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# CONTACT EFFECT OF *Jatropha curcas* L. EXTRACTS FOR THE CONTROL OF *Callosobruchus subinnotatus* (Pic) ON STORED BAMBARA NUT, *Vigna subterranea* (L.) VERDCOURT

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## ABSTRACT
The research was conducted in the year 2017 at the Entomology Laboratory of the Department of Crop Protection, Bayero University Kano to assess insecticidal properties of *Jatropha curcas* L. leaf and seed powders on *Callosobruchus subinnotatus* (Pic) infesting stored bambara nut, *Vigna subterranea* (L.) Verdcourt. The study aimed at comparing the effectiveness of the product with conventional chemical insecticide (pirimiphos-methyl 2%). Factorial experiment of 2×2×2 levels (leaf and seed powders at the rates of 0.0 and 0.5 g, with and without addition of the synthetic chemical at 0.01 g/20 g bambara nut seed) were laid out in a completely randomized design and replicated three times. Results obtained indicated positive contact effect of Jatropha leaf/seed extracts on adult bruchids. The results also showed strong repellent both singly and combined treatments although better results were obtained on leaf and seed combination with increase with the time of exposure. In conclusion, appreciable level of protection on bambara nut seeds was achieved using seed powder of *J. curcas*. Therefore, it is recommended that for effective management of *C. Subinnotatus* infesting bambara nut, farmers could use 1.0 g seed powder on 20 g bambara nut seeds.
**Keywords:** *Callosobruchus subinnotatus*, bambara nut, *Jatropha*, contact, repellent

## INTRODUCTION
Grain legumes are important major sources of plant protein and fat in tropical countries. The industrial applications of these depend on the knowledge of their nutritional importance and functional properties (Aremu *et al*., 2006a). Many workers (Onwuliri and Obu, 2002; Aremu *et al.*, 2006b) have reported the compositional evaluation, functional properties, amino acids and protein solubility of legume flours. In terms of dietary balance, grain legumes or pulses contain more proteins than cereals and about ten times as much protein as most root and tuber crops (FAO, 2016). They serve as a cheap source of protein to a large proportion of the population in poor countries of the tropics (Purseglove, 1968). For rural and urban dwellers in developing countries, especially where animal protein is scarce and/or expensive, grain legumes serve as a source of protein to a large proportion of the population by being the least expensive and non-processed protein source (Rachie and Silvestre, 1997).

An indigenous African legume, bambara nut, *Vignasubterranea*(L.) Verdcourt (Fabales: Fabaceae) whose origin reportedly extend from Jos in Plateau State and Yola in Adamawa State of Nigeria to Garoua in Cameroon (Goli, 1995), has been cultivated for centuries in sub-Saharan Africa, mainly in the semi-arid regions and has in the past contributed to food security especially for small holder farmers (Azam-Ali *et al*., 2001; FAO, 2001; Mwale *et al*., 2007). Bambara nut has the potentials to provide a balanced diet in areas where animal protein is scarce and/or expensive and where cultivation of other legumes is not feasible due to low rainfall (Quaye and Kanda, 2004). Bambara nut compares favourably in nutritional status with other well-known and highly commercialized beans and it is a good source of fibre, calcium, iron and potassium (Quaye and Kanda, 2004; Hillocks *et al.*, 2012). Sharing a high nutritive value with other widely consumed legumes, bambara nut also has an appealing flavour which is reflected in its demand from small local and niche markets (Hillocks *et al*., 2012).

This underutilized legume grown in the Northern part of Nigeria was once said to be the third most important grain legume after groundnut (*Arachis hypogea* L.) and cowpea (*Vigna unguiculata* Walpers). Its compact habit seems to be an adoption to growing in hot, windy environment (Doku and Karikari, 1971; Duke, 1981). Mainly grown by women for the sustenance of their families, bambara nut was cultivated in extreme, tropical environments by peasant farmers without access to irrigation and/or fertilizers and with little guidance on improved practices (Mwale *et al*., 2007). Bambara nut yields well under conditions which are not favourable for groundnut (*A. hypogea*), maize (*Zea mays* L.) and even sorghum (*Sorghum bicolor*(L.) Moench) (Brink and Belay, 2006). Its drought tolerance makes it a useful candidate in climate change adaptation strategies (Hillocks *et al*., 2012).

The plant is also used in traditional medicines as a remedy for many ailments of livestock and human beings, which include helminthosis, schistosomiasis, leprosy, diarrhoea and psoriasis (Burkill, 1995). However, in spite of the nutritional values and usefulness of bambara nut, the crop is reported to be threatened by the devastating activities of stored products pests, notable among them is, *Callosobruchus subinnotatus* (Pic.) (Lale and Vidal, 2003).

## MATERIALS AND METHODS

### Experimental Site

The experiment was conducted in 2018 in the Entomology Laboratory of the Department of Crop Protection Faculty of Agriculture, Bayero University, Kano, Kano State, Nigeria. The State is located on 11°59'47"N, 8°31'0"E (Kowal and Knabe, 1972).

### Preparation of Bambara Nut Seeds

Fifty Kilogrammes (50 kg) of unshelled, pest free bambara nut, cream/brown eye variety seeds were purchased at a local market in Dambatta Local Government Area, Kano State. The seeds were decorticated manually. Shrivelled (shrunken) and damaged seeds as well as all other debris were removed. To disinfest the cleaned whole seeds, they were put in a polythene bag together with two phostoxin tablets (in an envelope) for 24 hours. The mouth of the bag was tied securely to ensure that any insect pest present within the seeds was killed according to the method of Ogunwolu *et al.,* (2002). Thereafter, the seeds were opened and spread in a shaded well ventilated place for 48 hours to ensure that the seeds were free from the phostoxin residue. To avoid subsequent re-infestation and to ensure that any insect pest that might still remain within the seeds was killed the previously fumigated seeds were transferred into a fresh and different polythene bag and kept at -4˚C inside a fridge for four days (Ahmed, 2007).

### Collection of the Experimental Plant Parts

The leaves and seeds of the physic nut *J. curcas* were collected in the morning during rainy season at the orchards of Audu Bako College of Agriculture, Dambatta, Kano State, while the Actellic dust was purchased from a pesticide store at Abubakar Rimi market, Sabon-gari, Kano, Kano State, Nigeria.

### Preparation of Experimental Plant Parts

The plant parts were dried in shade to crispy condition. Thereafter, it was pounded in a mortar with pestle and then passed through a sieve 40 µmm to give a very fine powder as described by Youdeowei (2004) and Yusuf and Ahmed (2005). The fine powdered plant materials were kept in plastic bags until needed.

### Source and Rearing of Insect Culture

The initial culture of the bambara nut bruchids was obtained from naturally infested bambara nut seeds at Kurmi market, Kano city, Kano State, Nigeria. A sample of the insects on infested seeds was taken to the Department of Crop Protection, Ahmadu Bello University, Zaria, Kaduna State, Nigeria for proper taxonomic identification as *Callosobruchus subinnotatus* (Pic.). These were then massively reared in transparent plastic buckets measuring 30 cm in height and 15 cm top diameter. The top end of the plastic buckets was covered with white muslin cloth, secured firmly into place with rubber bands, hence allowing for ventilation. These were incubated in Kliner jar at an ambient temperature and relative humidity (32±3$^{o}$C and 57±3% respectively) with alternating light and dark cycle for 12 hours as previously described by Abduljalal *et al.* (2011). One kg of the clean disinfested bambara nuts were transferred into ten plastic buckets each. In addition, 100 adults of *C. Subinnotatus* from the initial culture were introduced into the buckets. To ensure that the introduced bruchids did not escape away, the top ends of the buckets were covered with white muslin cloth and secured firmly with rubber bands. The insects were allowed to mate and oviposit for 10 days after which they were removed.

### Experiment and Experimental Design

Bioactive (contact toxicity) effect of the treatments was assessed on the adult bruchids for seven days. In a 2×2×2 factorial experiment, the leaves and seeds of physic nut, *J curcas* L. were used for the assessment. The leaves and seeds powder were applied at two levels each (0 and 0.5 g/20 g seed) with and without pirimiphos-methyl (Actellic dust) applied at the reduced rate of 0.01g/20 g (Gwinner, *et al.,* 1996). There were eight treatments, which were replicated three (3) times in a completely randomized design. The treatments were admixed with the bambara nut and shaken vigorously after which, five pairs of emerged insects were introduced into each treatment in plastic cups. A total of 24 transparent plastic cups measuring 10 cm in depth and 9 cm top diameter were kept in the laboratory at ambient temperature and relative humidity of 32±3$^{o}$C and 57±3%, respectively.

### Contact Toxicity

Methods described by Liu and Ho (1999) and Juntarajumnong and Chandrapatya (2009) were adopted with some modifications (using chick feather instead of Burkard Arnold microapplicator and camel hair brush used by Liu and Ho; Juntarajumnong and Chandrapatya, respectively). 0.5 g of both test plant materials and 0.02 g Actellic dust were applied topically at the dorsal part of the thorax of *C. Subinnotatus* adults using the chick feather, while control insects were left untreated. Both treated and control insects were placed into pure culture of bambara nut seeds. The number of dead insects was recorded daily for one week.

### Phytochemical Screening

Phytochemical analyses of the crude leaf and seed powder collected were conducted according to standard procedures to identify their chemical components (Sofowora, 1993; Harborne, 1988; Trease and Evans, 1989; and Kokate *et al.,* 2008). This was conducted at the National Research Institute for Chemical Technology (NARICT) Zaria, Kaduna State, Nigeria. Ferric chloride (FeCl3) test for tannins, organic acid (OAT) test for oxalates, foam test for saponins, Keller-Killiani test for glycosides, ferric chloride (FeCl3) test for flavonoids and Wagner's Reagent as well as Meyer's Reagent tests for alkaloids were carried out to identify the chemical constituents present in the leaf and seed products of the plant.

### Tannin test

Five millilitre (5ml) of each of the plant part (leaf and seed) extract was treated with 2ml of Ferric chloride (FeCL3) and boiled for five (5) minutes. Formation of red precipitate confirmed the presence of tannins.

**Oxalate test**

To three milliner (3ml) portion of the extracts, a few drops of ethanoic acid glacial were added. Greenish black colouration indicated presence of oxalates.

**Saponin test**

To one millilitre (1ml) of each of the plant part extract, four millilitres (4ml) of distilled water was added and shaken vigorously for a stable persistent froth. The frothing was mixed with three drops of olive oil and shaken vigorously; and then for the formation of emulsion as evidence for presence of saponins.

**Glycoside test**

The plant part extracts were treated with few drops of glacial acetic acid and Ferric chloride solution and mixed. Concentrated sulphuric acid was added, formation of two layers two layers was observed. Lower reddish brown layer and upper acetic acid layer which turns bluish green indicated a presence of glycosides.

**Flavonoid test**

Test plant parts were treated with few drops of Ferric chloride (FeCl3) solution which resulted in the formation of blackish red colour indicating the presence of flavonoids.

**Alkaloid test**

Five millilitre (5ml) of 2% of hydrogen chloride (hydrochloric acid HCL) was added to 2ml of each of the plant part extract in a test tube placed on a steam bath and warmed. It was filtered and divided into two parts for the following tests:

Few drops of Wagner's Reagent (Potassium-iodine solution) were added to one part of the filtrate in a test tube. A reddish brown precipitate was observed.

Few drops of Meyer's Reagent (Potassium mercuric iodine solution) were added to the other filtrate of the solution in a test tube. A cream coloured precipitate was observed.

In both cases, formation of precipitation indicated presence of alkaloids.

**Data Analysis**

Data in percentages were transformed into arc sine percentages, while numerically count data were transformed using $\sqrt{n+1}$ before analysis, as described by Little (1978). All the data were subjected to analysis of variance using computer software (SAS for windows) statistical package. Treatments with significant differences were compared and separated at 0.05% level of probability using Duncan's multiple range test (DMRT).

**RESULTS**

Contact toxicity effect of the leaf powder, with and without addition of the synthetic chemical, was presented in Table 1. After contact with the treatments, at two days after treatments DAT, dead bruchids (5.67 and 5.83) observed in the leaf powder treatment at 0.5 g, with and without the actellic dust were similar to that observed (6.33) in the check, and all these were significantly ($p<0.05$) higher than that (4.00) in the control.

Table 2 shows the contact effect of the seed powder treatment (0.5 g), with and without the synthetic chemical applied directly on the dorsal part of the bruchids. At one DAT, significant ($p<0.01$) toxic contact effect was observed from the seed powder treatment (0.5 g), with and without the synthetic chemical. Number of dead insects (2.33 and 3.00) observed in the seed powder treatment, with and without the synthetic chemical, respectively, was statistically similar to both the number of dead insects (1.17) in the control and that observed (4.17) in the check. Subsequently however, at 2, 3 and 6 DAT, the number of dead insects (5.83, 7.67 and 8.66, respectively) using the seed powder without the synthetic chemical was statistically similar to that (5.83, 9.00 and, 9.17, respectively) in the check, at the same time, both treatments were significantly ($p<0.001$) effective when compared to the number of dead insects (3.67, 3.83 and 3.83, respectively) in the control. However, at 7 DAT, number of dead insects (8.17, 9.17 and 9.33) from the treatment, with and without the actellic dust, and the check, respectively, were similar and at the same time significantly ($p<0.01$) higher the number of dead insects (5.50) in the control.

Table 3 shows the toxic contact effect of the treatments and their combination, with and without the actellic dust when applied dorsally on the bruchids. With the exception of where 0.5 g seed powder with Actellic dust was used, at 2 DAT, toxic effect, similar to that obtained from the check and which altogether was significantly ($p<0.05$) better than the one recorded from the control, were observed in all the treatments. At this same period (2 DAT), the number of dead insects (2.33) caused by the application of 0.5 g seed powder with Actellic dust was similar to that (1.67) obtained in the control. At 3 DAT however, the potency of the 0.5 g seed powder with Actellic increased, number of dead insects (2.67) caused became significantly ($p<0.001$) higher than that (2.33) in the control. Notwithstanding, this was lower than the number of dead insects (10.00) in the check. On the other hand, at this period (3 DAT) the number of dead insects in all other treatments was similar to that obtained in the check. At 7 DAT, the number recorded from treated seeds was significantly ($p<0.01$) higher than the number of dead insects (3.67) in the control. Moreover, at this period (7 DAT), the number of dead insects in all the treatments, with and without Actellic dust was similar to number of dead insects in the check, except when 0.5 g leaf powder without actellic dust was applied. The number of dead insects (7.33) in this treatment (0.5 g leaf powder without actellic dust) was statistically lower than that of dead insects (10.00) of the check.

Table 1: Contact effect of *Jatropha curcas* leaf extract with and without synthetic chemical application on adults of *Callosobruchus subinnotatus*

| Treatment | | Contact effect days after treatment (DAT)$^{\triangle}$ | |
|---|---|---|---|
| **Leaf powder(g)** | **Pirimiphos-methyl(g)** | **2** | **3** |
| 0.0 | 0.00 | $3.67^{a\Omega}$ (10.94) | $4.00^{a\Omega}$ (11.54) |
| 0.0 | 0.01 | $4.00^{a}$ (11.54) | $6.33^{b}$ (14.54) |
| 0.5 | 0.00 | $5.83^{b}$ (13.94) | $6.00^{b}$ (14.18) |
| 0.5 | 0.01 | $5.67^{b}$ (13.69) | $6.83^{b}$ (15.12) |
| | L.S.$^{*}$ | * | * |
| | SE± | 0.447 | 0.442 |

$^{\Omega}$Means within a column followed by different letters are statistically significantly different at * = P ≤ 0.05, Duncan's multiple range test.$^{\triangle}$Figures in parentheses are Arcsine √percentage transformations.$^{*}$L.S = level of significance.

Table 2: Contact effect of *Jatrophacurcas* seed extract with and without synthetic chemical application on adults of *Callosobruchus subinnotatus*

| Treatment | | Contact effect days after treatment (DAT)$^{\triangle}$ | | | | |
|---|---|---|---|---|---|---|
| **Seed powder(g)** | **Pirimiphos-methyl(g)** | **1** | **2** | **3** | **6** | **7** |
| 0.0 | 0.00 | $1.17^{b\Omega}$ (6.02) | $3.67^{b\Omega}$ (10.94) | $3.83^{c\Omega}$ (11.24) | $3.83^{c\Omega}$ (11.24) | $5.50^{b\Omega}$ (13.56) |
| 0.0 | 0.01 | $4.17^{a}$ (11.68) | $5.83^{a}$ (13.94) | $9.00^{a}$ (17.46) | $9.18^{a}$ (17.56) | $9.33^{a}$ (17.76) |
| 0.5 | 0.00 | $3.00^{ab}$ (9.98) | $5.83^{a}$ (13.94) | $7.67^{a}$ (16.00) | $8.66^{a}$ (17.05) | $9.17^{a}$ (17.56) |
| 0.5 | 0.01 | $2.33^{ab}$ (8.72) | $3.83^{b}$ (11.24) | $5.50^{b}$ (13.56) | $7.17^{b}$ (15.45) | $8.17^{a}$ (16.54) |
| | L.S.$^{*}$ | ** | *** | *** | *** | ** |
| | SE± | 0.591 | 0.447 | 0.442 | 0.626 | 0.520 |

$^{\Omega}$Means within a column followed by different letters are statistically significantly different at ** = P ≤ 0.01 and *** = P ≤ 0.001, Duncan's multiple range test.$^{\triangle}$Figures in parentheses are Arcsine √percentage transformations.$^{*}$L. S = level of significance.

Table 3: Contact effect of *Jatrophacurcas* extracts with and without synthetic chemical application on adults of *Callosobruchussubinnotatus*

| Treatment | | | Contact effect days after treatment (DAT)$^{\triangle}$ | | |
|---|---|---|---|---|---|
| **Leaf powder(g)** | **Seed powder(g)** | **Pirimiphos-methyl(g)** | **2** | **3** | **7** |
| 0.0 | 0.0 | 0.00 | $1.67^{b\Omega}$ (7.27) | $2.33^{c\Omega}$ (8.72) | $3.67^{c\Omega}$ (10.94) |
| 0.0 | 0.0 | 0.01 | $5.67^{a}$ (13.69) | $10.00^{a}$ (18.44) | $10.00^{a}$ (18.44) |
| 0.0 | 0.5 | 0.00 | $5.00^{a}$ (12.92) | $6.33^{ab}$ (14.54) | $8.33^{ab}$ (16.74) |
| 0.0 | 0.5 | 0.01 | $2.33^{b}$ (8.72) | $2.67^{b}$ (9.28) | $7.67^{ab}$ (16.00) |
| 0.5 | 0.0 | 0.00 | $5.00^{a}$ (12.92) | $6.00^{b}$ (14.18) | $7.33^{b}$ (15.68) |
| 0.5 | 0.0 | 0.01 | $6.00^{a}$ (14.18) | $8.00^{ab}$ (16.43) | $8.33^{ab}$ (16.74) |
| 0.5 | 0.5 | 0.00 | $6.67^{a}$ (14.89) | $9.00^{ab}$ (17.46) | $9.00^{ab}$ (17.46) |
| 0.5 | 0.5 | 0.01 | $5.33^{a}$ (13.31) | $8.33^{ab}$ (16.74) | $8.67^{ab}$ (17.05) |
| | | L.S.$^{*}$ | * | *** | ** |
| | | SE± | 0.632 | 0.625 | 0.736 |

$^{\Omega}$Means within a column followed by different letters are statistically significantly different at * = P ≤ 0.05, ** = P ≤ 0.01, *** = P ≤ 0.001, Duncan's multiple range test.$^{\triangle}$Figures in parentheses are Arcsine √percentage transformations.$^{*}$L.S = level of significance.

Table 4 showed the toxic contact effect of *J. Curcas* leaf/seed combinations on the adult bruchids. At two 2 days after treatment (DAT), six dead bruchids were observed among the insects infesting bambara nut seeds treated with 0.5:0.5 g leaf/seed combination. This observation was similar to the number of dead insects obtained with leaf powder treatment only. At the same time, mortality of insects in both treatments was significantly ($p<0.001$) higher than that observed in the control. However, within the same test period (2 DAT), the number of dead insects (3.67) treated with seed powder only was less than the number (4.00) obtained in the control. Subsequently however, at three, six and seven DAT, significant ($p<0.001$) contact toxicity effect was indicated by the leaf/seed combination only. The contact toxic effects of all other treatments were similar to, or even less than that observed in the untreated control.

In Table 5, the results of contact toxicity assessment of pirimiphos-methyl were shown. When applied topically, at three DAT, substantial toxic contact effect was observed when the synthetic insecticide was used. At this time (3 DAT), number of dead insects (7.25) observed in treated seeds significant ($p<0.01$) exceeded the number of dead insects (5.75) in the control. Similarly, at six and seven DAT, significant differences ($p<0.05$) were observed in the mortality of the insects as a result of applying the synthetic insecticide. During this period (6 and 7 DAT), significantly ($p<0.05$) more insects (8.25 and 8.67, respectively) were dead as a result of using pirimiphos-methyl when compared to the number of dead insects (6.50 and 7.08, respectively) found in the control.

Table 6. Compared to the number of mortality (6.58) in the control treatment, at six DAT significantly ($p<0.05$) more bruchids (8.17), were found dead when the treatment was applied. On the other hand, insect mortality by direct contact with the leaf powder treatment was presented in Table 7. At two and three DAT, compared to the number of dead insects (3.83 and 5.12, respectively) observed in the control, significantly ($p<0.001$) higher number of insects (5.75 and 7.83, respectively) were found dead using the leaf powder at all the treatments.

Table 8 shows chemical constituents of physic nut leaf and seed. With the exception of the cynogenic glycoside (cardiac glycoside), tannins, oxalates, saponnins, flavonoids and alkaloids were present in both leaf and seed of the plant. Presence of cynogenic glycosides was indicated only in the leaf.

Table 4: Contact effect of *Jatropha curcas* leaf/seed extracts on adults of *Callosobruchus subinnotatus*

| **Treatment** | | **Contact effect days after treatment (DAT)**$^{\triangle}$ | | | |
|---|---|---|---|---|---|
| **Leaf powder (g)** | **Seed powder (g)** | **2** | **3** | **6** | **7** |
| 0.0 | 0.0 | $4.00^{a\Omega}$ (11.54) | $5.83^{bc\Omega}$ (13.94) | $6.50^{a\Omega}$ (14.77) | $6.83^{a\Omega}$ (15.12) |
| 0.0 | 0.5 | $3.67^{a}$ (10.94) | $4.50^{a}$ (12.25) | $7.17^{ab}$ (15.45) | $8.00^{ab}$ (16.43) |
| 0.5 | 0.0 | $5.50^{b}$ (13.56) | $6.67^{b}$ (14.89) | $7.00^{ab}$ (15.34) | $7.83^{ab}$ (16.22) |
| 0.5 | 0.5 | $6.00^{b}$ (14.18) | $8.33^{c}$ (16.74) | $8.67^{b}$ (17.06) | $9.17^{b}$ (17.56) |
| | L.S.$^{*}$ | *** | *** | *** | *** |
| | SE± | 0.447 | 0.442 | 0.626 | 0.520 |

$^{\Omega}$Means within a column followed by different letters are statistically significantly different at *** = $p \leq 0.001$, Duncan's multiple range test.$^{\triangle}$Figures in parentheses are Arcsine √percentage transformations.$^{*}$L.S = level of significance.

Table 5: Contact effect of pirimiphos-methyl application on adults of *Callosobruchus subinnotatus*

| **Pirimiphos-methyl(g)** | **Contact effect days after treatment (DAT)**$^{\triangle}$ | | |
|---|---|---|---|
| | **3** | **6** | **7** |
| 0.00 | $5.75^{a\Omega}$ (13.81) | $6.50^{a\Omega}$ (14.77) | $7.08^{a\Omega}$ (15.34) |
| 0.01 | $7.25^{b}$ (15.56) | $8.25^{b}$ (16.64) | $8.67^{b}$ (17.06) |
| L.S.$^{*}$ | * | * | * |
| SE± | 0.313 | 0.443 | 0.368 |

$^{\Omega}$Means within a column followed by different letters are statistically significantly different at * = $P \leq 0.05$, Duncan's multiple range test.$^{\triangle}$Figures in parentheses are Arcsine √percentage transformations.$^{*}$L.S = level of significance.

Table 6: Contact effect of *Jatrophacurcas* seed powder on adults of *Callosobruchus subinnotatus*

| Seed powder(g) | Contact effect 6 day after treatment (DAT)[△] |
|---|---|
| 0.0 | 6.58[aΩ] (14.77) |
| 0.5 | 8.17[b] (16.54) |
| L.S.[*] | * |
| SE± | 0.443 |

[Ω]Means within a column followed by different letters are statistically significantly different at * = P ≤ 0.05, Duncan's multiple range test.[△]Figures in parentheses are Arcsine √percentage transformations.[*]L.S = level of significance.

Table 7: Contact toxicity effect of *Jatrophacurcas* leaf powder on adult *Callosobruchus subinnotatus*

| | Contact effect days after treatment (DAT)[△] | |
|---|---|---|
| Leaf powder(g) | 2 | 3 |
| 0.0 | 3.83[aΩ] (11.24) | 5.12[aΩ] (13.05) |
| 0.5 | 5.75[b] (13.81) | 7.83[b] (16.22) |
| L.S.[*] | *** | *** |
| SE± | 0.316 | 0.313 |

[Ω]Means within a column followed by different letters are statistically significantly different at *** = P ≤0.001, Duncan's multiple range test.[△]Figures in parentheses are Arcsine √percentage transformations.[*]L.S = level of significance.

Table 8: Phytochemical constituents in the leaf and seed of *Jatrophacurcas*

| Chemical compound | Leaf | Seed |
|---|---|---|
| Tannin | +[Ω] | +[Ω] |
| Oxolate | + | + |
| Saponnin | + | + |
| Cynogenic glycoside | + | - |
| Flavonoid | + | + |
| Alkaloid | + | + |

[Ω] + = indication of presence and - = indication of absence of chemical compound.

**DISCUSSION**

In spite of their health and environmental impacts, the most widely used curative measure in stored-product insect pest control is the application of synthetic residual or contact insecticides. Recently however, there is renewed interest in the use of eco-friendly botanical pesticides. The present study evaluated the bioactivity and fumigation effects of crude leaf and seed extracts of the physic nut, *Jatropha curcas* L.plant on *Callosobruchus subinnotatus* (Pic.) infesting stored bambara nut. The study also investigated the most effective rate of application that could provide optimum control. The crude extracts (leaf and seed powder) were investigated at three different levels (0.5, 1.0 and 1.5 g/20 g bambara nut seeds) each and the levels were factorially mixed together to form different combinations (leaf/synthetic chemical, seed/synthetic chemical, leaf/seed and leaf/seed/synthetic chemical). These were compared with the synthetic insecticide Pirimiphos-methyl 2% dust (at 0.01 g/20 g bambara nut seeds) as check treatment and the untreated control (0.0 g).

The plant extracts used in this study proved effective and provided substantial reduction of adults through contact with the extracts. Substantial protection was achieved by using all the extracts and chemicals applied singly and in combination, which was similar to that provided by using the residual insecticide powder (Actellic dust, 2%). This agreed with findings of Asawalam and Adesiyan (2001) from which it was observed that plant parts; oil, extract, and powder mixed with grains reduced insect oviposition, egg hatchability, postembryonic development, and progeny production.

Research conducted by other people had shown that*Jatropha* has insecticidal and antifeedant efficacies against wide range of insects, sometimes the effects were comparable to that provided by synthetic insecticides. In the store, *Jatropha*extracts have been used as anti-oviposition and ovicides on *Callosobruchusmaculatus*in cowpea (Adebowale and Adedire, 2006), oviposition deterrence and inhibiting egg hatching of potato tuber moth, *Phthorimaeaoperculella*(Shelke *et al.*, 1987). Similarly, Ohazurike*et al.* (2003) reported substantial control of maize weevil, *Sitophiluszeamais*infesting stored maize. Umar (2008) also observed reduced oviposition by *C. maculatus* when *Jatropha*seed and leaf powder were used on stored cowpea.

This investigation also revealed that all the treatments indicated that there was toxic contact effect on the bruchids. However, longer period of exposure up to six and seven days was required when using the seed powder singly and leaf/seed powder combined together leading to higher mortality. Quick mortality was caused by using the leaf extract, where treated bruchids died within 72 h of application. Similarly, Araya and Emana (2009) reported that hundred percent mortality of *Z. Subfasciatus* was obtained with *C. Ambrosioides* leaf powder at all levels of concentrations 24 h after treatment and more than 90% mortality of adult *Z. subfasciatus*was also observed for bean seeds treated with *J. curcas*, *D. stramonium*and *P. dodecondra*96 h after treatment.

This study did not aim at elucidating the chemical compounds which might have been responsible for any of the effects on the bambara nut bruchids, *C. subinnotatus*, however, phytochemical analysis of the physic nut was conducted in order to know the chemical constituents and the metabolites contained in the leaf and seed of the plant. Phytochemical analysis indicated that apart from the cynogenic glycosides, tannins, oxalates, saponnins, flavonoids and alkaloids in varied concentrations, were also present in both the leaves and seeds of the plant. Traces of cynogenic (cardiac) glycocides were found only in the leaves of the plant. This conforms to the findings of Constance *et al.* (2013) who, while screening *J. curcas*, showed that the plant had abundant saponins and cardiac glycosides. The work further stated that the concentrations of tannin, flavonoids, and steroids were lower than that of saponins but higher than the concentrations observed in alkaloids, phlobatannins, and terpenoids. However, the concentrations of the saponins and cardiac glycosides in the plant extracts were significantly higher compared to other phytochemicals.

**CONCLUTION**

From the results obtained in this research, it could be concluded that by using the different plant parts (leaf and seed extracts) and their combinations at 0.5 g, an appreciable level of protection, similar to that provided by the conventional synthetic insecticide, was achieved. Therefore, the plant parts (at 0.5 g) could be used for the management of *C. Subinnotatus* infesting stored bambara nut.

**RECOMMENDATIONS**

From the findings of this study, it could be recommended that:

i. for repellence effect, the leaf and seed powders, singly and combined together, especially 0.5 g leaf powder, could be adopted as to repel the bruchids and protect bambara nuts from infestation by *C. subinnotatus*;
ii. similarly, the leaf powder singly and equal ratio of the leaf/seed powder combinations provide the best contact effect at 0.5 g.

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