the mean number of shoots, and the mean number of leaves is most likely because of the similarity in their genetic make-up. This is buttressed by Linnemann et al., [14] who reported no significant difference between the cultivated genotype forms of Bambara nut.

Despite the fact that there were no significant differences in the mean number of days after planting for germination rate, a careful study of the data (fig 1,2 1 and 3) showed that black colored variety which was the smallest in size and lightest in weight (Table 1) germinated faster and had the highest mean number of leaves and shoots (fig. 4, 5, 7 and 8) among the three varieties. This result is in tandem with that of Smykal et al. [17] who reported that, dark colored seed have greater germination vigor in terms of germination and seedling establishment. This also agrees with previous studies of Sinefu [18] and Modi [19] that focused on plain Bambara nut colors. They reported that, dark colored seeds to perform better compared to light-colored seeds because of the presence of tannins (and specifically polyphenols) in dark-colored seeds. Polyphenols exhibit antioxidant properties and act as defense mechanism against plant stress and could therefore confer a degree of stress tolerance during germination [20].

The fact that all the preceding treatment irrespective of variety or socking durations germinated and grew, shows that none of the treatment or treatment combinations was hazardous to the germination rate and growth of the seeds compared to the control group.

There were no significant differences in the mean germination rate for all the treatment and treatment combinations (including control) but when the performance of these treatments were looked at critically against control, it can be observed that control was poor under the 24 hours' and 27 hours' duration. This implies that the preceding treatments which were all in one liquid form or the other (presence in liquid form) had some influence on the germination rate of the seeds. These liquids would have softened the seed coat of the plant which enhanced quick germination. This agrees with Hossain et al. [21] who reported that seeds with hard, solid, impermeable seed coat were noted to establish germination after preceding treatments. However, braking of dormancy varies from species to species. The softening of the seed coat may also enhance metabolic activities within the embryo. This conforms with the report of Omoakoh et al [22] who stated that a very widespread cause of seed dormancy is the presence of hard seed coats which prevent the entrance of water, exchange of gases and/ or mechanically constrained the embryo.

Concerning the natural sources of hormones (fresh cow milk and coconut milk) performance against control on the germination rate, it could be observed that the fresh cow milk produced a better germination rate after long soaking duration (27hrs and 30hrs), by which time the seed would have properly imbibed the milk. Fresh cow milk has been reported to contain hormones such as Indole acetic acid and Abscisic acid [22]. Hormones are known to speed up the rate of germination of seeds and other growth parameters; this is probably the reason why the influence of cow milk and coconut milk on the number of shoots when viewed against control were statistically the same at all the early growth stages. Within a certain concentration range, natural plant hormones stimulate germination and plant growth, but beyond that, the seed becomes insensitive and growth is impeded [23]. As the plants grew older, the effect of the hormones on number of leaves especially for the 27 hours soaking when compared to control appears noticeable (fig. 8). Growth hormones are organic substances besides nutrient in plant, synthesized in plant causing alteration in their cellular metabolism [24].

5. CONCLUSION

Since there were no significant effects of the pre-treated varieties of Bambara nuts exposed at different durations when compared to the control, it can be concluded that no significant benefit will be derived in pretreating Bambara nut seeds with either fresh cow milk, coconut milk, or mechanical scarification before sowing.

RECOMMENDATION

Further research using shorter time duration and lesser concentration of fresh coconut milk and cow milk in overcoming dormancy of Bambara nut is recommended.

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