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# Entomopoison Efficacy of Fume of Different Parts of *Newbouldia Laevis* against *Callosobruchus Maculatus* in Storage

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**Abstract:** *Entomopoison efficacy of fume from extracts of different part of Newbouldia laevis against Callosobruchus maculatus infesting stored cowpea in storage. The extract from the leaf, stem bark, root bark and stem ash was used as fumigant at 1, 2, 3, 4 and 5% concentrations while methanol treated cowpea and cowpea without any treatment were used as controls. The result obtained showed that the fumigant toxicity of the extracts increased with increase in their concentration and root extract of the plant showed more fumigant toxicity against the adult beetle as reflected by its $LC_{50}$ and $LC_{95}$ of 1.23% (0.88-1.47) and 3.51% (3.09-4.22) respectively. The extracts significantly reduced the oviposition and adult emergence of the insect at high concentrations but none of the extract fume was able to prevent the emergence of the insect. Also, the fume of the extracts reduced the ability of the insect to cause seed damage and weight loss when compared with the controls. Base on the findings of this work the order of fumigant toxicity of the extract could be arranged as follow root bark > leaf > stem bark > stem ash. However, for this plant to be used as fumigant, high concentrations will be required as reflected by their lethal concentrations and this may have no adverse effect on the protected cowpea.*

**Keywords:** *Fumigant, Entomopoison, Newbouldia laevis, lethal concentration, Callosobruchus maculatus, plant extract.*

## 1. Introduction

For epochs, insects have been the major competitor of human on earth in term of food consumption. These insects ranging from coleoptera to lepidoptera to diptera attack human crops both on the field and in storage where their noxious activity is more prominent. Insects alone have been noted to be a factor of food insecurity and encumbering stone thwarting the development of agriculture in many developing countries. For example, insects attack alone was noted for the loss of more 40% stored grains in the tropical regions of the world (Ogungbite *et al.*, 2014a). Cowpea, *Vigna unguiculata* being one of the major staple foods in many developing countries including Nigeria have been suffering from wide range of insects among which *Callosobruchus maculatus* remains the most popular. *C. maculatus* not only affect the production and storage of this African poor man's meat grain legume but also affects its marketability among other farm produce. The multivotine kind of reproduction of this important insect pest of cowpea makes its destructive activity to be more pronounced and popular throughout the year especially in the countries where environmental conditions are favourable.

Over the years, the control of this dreadful insect pest of cowpea has been overwhelmingly relied upon the use of synthetic chemical insecticides which were associated with many downsides frustrating their widespread use globally. However, before the popularity of many synthetic chemical insecticides, use of plant materials in fighting against insects pest have been the major weapon in the farmer's arsenal as crop protection is as old as agriculture itself. The replacement of synthetic chemical insecticides which have been labeled with danger becomes a key subject among the world entomologists, crop protection researchers and government parastatal concerned as governments of many developed nations are placing embargo on the use of these chemicals (Isman, 2000; 2006). Researches have been shifted toward the use of plant oils, extracts and powder as new thoroughfare of insect control because they are believed to have no or low adverse effect on human and environmental health (Zibaee, 2011; Forim *et al.,* 2012; Oyeniyi *et al.,* 2015).

Despite the fact that many plant species have been proven insecticidal in nature, their acceptability among farmers and consumers has not been encouraging because consumers find it difficult to accept the adverse effect posed by these botanical insecticides. For example, nicotine from nicotiana species has repulsive odour which it also pose on the protected commodities (Begum *et al.*, 2013). Also, many if not all of the botanical insecticides have colour change effect on the protected grains. In order to overcome this challenge of application of botanical insecticides, fumigant application of these botanical insecticides has been suggested as an alternative method of application that could lead to acceptability of the plant base insecticides (Begum *et al.*, 2013).

*Newbouldia laevis* is a popular plant among Africans because of its medicinal importance. The powders and extracts of this plant has been proven insecticidal against different insects (Ashamo *et al.*, 2013; Ogungbite and Oyeniyi, 2014; Ogungbite *et al.*, 2014a). This research investigated the entomopoison efficacy of the fume of different parts of this plant against *Callosobruchus maculatus*.

## 2. Materials and Methods

### 2.1. Insect culture

The starter culture of *Callosobruchus maculatus* was obtained from an infested cowpea from Food Storage Research Laboratory, Federal University of Technology, Akure. They were reared on dried cowpea bought from Agriculture Development Project (ADP), Akure, Ondo State. The seeds were cleaned of foreign matter and disinfested by keeping in freezer at -5 $^oC$ for 31 days. The disinfested seeds were then air dried in the laboratory to prevent before introduction of insects. This container was placed inside insect rearing cage at ambient temperature 28 ± 2$^o$C and 70±5% relative humidity.

### 2.2. Collection of Plant and Cowpea Seeds

*N. leavis* root bark, stem bark and leaves were collected from Oke-Odo Aratunsin area of Akure, Ondo State. Collected plant was taken to the Natural History Museum Obafemi Awolowo University, Ile-Ife for identification. The cowpea that was used was collected from ADP, Akure. The cowpea variety that was used is Ife Brown.

### 2.3. Preparation of the Wood Ash

The wood ash was collected from burnt *N. laevis* stem wood and was sieved to get the fine ash before application (Mesele *et al.*, 2010). Also, the wood ash extract was prepared by dissolving 0.5kg of sieved wood ash powder of *N. laevis* in 4litres of water and was stirred properly every day for seven days. This dissolved wood ash powder was sieved after seven days using muslin cloth and kept inside a covered container for subsequent use (Moyin-Jesu, 2010).

### 2.4. Preparation of the Plant Powder

The plant parts (leaf, stem bark and root bark) used was collected fresh and sun dried. The plant was grounded into fine powder using electric blender and the powders were further sieved to pass through 1mm$^2$ perforations before it was stored in separate plastic containers with tight lids for subsequent use.

### 2.5. Preparation of Plant Extract

Twenty grams of each pulverized plant materials (leaf, stem bark and root bark) was put in a muslin cloth and transferred into the thimble and extracted with methanol in a soxhlet apparatus. The extraction was terminated when the solvent in the thimble becomes clear. The resulting extracts contain both the solvent and the oil. The solvent was separated from the oil using rotary evaporator, after which the oil was exposed to air so that traces of the volatile solvents evaporates, leaving the oil extract. This is important so as to avoid making false concentrations.

From this main stock solution, different concentrations of 1%, 2%, 3%, 4% and 5% oil concentrations were made. A concentration of 1% was made by diluting 0.1ml of plant extract in 9.9ml of methanol (solvent). 2% concentration was made by diluting 0.2ml of plant extract in 9.8ml methanol. Also, 3%, 4% and 5% concentration was made by diluting 0.3ml, 0.4ml and 0.5ml of the plant extract with 9.7ml, 9.6ml and 9.5ml of the solvent respectively.

### 2.6. Fumigant Toxicity

Fumigant effect of extracts was tested at different concentration of 1%, 2%, 3%, 4% and 5%, against ten pairs of *C. maculatus*. Twenty grammes of cowpea seed was weighed into 250ml plastic container and extracts (leaf, stem bark and root bark) of the plant at different concentration were hung from the plastic container using a tight fitting cork. The parameters that were monitored include beetle mortality counted at24, 48, 72 and 96 hours after post treatment. Dead and live insects were removed after 4 days and oviposition was recorded. Also, percentage adult emergence, percentage weight loss and percentage damage seeds were calculated after 42days. The percentage adult emergence was calculated using the formula indicated below.

$$\% \text{ Emergence} = \frac{\text{Number of adult emerged}}{\text{Total number of egg laid}} \text{X} \frac{100}{1}$$

### 2.7. Determination of Severity of Damage and Weight Loss

After the termination of the experiment when no adult emergence had been recorded for five consecutive days, the percentage damaged grain and weight loss was calculated using the formula below respectively

$$\% \text{ Damage} = \frac{\text{Number of holed seed}}{\text{Total number of seeds}} \text{X} \frac{100}{1}$$

$$\% \text{ Weight Loss} = \frac{\text{Difference in weight}}{\text{Weight of undamaged grains}} \text{X} \frac{100}{1}$$

### 2.8. Statistical Analysis

All the data obtained were subjected to one-way analysis of variance at 5% significant level and means were separated with New Duncan's Multiple Range Tests using SPSS version 17. Also data, obtained from beetle's mortality, were subjected to regression analysis to calculate the $LC_{50}$ and $LC_{95}$of the extracts using probit analysis (Finney, 1971).

## 3. Results

### 3.1. Fumigant Effect of Wood Ash and Plant Extracts of Newbouldia Laevis on Mortality of Cowpea Beetle (Callosobruchus Maculatus)

The fumigant effect of ash, leaf, stem bark and root bark extract of *N. laevis* on mortality of *C. maculatus* at different concentration and period is presented in Table 1. The percentage beetle mortality varied with period of exposure, plant extract used and the concentration of the extracts. Significant ($p<0.05$) differences existed among all the treatments.

The extracts achieved low percentage beetle mortality even at higher concentrations. The ash extract had the lowest percentage beetle mortality after 96hours of application at all different concentrations. Moreover, the root extract at 5% concentration achieved the highest percentage beetle mortality of 26% after 96hours of application and was significantly ($p<0.05$) different from that of the wood ash extract and stem extract. Also, leaf, stem, root and ash extract had a fumigant effect that was significantly different from the control. In addition, it was noted that there was no significant ($p>0.05$) difference between the treated and untreated controls after 96hours of application.

**Table1.** *Mortality (%) of adult C. maculatus on cowpea seeds Fumigated with wood ash and plant extracts of N. laevis. (Means ± S.H).*

| Concentrations(%) | Treatments | Hours | | | |
|---|---|---|---|---|---|
| | | 24 | 48 | 72 | 96 |
| 1 | Leaf | $0.00\pm0.00^{a}$ | $3.00\pm0.24^{bc}$ | $4.00\pm0.20^{bc}$ | $9.00 \pm 0.44^{bc}$ |
| | Stem | $0.00\pm0.00^{a}$ | $1.00\pm0.20^{ab}$ | $3.00 \pm0.24^{bc}$ | $6.00 \pm 0.37^{bc}$ |
| | Root | $2.00\pm0.24^{b}$ | $5.00\pm0.00^{c}$ | $5.00\pm0.00^{c}$ | $10.00\pm0.49^{c}$ |
| | Ash | $0.00\pm0.24^{a}$ | $1.00\pm0.00^{ab}$ | $4.00 \pm0.20^{bc}$ | $6.00 \pm 0.37^{bc}$ |
| 2 | Leaf | $0.00\pm0.00^{a}$ | $6.00 \pm 0.20^{cd}$ | $8.00\pm 0.40^{cd}$ | $13.00\pm0.24^{c}$ |
| | Stem | $0.00\pm0.00^{a}$ | $4.00 \pm0 .20^{bc}$ | $9.00\pm 0.37^{cd}$ | $12.00\pm0.24^{c}$ |
| | Root | $2.00\pm0.24^{b}$ | $8.00 \pm 0.40^{d}$ | $10.00\pm0.32^{d}$ | $15.00\pm0.32^{c}$ |
| | Ash | $0.00\pm 0.00^{a}$ | $2.00 \pm 0.24^{ab}$ | $5.00 \pm 0.00^{bc}$ | $6.00 \pm 0.20^{b}$ |
| 3 | Leaf | $4.00\pm0.37^{ab}$ | $10.00\pm 0.44^{bc}$ | $14.00 \pm0.58^{c}$ | $19.00\pm0.37^{c}$ |
| | Stem | $3.00\pm0.40^{ab}$ | $5.00 \pm 0.45^{ab}$ | $10.00 \pm0.32^{bc}$ | $14.00\pm0.37^{c}$ |
| | Root | $5.00\pm0.32^{b}$ | $12.00 \pm 0.51^{c}$ | $12.00\pm0.51^{bc}$ | $17.00\pm0.51^{c}$ |
| | Ash | $1.00\pm0.20^{ab}$ | $4.00 \pm 0.37^{b}$ | $8.00 \pm 0.24^{b}$ | $8.00 \pm 0.24^{b}$ |
| 4 | Leaf | $6.00\pm0.37^{bc}$ | $12.00\pm0.40^{b}$ | $15.00\pm0.44^{cd}$ | $22.00\pm0.51^{cd}$ |
| | Stem | $4.00\pm0.37^{abc}$ | $8.00 \pm 0.24^{b}$ | $12.00\pm0.24^{bc}$ | $17.00\pm0.51^{c}$ |
| | Root | $8.00\pm0.24^{c}$ | $12.00\pm0.60^{b}$ | $18.00\pm0.24^{d}$ | $23.00\pm0.40^{d}$ |
| | Ash | $2.00\pm0.20^{ab}$ | $8.00 \pm 0.24^{b}$ | $9.00 \pm 0.37^{b}$ | $10.00\pm0.37^{b}$ |
| 5 | Leaf | $9.00 \pm 0.37^{b}$ | $12.00\pm0.60^{b}$ | $17.00\pm0.51^{c}$ | $24.00\pm0.37^{c}$ |
| | Stem | $8.00 \pm 0.51^{b}$ | $11.00\pm0.37^{b}$ | $15.00\pm0.55^{c}$ | $18.00\pm0.68^{b}$ |
| | Root | $10.00\pm0.45^{b}$ | $14.00\pm0.49^{b}$ | $19.00\pm0.20^{c}$ | $26.00\pm0.49^{c}$ |
| | Ash | $3.00 \pm 0.24^{a}$ | $8.00 \pm 0.40^{b}$ | $9.00 \pm 0.37^{b}$ | $12.00\pm0.32^{b}$ |
| Control 1 | | $0.00\pm 0.00^{a}$ | $0.00\pm 0.00^{a}$ | $2.00\pm 0.24^{a}$ | $2.00 \pm 0.24^{a}$ |
| Control 2 | | $0.00\pm 0.00^{a}$ | $0.00\pm 0.00^{a}$ | $0.00\pm 0.00^{a}$ | $0.00 \pm 0.00^{a}$ |

*Each value is the mean ± standard error of 5 replicates. Mean followed by the same letters are not significantly (P > 0.05) different from each other using New Duncan's Multiple Range Test.*

### 3.2. Lethal Concentrations ($LC_{50}$ And $LC_{95}$) of N. Laevis Powder and Extract in C. Maculatus After 96 H

Table 2 indicated that higher amounts of leaf, stem bark, root bark and ash extract of *N. laevis* were needed to achieve 50% and 95% mortality in the beetle as reflected in their fiducial limits. However, the root extract showed highest fumigant effect than other extracts as it required the lowest concentrations to achieve 50 and 95% insect mortality. This shows that the root of this plant material was more toxic than the leaf, steam and ash. Moreover, fiducial limits revealed that ash extract had the lowest fumigant effect on the beetle as it requires 4.30% (3.75-5.18) concentration to achieve 50% mortality of the insect and 11.42% (9.21-13.52) concentration to achieve 95% beetle mortality. Base on the lethal concentration of the extracts and their fiducial limit, their other of effectiveness can be arranged as root>leaf>stem>ash.

**Table2.** *Lethal concentration of extract of N. laevis from different part after 96 h of application*

| Plant parts | Slope (±SE) | Intercept (±SE) | $X^2$ | $LD_{50}$ (95% FL) | $LD_{95}$ (95% FL) |
|---|---|---|---|---|---|
| Leaf | 0.72 ± 0.97 | -0.95 ± 0.20 | 6.27 | 1.33 (1.01-1.56) | 3.62 (3.21-4.30) |
| Stem | 0.44 ± 0.05 | -0.81 ± 0.14 | 11.69 | 1.83 (1.44-2.13) | 5.57 (5.01-6.39) |
| Root | 0.72 ± 0.10 | -0.88 ± 0.21 | 14.95 | 1.23 (0.88-1.47) | 3.51 (3.09-4.22) |
| Ash | 0.23 ± 0.42 | -0.99 ± 0.14 | 6.18 | 4.30 (3.75-5.18) | 11.42 (9.21-13.52) |

*$X^2$: Chi-square; SE: Standard error; FL: Fiducial limits; LC: Lethal concentration*

### 3.3. Fumigant Effect of Extracts of Plant and Wood Ash of N. Laevis on Oviposition and Adult Emergence of C. Maculatus.

The fumigant effect of the extracts of *N. laevis* leaf, stem, root and wood ash at different concentration is presented in Table 3. All the extracts were not significantly reduced the number of eggs laid by *C. maculatus* when compared to the controls. The fumigant effect of the extracts was not significantly ($p > 0.05$) different from each other and from that of the controls. However, the root extract at 5% concentration had the highest fumigant effect on oviposition of *C. maculatus* with mean total of 26.20 eggs while stem extract had the lowest fumigant effect with mean total of 29.00 eggs. At all levels of extract concentration, the number of adult *C. maculatus* emerged was not significantly reduced when compared to that of the controls. However, there were no significant ($p > 0.05$) difference between the extracts and the controls except at 4% and 5% where significant differences occur.

**Table3.** *Oviposition and adult emergence of Callosobruchus maculatus on cowpea seeds Fumigated with wood ash and plant parts extract of Newbouldia laevis.*

| Concentrations(%) | Treatments | Oviposition | % adult emergence |
|---|---|---|---|
| 1 | Leaf | $32.40 \pm 0.86^b$ | $86.61 \pm 0.69^b$ |
| | Stem | $32.20 \pm 1.24^b$ | $86.11 \pm 0.70^b$ |
| | Root | $32.60 \pm 1.96^b$ | $86.04 \pm 0.90^b$ |
| | Ash | $33.60 \pm 1.53^b$ | $87.59 \pm 0.67^b$ |
| 2 | Leaf | $32.60 \pm 1.03^a$ | $86.52 \pm 1.40^b$ |
| | Stem | $30.60 \pm 1.03^a$ | $84.99 \pm 1.08^a$ |
| | Root | $31.40 \pm 1.03^a$ | $84.70 \pm 0.58^a$ |
| | Ash | $32.60 \pm 1.17^b$ | $86.70 \pm 1.01^b$ |
| 3 | Leaf | $31.80 \pm 0.92^a$ | $84.81 \pm 0.93^a$ |
| | Stem | $29.60 \pm 0.97^a$ | $84.49 \pm 1.16^a$ |
| | Root | $30.00 \pm 1.30^a$ | $84.78 \pm 1.31^a$ |
| | Ash | $30.00 \pm 1.03^a$ | $85.37 \pm 0.54^a$ |
| 4 | Leaf | $28.20 \pm 0.66^a$ | $82.26 \pm 1.25^a$ |
| | Stem | $28.20 \pm 0.73^a$ | $83.31 \pm 1.37^a$ |
| | Root | $28.20 \pm 0.66^a$ | $82.33 \pm 0.74^a$ |
| | Ash | $29.40 \pm 0.93^a$ | $83.67 \pm 0.55^a$ |
| 5 | Leaf | $27.60 \pm 1.08^a$ | $81.13 \pm 0.47^a$ |
| | Stem | $29.00 \pm 1.89^a$ | $81.30 \pm 1.21^a$ |
| | Root | $26.20 \pm 0.58^a$ | $80.31 \pm 2.51^a$ |
| | Ash | $27.60 \pm 0.93^a$ | $83.23 \pm 1.67^a$ |
| Control 1 | | $33.60 \pm 1.83^b$ | $87.37 \pm 1.21^b$ |
| Control 2 | | $33.40 \pm 1.60^b$ | $87.47 \pm 1.58^b$ |

*Each value is the mean of ± standard error of 5 replicates. Mean followed by the same letters within the same column are not significantly (p > 0.05) different from each other using New Duncan's Multiple Range Test.*

[xx] *control 1 is the cowpea treated with 2ml methanol while control 2 is the cowpea neither treated with extracts nor solvent.*

### 3.4. Seed Damage and Weight Loss Caused by C. Maculatus Infestation on Cowpea Fumigated With N. Laevis.

Table 4 showed the fumigant effect of *N. laevis* on ability of *C. maculatus* in causing seed damage and weight loss. At all levels of concentration the extracts were not significantly reduced the weight loss and damage of the seeds. At all levels of concentration, none of the extracts achieved 0% seed damage and weight loss. For the seed damage, the effect of these extracts was not significantly ($p > 0.05$) different from the controls at 1%. Also, the fumigant effect of the extracts on seed weight loss was not significantly ($p > 0.05$) different from the controls except at 4%l and 5% where significant ($P < 0.05$) differences occur. However, the fumigant effect of the extracts was not significantly different from each other and the both controls were also not significantly ($p > 0.05$) different from each other.

**Table4.** *Seed damage and weight loss caused by C. maculatus infestation on cowpea fumigated with extracts of N. laevis.*

| Treatments | Concentration (%) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Leaf | $32.69 \pm 0.85^a$<br>($9.59 \pm 0.30^a$) | $30.63 \pm 1.49^a$<br>($9.37 \pm 0.28^a$) | $29.64 \pm 1.87^a$<br>($9.14 \pm 0.00^a$) | $24.46 \pm 1.00^a$<br>($7.21 \pm 0.38^a$) | $22.44 \pm 0.63^a$<br>($6.59 \pm 0.49$) |
| Stem | $30.59 \pm 0.79^a$<br>($9.50 \pm 0.33^a$) | $30.03 \pm 0.62^a$<br>($8.59 \pm 0.55^a$) | $26.10 \pm 0.75^a$<br>($8.10 \pm 0.53^a$) | $23.71 \pm 0.99^a$<br>($7.11 \pm 0.23^a$) | $23.87 \pm 1.91^a$<br>($7.03 \pm 0.00^a$) |
| Root | $30.35 \pm 1.22^a$<br>($9.26 \pm 0.64^a$) | $29.36 \pm 1.05^a$<br>($8.74 \pm 0.62^a$) | $26.30 \pm 1.38^a$<br>($8.36 \pm 0.51^a$) | $23.49 \pm 1.16^a$<br>($7.25 \pm 0.26^a$) | $20.48 \pm 1.14^a$<br>($6.10 \pm 0.27^a$) |
| Ash | $31.80 \pm 1.25^a$<br>($9.75 \pm 0.33^a$) | $29.36 \pm 1.01^a$<br>($9.14 \pm 0.73^a$) | $26.65 \pm 1.21^a$<br>($8.80 \pm 0.53^a$) | $24.20 \pm 0.82^a$<br>($7.76 \pm 0.48^a$) | $22.83 \pm 0.85^a$<br>($7.23 \pm 0.55^a$) |
| Control 1 | $33.25 \pm 1.44^a$<br>($9.25 \pm 0.86^a$) | $33.25 \pm 1.44^b$<br>($9.25 \pm 0.86^a$) | $33.25 \pm 1.44^b$<br>($9.25 \pm 0.86^a$) | $33.25 \pm 1.44^b$<br>($9.25 \pm 0.86^b$) | $33.25 \pm 1.44^b$<br>($9.25 \pm 0.86^b$) |
| Control 2 | $33.80 \pm 1.46^a$<br>($9.39 \pm 0.56^a$) | $33.80 \pm 1.46^b$<br>($9.39 \pm 0.56^a$) | $33.80 \pm 1.46^b$<br>($9.39 \pm 0.56^a$) | $33.80 \pm 1.46^b$<br>($9.39 \pm 0.56^b$) | $33.80 \pm 1.46^b$<br>($9.39 \pm 0.56^b$) |

*Each value is the mean of ± standard error of 5 replicates. Mean followed by the same letters within the same column are not significantly (p > 0.05) different from each other using New Duncan's Multiple Range Test.*

[xx] *Values in parenthesis shows weight loss of cowpea seeds.*

[xx] *control 1 is the cowpea treated with 2ml methanol while control 2 is the cowpea neither treated with extracts nor solvent.*

## 4. Discussion

The acceptability of any insecticide depends on its ability to prevent or reduce infestation by insects and to have less or no adverse effect on the human and environmental health as well as the protected commodities. Since botanical insecticides however remain the most accessible source of insect control for both poor and mechanize farmers, their method of application still remain a major challenge which need to be tackled. Fumigant toxicity has been suggested however to be an alternative application method since it may not have effect on the colour and scent of protected commodities (Ogungbite *et al.*, 2014b).

The result obtained from this research showed that the fume from different extract of *N. laevis* had a significant effect on the survival of the adult *C. maculatus* when compared to the controls. The effect of these extracts however varied with the period of application, part of *N. laevis* and concentration. The ability of the extract to effect significant mortality could be due to ability of the fume from the extracts to disrupt normal respiratory process of the insects which in turn results in suffocation and subsequent death of the adult beetle. In addition, since respiration is a major pathway required by living organisms, the ability of the gas from these plant parts to disrupt normal respiratory process of the insect could affect their ability to feed and in turn results in starvation. The result of this present work acquiesced with work of Ogungbite et al. (2014) in which fume from *Euginea aromatica* effect high mortality on *Sitophilus zeamais*. The result obtained showed that root extract of *N. laevis* had more fumigant toxicity than the leaves, stem bark and ash extract as reflected by their lethal concentration. This agreed with the work of Ogungbite and Oyeniyi (2014) as well as Ogungbite et al. (2014a) in which the root extract of *N. laevis* had the highest mortality effect on *S. zeamais* and *S. oryzae*. However, none of the extract achieve up to 50% beetle mortality within the period of exposure. This was not in accordance with the result obtained by Ashamo et al. (2013) as well as Ogungbite et al. (2014a) in which the powder and extract of different parts of *N. laevis* achieved more than 70% mortality of *C. maculatus* within the period of applications. This could be due to the fact that the extract has low repulsive smell unlike other plants such as *Nicotiana spp* which has high unattractive smells.

Furthermore, regardless of the plant part used, *N. laevis* extracts reduced the oviposition and adult emergence of *C. maculatus* at higher concentrations when compared to the controls. This inability of the insect to lay more eggs could be due to the fume of the extracts which had affected the respiratory rate of the insects and in turn affected the rate of mating among the insects. Also, the high rate of mortality could also be responsible for the low rate of oviposition. The low adult emergence of the insects could be due to inability of the larvae to emerge as they may not be able to fully castoff their exoskelecton which remain joined to their abdomen (Trindade *et al.,* 2008; Oigiangbe *et al.,* 2010). This may also be due to the allelochemicals present in the extracts of this plant. For example, tannin, saponins, alkaloids, cardiac glycosides (Germann *et al.,* 2006; Akerele *et al.*, 2011) present in different parts of this plant had been reported to have inhibitory effect on the development of insects (Yang *et al.,* 2006). The reduced weight loss and damage of the cowpea protected by extract of different parts of *N. laevis* could be due to reduced adult emergence as suggested by Oni and Ogungbite (2015). These authors opined that the higher the rate of adult that emerge from a stored commodity the higher will be the rate of weight loss of the commodity. The result obtained in this research showed that the extracts of *N. laevis* could be a promising tool in insect control since it has no adverse effect on the colour and smell of the protected cowpea. However, the fumigant toxicity of the these extracts was too low compared to the result obtained by the research of Ashamo et al. (2013), Ogungbite et al. (2014a) as well as Ogungbite and Oyeniyi (2014) in which the extracts and powders of *N. laevis* was used as protectant against *C. maculatus, S. oryzae* and *S. zeamais*. Moreover, the result obtained in this work agreed with the work of above mention authors which reported that the root powder and extract of *N. laevis* were more effective than the powders and extracts of other parts of the plant. The concentration of these extracts could however be increased to increase their effectiveness. More so they have no adverse effect on the colour and smell of the protected commodity. Also, the actual active compound of this plant need to be characterized and isolated as this could help in its large production in the laboratory.

## 5. CONCLUSION

The extracts of different parts of *Newbouldia laevis* showed low fumigant toxicity. However, these extracts could be a promising tool in insect control if their concentration is increased as reflected by their lethal concentrations. Also, the root extract appeared most effective as fumigant than other extracts and can be used instead of other parts in order to achieve effective insect control.

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