Original Research Article

Effect of Different Seed Treatment Methods on the Germination of *Senna occidentalis* L. 1829 (Coffee Senna) in Sokoto, Sudan Savanna Ecosystem, Nigeria

ABSTRACT

Background and Objective: Seed treatment is an act of subjecting a seed into water, chemical or heating medium often to break its dormancy and enhance its embryo to germinate into a seedling within the shortest time possible. Therefore, seed dormancy has remained the greatest challenging issue in seedling production for any reason in plant production programme the world over. The aim of this study was to determine the effect of different seed treatment methods on the germination of *Senna occidentalis* L. 1829 (Coffee Senna) in Sudan Savanna ecosystem, Nigeria. **Materials and Methods:** Hence, three (3) in vitro germination tests at different levels were conducted at Agricultural Chemical Laboratory of the Usmanu Danfodiyo University Sokoto, for 36 days period to tackle seed dormancy difficulties of *S. occidentalis*. This was with the view to providing some basic information on the matter due to the socioeconomic nutritional potentials of the plant to man in the Sudano-Sahelian ecosystem. **Results:** The study determined 2 days soaking (83.00%), 15 minutes hot water (76.65%) and 10 minutes chemical (H_2SO_4) (90.02%) methods as the best germination tests for the seed germinability of *S. occidentalis* and the results were reported in percentages. The field experiment in turn, revealed that germination percentages of *S. occidentalis* seeds obtained were 45.78% at Fadama habitat and 35.56% at upland location, respectively. **Conclusion:** Therefore, the best methods determined are recommended for practice in the seedling production of the study species and its allied.

KEYWORDS

Seed Treatment; Germination; *S. occidentalis*; Sudan Savanna; Laboratory/Field Experiment.

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INTRODUCTION

S. occidentalis (L.) (Synonyms: C*assia occidentalis* L. and *Ditremexa occidentalis* L.) belongs to the family Fabaceae, commonly referred to as the bean family. The common names of this plant include Senna Weed, Coffee Senna, Septic Weed, Ant Bush and Arsenic Bean with other vernacular names as "Sanga – Sanga" in Hausa and "Sanga-Sangahi" in Fulfulde. Literature searches revealed that these species of plant have not been domesticated, but grow in the wild as weed but the contributions of the plant and its leaves as medicinal and dietary food vegetables to the populace in Sokoto (the study area) has made the species very popular in the local communities of Sudan Savanna, North-Western, Nigeria[1]. This assertion was supported by Bulus *et al.*[2] that most people are now incorporating the non-conventional (wild) food plants in their

diets, to provide not only nutrients but also traditional treatment for various ailments. Tukan *et al*.[3] have reported that over the last two decades, wild or semi-wild plants are nutritionally important because of higher vitamins, minerals, essential fatty acids and fibre contents. Some of the plants also enhance taste and colour in diets[4]. High protein content was also reported in some wild vegetables in Bostwana[5].

Coffee Senna is a tropical and sub-tropical plant occurring more natural than planted in both upland and Fadama areas of the study area[6]. It is commonly found in fertile cultivated meadows and river or gully flow areas recognized and preserved for its medicinal value than nutritional contribution to the inhabitants of the study area. All its parts – mainly roots, stems and leaves, flowers and fruits are used in the preparation of traditional medicines either singly or in concoction with other parts of other plants for treatments of different ill-health conditions. The plant is used in the study area for the treatment of typhoid fever, malaria, cough, throat inflammation, asthma and snake bites. The plant is also used in treating dysentery, hemorrhoids, constipation, abdominal problems, general body weakness and convulsion, prepared in form of pap. It is used to check chest pain and liver detoxification[7, 8].

The leaves and sometimes with flowers are cooked specially in pots and used as vegetable food. While in another case, the leaves are harvested, cooked, dried, stored and later mixed with grounded powder of cereal crops such as rice, guinea corn and maize, steamed on pots and used as food in African societies especially in dry and early rainy seasons when cereal staples are in short supply. The seeds as well are roasted and made into a coffee - like drink, tea or food additives in the study area. The plant is less grazed by animals. It provides shelter to many small animal populations such as ants, insects, reptiles, and the like. It also supports soil with nutrients in the study area. The plant stalks when dry are used as fuel wood for cooking in rural houses. The plant is scarcely and arbitrarily propagated sporadically and by direct seeding planting on land during rainy season mostly, talk less of dry season in the study area[1, 6].

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It is against this background that the study was designed to investigate the effect of different methods of seed treatment on the germination of *S. occidentalis* using different means and times at different conditions and locations. This has become necessary as a case study to provide additional information on the seed germinability potentials of the selected wild plant in the study area so as to enhance its possible domestication as well as its conservation and hence increase in plant resources of food security in nature.

MATERIALS AND METHODS

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Study Area/Site

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The study site was the Agricultural Chemical Laboratory, Fadama land and upland locations in Usmanu Danfodiyo University, Sokoto located at the Northern part of Sokoto city in Wamakko Local Government Area, Sokoto, Sokoto State, North-Western Nigeria (05º 10E - 05º 12^{1}E Longitude and 13º 04 0N – 13º 06 40N Latitude). The altitude is 308m above sea level[9, 10, 11].

Seed Collection

Comment [U9]: ?

Seeds of *S. occidentalis* (L.) were collected by handpicking fully ripe pods from parent plants. The pods were then crushed manually, and good seeds were sorted out, washed to removed dirt

and other foreign materials, sun-dried and packed in large paper envelope, stored under metal cabinets at room temperature (28±2ºC) using floatation method of extraction in which viable seeds sank to the bottom of water while the unviable or damaged ones floated[12, 13].

Seed Dormancy Tests

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Three (3) seed treatment methods were tried for all the seeds of the plant species to determine the best method that gives higher germination rate of the seeds under room temperature (28±2ºC) in the laboratory before field sowing in beds. The methods are:

Water Treatment

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Viable seeds were placed in ordinary collected tap water under room temperature (28±2ºC) for different time periods (treatments) ranging from one (1) day, 2 and 3 days. Seeds not soaked in water were the control. After soaking, the seeds were rinsed in running water and put in 12 petri-dishes measuring 9cm each, with soaked filter paper for germination. Each treatment was therefore replicated thrice, i.e. 10 seeds were soaked for each treatment and the control = 10 x 3 x 4 = 120 seeds[13].

Hot Water Treatment

Comment [U12]: ?

Viable seeds were placed in muslin cloth and dipped in boiling water (in a beaker) and allowed to stand for 5 minutes**,** removed and cooled in tap water at room temperature (28±2ºC). The seeds were placed in 12 petri-dishes measuring 9cm each, with soaked filter paper for germination. The same treatment was repeated for 10 and 15 minutes, respectively, replicated thrice. Untreated seeds not dipped in hot water were the control, i.e. 10 x 3 x 4 = 120 seeds[14].

Acid Treatment

Comment [U13]: ?

Viable seeds were soaked in Sulphuric acid (H_2SO_4) for periods of time, varying from 5, 10 and 15 minutes, respectively. The seeds were washed in several changes of water and placed in 12 petri-dishes of 9cm each, with soaked filter paper for germination at room temperature (28±2ºC)[15]. Each treatment was replicated thrice with untreated seeds as control.

All the treatments in the three methods were watered with distilled water at 12 hours interval daily according to the need, up to the end of the experimental period (36 days).

Experimental Design and Site Selection

Comment [U14]: ?

The experimental design for this study was complete randomized block design (CRBD). 7/7 meters Fadama and upland sites were obtained at Kwalkwalawa Fadama and Usmanu Danfodiyo University, Sokoto Botanical Garden and used for direct seeding planting in beds.

Beds Preparation and Layout

Comment [U15]: ?

Three (3) beds were prepared for sowing the seeds of the plant species. Cow dung manure was applied to each of the beds and mixed thoroughly before planting to enhance moisture retention in the beds. The size of each bed was 1.8/1.2 meters with 50cm spacing in between the beds for easy watering and weeding.

Seed Rate, Planting and Spacing

Viable seeds from the seed lot kept in metal cabinets in paper envelops for all the study plant species were sorted out and planted in the beds at each of the two locations (Fadama and upland). 24 holes in 6/4 rows were dug and planted at 1.5cm depth. 5 seeds per hole of 30cm inter and intra-row spacing were sown, giving a total of 120 seeds per bed sown.

Watering Regimes and Weeding

The beds planted with seeds were watered with watering cans twice daily for five (5) weeks until seedlings become established under observation during the harmattan season. Weeding was regularly conducted based on the need.

Data Analysis

Data generated for this study were collected on daily basis and analysed using percentages in tables.

RESULTS

Laboratory Experiment Germination Test Results

The laboratory germination test results were reported based on ordinary water (soaking) treatment method; hot water treatment; and chemical (H_2SO_4) treatment for the seeds of *S. occidentalis* (Tables 1 - 3) respectively as follows:

Ordinary Water Treatment

Results in Table 1 indicates that at the end of the 36 days observation period, the unsoaked seeds (control) and seeds soaked in ordinary water for two (2) days commenced germination on the 5th day and germination for all the treatments ceases on the 23rd day of the observation period except that of the control which ceases on the 24th day. The highest daily % germination of 10.00% was recorded only in both 2- and 3-days treatments with highest occurrence in 2 days treatment. This had led the 2 days treatment to be the most effective ordinary water treatment method accounted for the highest percentage (%) seed germinability of 83.00%, followed by both 1- and 3-days treatments (70.00%) with control being the least (56.64%).

Table 1: Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Treated at Different Times (Days) Using Ordinary Water (Soaking) Treatment Method

Days After Sowing	Seed Treatment Times (Days)		
	Control	1 Day	2 Days	3 Days
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	3.33	0.00	3.33	0.00
6	0.00	0.00	0.00	0.00
7	6.67	3.33	0.00	6.67
8	3.33	6.67	3.33	6.67

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9	0.00	6.67	0.00	10.0	
10	6.67	3.33	10.0	3.33	**Daily % Germination**
11	3.33	3.33	0.00	10.0	
12	3.33	3.33	10.0	6.67	
13	3.33	3.33	10.0	0.00	
14	6.67	6.67	0.00	10.00	
15	0.00	0.00	3.33	3.33	
16	3.33	6.67	0.00	3.33	
17	0.00	3.33	10.0	3.33	
18	3.33	0.00	6.67	0.00	
19	3.33	6.67	0.00	3.33	
20	3.33	6.67	3.33	0.00	
21	0.00	3.33	6.67	0.00	
22	0.00	3.33	0.00	0.00	
23	3.33	3.33	6.67	0.00	
24	3.33	0.00	6.67	3.33	
25	0.00	0.00	0.00	0.00	
26	0.00	0.00	0.00	0.00	
27	0.00	0.00	0.00	0.00	
28	0.00	0.00	0.00	0.00	
29	0.00	0.00	0.00	0.00	
30	0.00	0.00	0.00	0.00	
31	0.00	0.00	0.00	0.00	
32	0.00	0.00	0.00	0.00	
33	0.00	0.00	0.00	0.00	
34	0.00	0.00	0.00	0.00	
35	0.00	0.00	0.00	0.00	
36	0.00	0.00	0.00	0.00	
%Germination	**56.67**	**70.00**	**83.00**	**70.00**	

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Hot Water Treatment

Germination results of the seeds of *S. occidentalis* treated with hot water medium (Table 2) revealed that germination for both control and 10 minutes commenced on the 5th day after treatment but ceases on the 20th day for the control, 23rd day for 10 minutes treatment and on 24th day for 5- and 15-minutes treatments with highest daily % germination of 10.00% occurring in all the treatments including the control. Highest % seed germinability of 76.65% was recorded at 15 minutes treatment.

Table 2: Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Treated at Different Times (Minutes) Using Hot Water Treatment Method

Days After Treatment	**Seed Treatment Times**

	Control	(Minutes) 5 Minutes	10 Minutes	15 Minutes	
1	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	
3	0.00	0.00	0.00	0.00	
4	0.00	0.00	0.00	0.00	
5	3.33	0.00	3.33	0.00	
6	0.00	0.00	0.00	0.00	
7	3.33	0.00	0.00	3.33	
8	0.00	0.00	0.00	0.00	
9	0.00	0.00	6.67	3.33	
10	10.0	0.00	6.67	13.33	**% Daily Germinatio**
11	3.33	0.00	0.00	3.33	
12	0.00	0.00	3.33	0.00	
13	3.33	6.67	10.0	6.67	
14	6.67	3.33	6.67	20.0	
15	3.33	10.0	0.00	0.00	
16	0.00	6.67	3.33	0.00	
17	3.33	3.33	3.33	10.0	
18	0.00	6.67	3.33	3.33	
19	3.33	6.67	6.67	3.33	
20	3.33	6.67	3.33	0.00	
21	0.00	6.67	3.33	6.67	
22	0.00	0.00	3.33	0.00	
23	0.00	3.33	0.00	3.33	
24	0.00	3.33	0.00	0.00	
25	0.00	0.00	0.00	0.00	
26	0.00	0.00	0.00	0.00	
27	0.00	0.00	0.00	0.00	
28	0.00	0.00	0.00	0.00	
29	0.00	0.00	0.00	0.00	
30	0.00	0.00	0.00	0.00	
31	0.00	0.00	0.00	0.00	
32	0.00	0.00	0.00	0.00	
33	0.00	0.00	0.00	0.00	
34	0.00	0.00	0.00	0.00	
35	0.00	0.00	0.00	0.00	
36	0.00	0.00	0.00	0.00	
% Germination	**43.31**	**63.34**	**63.32**	**76.65**	

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Chemical Treatment Method

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The seed germination of *S. occidentalis* for the chemical (H_2SO_4) treatment method commenced three days after treatment for the 10 minutes treatment only (Table 3). Germination for the control and 15 minutes treatment commenced simultaneously on the 5th day, while that of 5 minutes commenced on the 9th day after treatment. Germination began to cease on the 17th day after treatment for the control and 15 minutes treatment; 20th day for the 10 minutes treatment and 22nd day for the 5 minutes treatment with the highest daily % germination of 13.33% occurring in 15 minutes treatment. 10 minutes treatment had the highest % seed germinability of 76.68%, followed by 5 minutes (63.34%), then 15 minutes treatment (53.33%) and control was the least (50.00%).

Table 3: Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Treated at Different Times (Minutes) Using Chemical (H_2S0_4) Treatment Method

Days After Treatment	Seed Treatment Times (Minutes)				
	Control	5 Minutes	10 Minutes	15 Minutes	
1	0.00	0.00	0.00	0.00	
2	0.00	0.00	0.00	0.00	
3	0.00	0.00	0.00	0.00	
4	0.00	0.00	3.33	0.00	
5	3.33	0.00	0.00	3.33	
6	0.00	0.00	0.00	0.00	% Daily Germination
7	6.67	0.00	0.00	0.00	
8	3.33	0.00	6.67	3.33	
9	6.67	3.33	6.67	13.33	
10	3.33	6.67	0.00	6.67	
11	6.67	6.67	6.67	6.67	
12	3.33	0.00	16.67	10.0	
13	6.67	16.67	6.67	0.00	
14	3.33	0.00	6.67	3.33	
15	0.00	6.67	6.67	6.67	
16	3.33	13.33	3.33	0.00	
17	3.33	0.00	6.67	0.00	
18	0.00	6.67	6.67	0.00	
19	0.00	0.00	3.33	0.00	
20	0.00	0.00	3.33	0.00	
21	0.00	0.00	0.00	0.00	
22	0.00	3.33	0.00	0.00	
23	0.00	0.00	0.00	0.00	

24	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
% Germination	**50.00**	**63.34**	**90.02**	**53.33**

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Field Experiment Germination Test Results

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Table 4 had presented the germination test results of the field experiment for the seeds of *S. occidentalis* treated for 10 minutes with H_2SO_4. Germination was presented as daily percentage germination and percentage germinability of the three replicate blocks of the study species. Germination of the seed of *S. occidentalis* commenced on the 7th day after treatment and sowing but ceases until the 16th day after treatment and sowing when it consecutively continued and ceases on the 35th day of the experimental period with highest daily percentage of 36.11% occurring on the 22nd day of the experimental period and of 45.78% germinability for Fadama location. Results for the germination of the seeds of *S. occidentalis* presented in Table 4 were for those seeds treated with chemical treatment method for 10 minutes. *S. occidentalis* seeds commenced germination on the 5th day after treatment and sowing and ceases on the 35th day of the experimental period with the highest daily percentage germination of 16.67% occurring on the 22nd - 24th day of the experimental period and 35.56% seed germinability for upland location.

Table 4: Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Sown at Fadama and Upland Locations, Treated at 10 Minutes Time Using Chemical (H_2SO_4) Treatment Methods

Days After Sowing	Upland Treatment	Fadama Treatment
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	1.39	0.00
6	0.00	0.00
7	0.00	1.39
8	2.78	0.00

9	0.00	0.00	
10	1.39	0.00	
11	1.39	0.00	
12	0.00	0.00	
13	5.56	0.00	
14	0.00	0.00	
15	2.78	0.00	
16	5.56	4.17	
17	5.56	2.78	
18	6.94	6.94	
19	11.11	9.72	
20	8.33	22.22	
21	6.94	23.61	
22	12.50	36.11	
23	16.67	15.28	
24	16.67	25.00	
25	0.00	6.94	
26	16.67	5.56	
27	8.33	6.94	
28	13.89	9.72	
29	1.39	5.56	
30	0.00	6.94	
31	2.78	4.17	
32	11.11	2.78	
33	8.33	16.67	
34	4.17	15.28	
35	2.78	1.39	
36	2.78	0.00	
%Germination	**35.56**	**45.78**	

Daily % Germination

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DISCUSSION

Laboratory Experiment: Ordinary Water Treatment

Comment [U29]: ?

The observation that the trend of the results (Table 1) showed steady increase in the daily percentage germination and percentage germinability values from 1 - 3 days pretreatments in comparison with control treatment and statistically non-significant agreed with reports of Hossain *et al.*[16]; Eghoruba *et al.*[17]; and Feike *et al.*[18] that seeds soaked in water overnight before planting showed highest seed germination in comparison with any method of breaking seeds dormancy in most plant species. This finding was supported by Anonymous[19] report that soaking of seed in water is used to tackle all the different types of dormancy by modifying hard seeds coat, removing inhibitors and softening the seeds which ensures adequate absorption of water by the seeds. The continued increase in germination percentage due to increase in the number of days of pretreatment methods showed clearly the relevance of moisture increase to softening the

hard seed coat of the study species, a reason why may be Awodola[20] reported that soaking of seed in water is the most simplest widely used pre-germination treatments for breaking seed dormancy in the plant world. This finding implies that pretreatment of seeds with ordinary water before sowing decreases germination in the seeds of *S. occidentalis*. Thus, soaking of seeds in water for breaking dormancy is not required for the seeds of *S. occidentalis.*

Laboratory Experiment: Hot Water Treatment

Comment [U30]: ?

The results of Table 2 simultaneously observed to increase steadily from 5 - 15 minutes with hot water treatment in the daily percentage germination but non-significant statistically and higher than the control value somehow in *S. occidentalis* agreed with reports of Valenti *et al.*[21]; Davis *et al.*[22]; Mackay *et al.*[23]; Mackay *et al.*[24] and Centenera *et al.*[25] that seeds immersed in 1 - 10 times volume of boiling water (100ºC) improved germination. The observation also agreed with finding of Duguma *et al.*[26] that seeds treated with hot water at 100ºC increased germination with increasing ratio of seeds to water in comparison with control treatment. But this observation had disagreed with report of Sasaki[27] that hot water treatment was less effective, possibly a reason why control treatment percentage germinability for hot water treatment was quantitatively higher than 5 - 15 minutes treatment at 15 minutes period being the best treatment for breaking seed dormancy for higher germination in seeds of *S. occidentalis*.

Laboratory Experiment: Chemical Treatment

Comment [U31]: ?

The findings of higher percentage germinability presented in Table 3 as for 5, 10 and 15 minutes chemical treatment method in comparison with control even though the result is not significant statistically agreed with report of Anonymous[19] that chemical scarification of seeds increase the percentage of seeds that germinate. The result also agreed with report of Moussa and Margolis[28] that chemical treatment of hard seed coat facilitate and has increased the germination rate of many seeds with hard and water impermeable seed coats. This might be a reason why 10 minutes chemical treatment showed high germination rates than all the other treatments with control inclusive in *S. occidentalis* but control proved the best as per Table 3. This finding implies that chemical treatment was the best for *S. occidentalis* than the other treatments.

Field Experiment: Fadama and Upland Habitats

Comment [U32]: ?

The observation that at Fadama habitat, *S. occidentalis* (45.78%) had quantitatively higher percentage germinability than upland (35.56%) as in Table 4 disagreed with report of Sasaki[27] that hot water treatment was less effective for breaking seeds dormancy, rather it further confirmed that hot water treatment was a successful medium for treating seeds of *S. occidentalis* for direct sowing into the soil at Fadama location.

CONCLUSION

Comment [U33]: CONCLUSION AND RECOMMENDATIONS

Results of the laboratory experiments revealed that 2 days ordinary water treatment as well as 15 minutes hot water treatment and 10 minutes chemical treatment methods for *S. occidentalis* seeds were the best methods which gave 83.00%; 76.65%; and 90.02% percentage seed germinability. Field experiment in turn revealed 45.78% at Fadama habitat; and 35.56% in *S. occidentalis* at upland locations, respectively. Effect of seed dormancy was observed on the germination of the seed sown in both Fadama and upland locations; hence, some could not germinate in the field

(during dry season) until during the subsequent rainy season. But all things being equal, the required stands of the study species at each location were from the experiment.

RECOMMENDATIONS

Comment [U34]: ?

To amalgamate the findings of this research on seed germinability of *S. occidentalis* for gains of the study, the following were recommended:

- For high germination of the seeds of the study species in the field, 10 minutes chemical (H_2S0_4) treatment method was recommended as the best method for seed pretreatment.
- Sowing the seeds of the study species into the field should be carried out during the rainy season; hence, some seeds that failed to germinate during the dry season, germinated at the early rainy sub-season in this study.
- Therefore, cultivation of the study species at any sub-season is hereby recommended to the farmers and for scientific researches especially at Fadama location.
- For further study and ensuring food security, similar research should be conducted on other similar species to bring out more of their potentials for domestication and conservation as well as enhancing more sources of food supply in the universe and advancement of knowledge.

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