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Evaluation of the Insecticidal Effects of Aqueous Extracts of the Leaves of: *Erythrophleum guineense* and *Uvaria chamae* against *Caryedon serratus* Ol. (Coleoptera, Bruchidae), an Insect Pest of Groundnut Grains in the Republic of Guinea

Aboubacar Safi Sylla[1], Adama Moussa Sakho[2], Aboubacar Diallo[1,3] and Abdoulaye Keita[1]

1. Department of Chemistry, Université Gamal Abdel Nasser de Conakry, Conakry 1147, Republic of Guinea

2. Laboratory Technique, Higher Institute of Technology of Mamou, Mamou 063, Republic of Guinea

3. Higher Institute of Architecture and Town Planning, Conakry 324, Republic of Guinea

Abstract: The aim of this study is to evaluate the insecticidal potential of aqueous extracts of the leaves of *Erythrophleum guineense* and *Uvaria chamae* on *Caryedon serratus* Ol. (Coleoptera, Bruchidae), an insect pest of groundnut grains in the Republic of Guinea. To do this, tests on their insecticidal efficacy were carried out separately on groups of 8 bruchids using concentrations of aqueous extracts from their leaves in jars each containing 20 g of groundnut. The mortality of the bruchids and the impact of their aqueous extracts were observed and recorded for 96 h and 120 days after infestation, followed by a test of the germinative power of the seeds. Concentrations (C1) of aqueous extracts of the leaves of *Erythrophleum guineense* and *Uvaria chamae* applied to 20 g of groundnut resulted in bruchid mortality of 86.99% and 78.82% of each plant respectively. At the same doses, the treated seeds were not attacked during 4 months' storage. The germination rate of groundnut seeds at the start and end of the experiment was 97.65% and 93.60% respectively. Thus, aqueous extracts of the leaves of *Erythrophleum guineense* and *Uvaria chamae* can be considered as an alternative bio-insecticide against pests in groundnut storage shops.

Key words: Insecticidal effect, *Erythrophleum guineense*, *Uvaria chamae*, *Caryedon serratus* Ol.

1. Introduction

In the Republic of Guinea, groundnut cultivation is considered to be one of the main crops with an economic and food impact. It occupies 16.41% or 160,632 ha of arable land [1]. This oilseed is rich in protein and lipids (25% and 50% respectively). However, these grains are often attacked by several insects, the most dreaded of which is *Caryedon serratus* (Olivier), responsible for quantitative losses of around 83% post-harvest [2]. These losses can exceed 50% to 60% of agricultural production [3]. In the Republic of Guinea, almost 30% of cereal and oilseed production is ravaged by insects during harvesting and storage. This results in losses of nutritional value [4]. To remedy this scourge, the government of the Republic of Guinea set up a programme to study all insect pests before and after harvest in the prefecture of Pita (December 1988) [5]. However, certain methods of controlling insect pests, such as chemical pesticides, present potential risks to human health and the environment, and their very high cost means that farmers have to resort to new pest control techniques. To minimize the risks associated with the use of chemical insecticides, a great deal of

Corresponding author: Aboubacar Safi Sylla, Doctoral student, research field: protection of foodstuffs post-harvest.

research has been carried out into the use of bio-insecticides of plant origin to replace traditional synthetic insecticides, as these natural substances have low toxicity for humans and the environment [6-10]. Our teams have recently reported work on certain plants with insecticidal properties [11, 12]. As an extension of our studies, we report in this study, "Evaluation of the insecticidal effects of aqueous extracts of the leaves of: *Erythrophleum guineense* and *Uvaria chamae* against *Caryedon serratus* Ol. (Coleoptera, Bruchidae), an insect pest of groundnut grains".

2. Materials and Methods

2.1 Survey Material

In order to carry out this study, survey forms were drawn up to collect information on the health risks associated with the prolonged storage and sale of groundnuts in five (5) markets in Conakry.

2.2 Presentation of the Study Area

This study was carried out in the city of Conakry, capital of the governorate of Conakry, which is located in south-west Guinea, on the Camayenne peninsula, near the Loos islands. The Conakry conurbation covers an area of 45,000 ha with a population density of 5,150 inhabitants/km^2. The city has an estimated population of 1,667,864, and lies between latitudes 9°35′ and 9°40′ north and between longitudes 13°37′ and 13°42′ west. The city of Conakry comprises five communes: Kaloum, Dixinn, Matam, Ratoma and Matoto. The economic activity of these five communes is reflected in the presence of a multitude of markets and commercial shops to which food products from the interior of the country are supplied and stored.

2.3 Study Setting

The organic chemistry laboratory of the Department of Chemistry at the Gamal Abdel Nasser University in Conakry served as the study setting.

2.4 Sampling

The leaves of: *Erythrophleum guineense* and *Uvaria chamae* were harvested in the morning between 8 and 10 a.m. in the sub-prefecture of Tondon (Dubréka prefecture, Republic of Guinea) in order to obtain a high concentration of active molecules. After harvesting, the fresh leaves of these two plant species were crushed, then soaked in water for 24 h (a process for aqueous extraction of active ingredients using the maceration technique). This aqueous extract was used for testing in the organic chemistry laboratory of the Department of Chemistry, Gamal Abdel Nasser University, Conakry.

2.5 Collection of Infected Peanut Kernels

The *C. serratus* strain used in the experiment came from infested groundnut grains purchased at the Matoto market (commune of Matoto). The peanut seeds used for rearing the *C. serratus* strain were also purchased at the same market, followed by sorting to eliminate bad seeds and foreign matter. After sorting, the peanuts were washed and dried at room temperature in the laboratory for 72 h, followed by a second drying at 40 ℃ in an oven for 15 min to eliminate residual contaminants. The beans were then placed in plastic jars and kept in the freezer for 96 h to eliminate any further infestation (Fig. 1).

Fig. 1 Peanut kernels purchased, sorted, washed, dried and preserved before insect rearing.

2.6 Rearing Insects (Caryedon serratus Ol.)

Procedure: The seeds are then placed in glass jars 16 cm high and 8 cm in diameter, hermetically sealed to prevent any further infestation. Mass rearing: The bruchids are reared in the laboratory. Mass rearing takes place in cylindrical glass jars (about 16 cm in diameter and 8 cm high), perforated and covered with muslin cloths to allow the insects to breathe. The peanut seeds serve as breeding grounds for the insects. In each jar, peanut seeds are introduced until the base is completely hidden and a sufficient number of insects are present. The jars are left in the dark at room temperature. After 48 h, peanut seeds infected with *Carydon serratus* eggs were placed in glass jars to allow the eggs to develop until the adults emerged. Adult emergence was recorded every two days. The following tests were carried out: insect mortality test (biological test) in the presence of *Erythrophleum guineense* and *Uvaria chamae* plant extracts, germination test on grains treated with these plant extracts and weight loss (agronomic test).

2.7 Preparation of the Stock Solution

A stock solution for each plant was obtained by introducing 200 g of the leaves of the plants: *Erythrophleum guineense* and *Uvaria chamae* in 500 mL of water respectively to obtain a 0.4 g/mL solution (Fig. 2).

Procedure: 200 g of fresh leaves from each of these plants were added to 500 mL of water in a jar. Then place in the fridge for 5 days to prevent fermentation. After 5 days, filter the aqueous solution using a household sieve reinforced with muslin into a funnel. The aqueous extract obtained was stored in a one-litre bottle for use (Fig. 2). The other aqueous extracts were obtained by dilution C2 = 200 g/L = 0.2 g/mL and C3 = 200 g/1.5 L = 0.13 g/mL.

2.8 Insect Attack Tests with Aqueous Extracts

Procedure: In each jar, eight new insects after rearing, 20 g of groundnut and 1 mL of each solution taken were placed together and covered with muslin cloth to allow the insects to breathe. The mortality rate of the insects following contact with the solution prepared from the extract of these two plants was observed and recorded every day for 10 days.

2.9 Calculating the Moisture Content of Groundnuts

Principle: The moisture content of groundnut kernels was determined by the complete desiccation method under study. This consists of drying a test sample in an

Fig. 2 Filtering process used to obtain the stock solution for each plant.

oven at a temperature of 100-105 ℃ until a constant weight is obtained, over a period of 3 h. The result is given by the following formula:

$$H\% = \frac{P_2 - P_1}{Pe} \times 100$$

H% = humidity; P_2 = weight of capsule + sample before drying; P_1= weight of capsule + sample after drying; Pe = weight of test sample.

2.10 Calculation of the Mortality Rate of C. serratus Adults

After the treatments, daily monitoring was carried out for each batch (3 batches, each batch consisting of 4 pots), followed by a count of the dead insects. The percentage mortality was determined using the empirical formula of W. S. Abbott [13].

$$\text{Mc} = \frac{Mo - Mt}{100 - Mt} \times 100$$

where *Mo* = mortality in treated batches, *Mt* = mortality in the control and *Mc* = calculated mortality.

2.11 Estimation of Damage to Groundnut Kernels

After infestation of the peanut kernels, the damage caused by the insects was calculated by separating the healthy kernels from the attacked kernels. The percentage of attack (*A*%) was calculated using the formula:

$$A(\%) = \frac{Na}{Ns + Na} \times 100$$

where *Ns* is the number of healthy grains and *Na* represents the number of attacked grains.

2.12 Germination Test

After contact treatments for 120 days, the seeds were subjected to a germination test. In fact, 20 seeds at random from each treated sample were spread out in uncovered jars on cotton moistened with distilled water at 26 ° C at laboratory temperature. After 5 days, germinated seeds were counted for each sample (Fig. 3). The germination rate was assessed by counting the number of seeds that had germinated in relation to the seeds sown, using the formula:

$$G\% = \frac{NGG}{NGE} \times 100$$

where: *G*% is the germination percentage, NGG represents the number of grains germinated and NGE the number of grains sown.

2.13 Statistical Analysis (R)

The data were recorded in Microsoft Excel spreadsheet as the database for the analyses. Statistical analyses of the measured variables were performed using R software. The resulting data were subjected to a non-parametric Wilcoxon and Kruskal-Wallis rank sum test. The first was used to determine the significant difference between the calculated means of two samples. The second was used to test for significant differences between the calculated sample means. The difference between two values is considered significant when the *p*-value is less than 5% ($p < 0.05$).

Fig. 3 Germination of infected peanut seeds after treatment with aqueous leaf extracts from the two plants.

3. Results

3.1 Determination of Moisture Content

The values of the moisture content of the groundnut grains used in this study are presented in Table 1. Insecticidal effects or toxicity of *Erythrophleum guineense* and *Uvaria chamae* extracts; Larvicidal effect of *Erythrophleum guineense* and *Uvaria chamae* extracts on *C. serratus*; Impact of *Erythrophleum guineense* and *Uvaria chamae* extracts on damage caused by *C. serratus*; Impact of *Erythrophleum guineense* and *Uvaria chamae* extracts on germination are shown in Tables 2-4.

Table 1 Average moisture found in peanut kernels.

Designation	P_1	P_e	P_2	*H*%	H_M
	24.30	5.00	24.95	13.00	
Groundnut	26.48	5.10	27.03	10.78	11.85
	22.80	5.01	23.39	11.77	

Table 2 Insecticidal effects or toxicity of extracts of *Erythrophleum guineense* and *Uvaria chamae*.

Leaves	Treatment	Doses (g/mL)	Average mortality rate (%)
	C1	0.4 g/mL	86.99 ± 18.45
Erythrophleum guineense	C2	0.2 g/mL	15.78 ± 24.29
	C3	0.13 g/mL	46.57 ± 43.24
White witness	TB	0 g/mL	0.00 ± 00.00
Solution indicator	TS	0 g/mL	31.35 ± 55.71
	C1	0.4 g/mL	78.82 ± 21. 20
Uvaria chamae	C2	0.2 g/mL	12.46 ± 20.25
	C3	0.13 g/mL	35.74 ± 25.77

Table 3 The percentage weight loss of grain infested by *C. serratus* after treatment with extracts of *Erythrophleum guineense* and *Uvaria chamae*.

Leaves	Treatment	Doses (g/mL)	Damaged grains	Percentage weight loss
	C1	0.4 g/mL	2.65 ± 2.47	0
Erythrophleum guineense	C2	0.2 g/mL	23.65 ± 3.07	4.55 ± 2.06
	C3	0.13 g/mL	65.66 ± 17.55	35.90 ± 10.38
White witness	TB	0 g/mL	92.22 ± 0.83	8.15 ± 0.06
Solution indicator	TS	0 g/mL	78.56 ± 0.55	7.21 ± 0.09
	C1	0.4 g/mL	1.36 ± 1.38	0.00 ± 00.00
Uvaria chamae	C2	0.2 g/mL	21.66 ±1.85	2.65 ± 0.21
	C3	0.13 g/mL	63.50 ±16.05	33.65 ± 10.33

Table 4 Impact of extracts of *Erythrophleum guineense* and *Uvaria chamae* on germination.

Leaves	Treatment	Doses (g/mL)	Percentage of germination
	C1	0.4 g/mL	97.65 ± 17.47
Erythrophleum guineense	C2	0.2 g/mL	53.65 ± 25.07
	C3	0.13 g/mL	36.66 ± 10.55
White Witness	TB	0 g/mL	13.22 ± 7.83
Solution indicator	TS	0 g/mL	28.56 ± 20.57
	C1	0.4 g/mL	93.60 ± 12.45
Uvaria chamae	C2	0.2 g/mL	53.60 ± 20.60
	C3	0.13 g/mL	27.36 ± 7.38

4. Discussion

The preparation of extracts from the leaves of *Erythrophleum guineense* and *Uvaria chamae* was an essential step in obtaining a solution containing the majority of these active ingredients with a view to evaluating their insecticidal activity. To achieve this objective, the hygroscopic moisture content was determined using the complete oven drying method on peanut grains. The average value found was 11.85% (Table 1). This value is within the range of 10%-13% maximum moisture content of groundnut pods indicated by that found by Ref. [14]. Determination of moisture content was followed by evaluation of the insecticidal effects or toxicity of extracts of *Erythrophleum guineense* and *Uvaria chamae* using concentrations of: 0.4 g/mL; 0.2 g/mL; 0.13 g/mL respectively. These concentrations resulted in mortality of *C. serratus* (Table 2). The highest value of the average mortality rate (toxicity) with the mixture of 20 g peanut and *Erythrophleum guineense* extracts after 5 days of observation was observed at 0.4 g/mL concentration (C1); followed by 0.2 g/mL (C2); 0.13 (C3) i.e. mortality rates of 86.99 ± 18.45; 46.57 ± 43.24 and 15.78 ± 24.29 respectively. For *Uvaria chamae* extracts, the highest mean mortality value was obtained at the same concentration of 0.4 g/mL, followed by 0.13 and 0.2 g/mL, giving mortality rates of 78.82 ± 21.20, 35.74 ± 25.77 and 12.46 ± 20.25 respectively (Table 2). These results confirm those found by Faye et al. [15] who concluded that the choice of dose applied influences the majority of compounds responsible for insecticidal action. Although the results obtained for the *Uvaria chamae* extract showed no significant difference ($p < 0.05$) with those recorded for the *Erythrophleum guineense* extract, a slight decrease in the mortality rate was observed. In general, depending on the concentrations and the number of dead individuals, *Erythrophleum guineense* extract appears to be more toxic to *C. serratus* than *Uvaria chamae* extract. A significant difference ($p < 0.05$) was recorded between the mean mortality rates obtained in jars treated with *Erythrophleum guineense* extract and *Uvaria chamae* extract and those in control jars. The results in Table 3 show that the percentage of damage and weight loss of peanut kernels after the application of 1 mL of each solution increased with the dilution rate of 200 g of *Erythrophleum guineense* and *Uvaria chamae* leaves using dilutions (200/500; 200/1,000 and 200/1,500 g/mL) with concentrations (0.4; 0.2 and 0.13 g/mL). The less diluted the solution, the more effective it is. Thus, the best concentration would be 200/500 dilution, i.e. 0.4 mg/mL. This may probably be due to the increased amount of water used rotting the peanut kernels. In the control jars there was an 8.15% ± 0.06% loss in weight of the peanut kernels. However, in the jars treated with *Erythrophleum guineense* extract, the percentages of weight loss were: 0; 4.55 ± 2.06 and 35.90 ± 10.38 at concentrations of 0.4; 0.2 and 0.13 g/mL respectively. For the *Uvaria chamae* extract, the percentages of weight loss at the same concentrations were: 0; 2.65 ± 0.21 and 33.65 ± 10.33 respectively. The germination test carried out at the beginning of the trial gave an appreciable rate (*Erythrophleum guineense*) (Table 4). Thus, the less dilute the solution in contact with the grains, the higher their germination percentages: (200/500, 200/1,000 and 200/1,500 g/mL) with concentrations of 0.4, 0.2 and 0.13 g/mL. For *Uvaria chamae*, the observations are identical to those for *Erythrophleum guineense* and these results are similar to those found by AGRAR [16], which showed that the germination capacity of wheat treated with Indian lilac before being stored was not affected during sowing. The germination rate increased as a function of dilution, i.e. in the order of: 93.60%, 53.60% and 27.36% respectively. On the other hand, in the control jars (T0) where the insects were in direct contact with the grains, the germination rate was 13.22% (Table 4).

5. Conclusion

This study enabled us to determine the insecticidal properties of aqueous extracts from the leaves of two

plants: *Erythrophleum guineense* and *Uvaria chamae* on *Caryedon serratus* Ol. (Coleoptera, Bruchidae), an insect pest of groundnut grains. To do this, we purchased groundnut seeds and sorted, cleaned, dried and preserved the seeds for rearing new insects, which were used in the experiments. To this end, we evaluated the moisture content of the acid grains, the average value of which was found to be: 11.85% before the experiment. This was followed by the preparation of a stock solution for each plant sample to obtain a solution of 0.4 g/mL. Then, 1 mL of stock solution was taken and put together with new insects, 20 g of groundnuts were covered with cloth to allow the insects to breathe. It was found that the highest value for the average mortality rate of bruchids after 5 days of observation was found with the C1 dose of *Erythrophleum guineense* and *Uvaria chamae* extracts (0.4 g/mL) with concentrations of 86.99% ± 18.45% and 78.82% ± 21.20% respectively. However, the lowest value for the percentage of damage and weight loss of peanut kernels was found with the 200 g/500 mL dilution of the solution extracts of the leaves of: *Erythrophleum guineense* and *Uvaria chamae* (Table 3). The germination rate at the start of the trial was 97.65% (*Erythrophleum guineense*) and 93.60% (*Uvaria chamae*). Untreated peanut kernels lost their germination capacity at a rate of 13.22%.

Conflict of Interest

We, declare that there is no conflict of interest between us on this article.

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