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Insecticidal effect of kaolin powder flavoured with essential oils of *Lantana camara* L. (Verbenaceae) and *Annona senegalensis* Pers. (Annonaceae) on *Caryedon serratus* Olivier (Coleoptera-Bruchidae), a groundnut stock pest

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ABSTRACT

The groundnut weevil, *Caryedon serratus,* causes significant losses of groundnut stocks in Senegal by developing larvae in the seeds. Essential oils extracted from leaves of two plants that grow naturally in Senegal, i.e. the sugar apple (*Annona senegalensis* Pers.) and lantana (*Lantana camara*), were tested on adults of *Caryedon serratus.* Purified and pulverized kaolin was flavoured with essential oils of *A. Senegalensis* Pers. and *L. camara (Lam)* obtained through vapour distillation. Adults *C. serratus* aged 24 hrs at most were treated with 0.1 g of powder flavoured with increasing doses (12.5 to 50 µl/g. of powder) of essential oil. With increasing doses (12.5 to 50 µl/g of powder) of essential oil. The powder Aromatized with essential oil of *A. senegalensis* at concentration 25 µl/g. induced 50% mortality after 36 hrs of contact at concentration 25 µl/g and 100% after 48 hrs at 50 µl/g. The powder mixed with the essential oil of *L. camara* induced after 12 hours of contact 22% mortality at the dose of 12.5 µl/g, the mortality increased with dose duration of exposure and reached 97.22% after 36 hrs with 50µl/g.

Keywords: Toxicity, *Caryedon serratus, Annona senegalensis, Lantana camara*, essential oils, kaolin.

INTRODUCTION

In other to control insects, farmers use chemical insecticides, most of which are harmful to environment, consumers, and induce insect resistance. Traditional methods using aromatic plants into attics are experiencing a renewed interest. Several censuses of these plants in the tropics areas have been carried out and insecticide or repellent action of the volatile compounds they emit has been the subject of numerous studies in laboratory conditions Sanon et al. (2002). These compounds have interesting biological properties, low toxicity to warm-blooded mammals and are very volatile

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(Shaaya et al., 1991, 1997; Li and Zou, 2001; Wang et al., 2006).

The insecticidal effect of essential oils extracted from leaves of two plants that naturally grow in Senegal, i.e. the sugar apple (*Annona senegalensis* Pers.) and lantana (*Lantana camara*) has been reported by some authors. Indeed, Gwinna et al. (1996) reported that crushed fresh leaves of *L. camara* mixed with seeds or arranged in barrier layer on the ground or as a protective layer (sandwich method), have a repellent effect against legume weevils. This protective effect can last up to 6 months. Fresh or dried leaves of *Annona* spp have a repellent and insecticidal effect against weevils as well as pests of sorghum and millet (Foua-Bi, 1993; Gwinner et al., 1996). Previous studies conducted within our team allowed us to highlight the adulticide effect of essential oils extracted from these plants (Gueye, 2008). According to Subramanyam et al. (1994) and Banks & Fields (1995), mineral powders and ashes have long been used successfully to control insect populations in stored products.

Pure kaolin, that is to say, the fine powder, is recognized by some traditional societies for its ability to control insect populations (Keita et al., 2000).

For this study we tested the effect of kaolin flavoured with essential oils of *Annona senegalensis* Pers. and *Lantana camara* on adults of *Caryedon serratus*, a pest of groundnut stocks.

MATERIALS AND METHODS

Collection of plants and extraction of essential oils

L. camara was harvested in Mbao (14 ° 43'51" North, 17 ° 19'28" West) and Sangalkam (14 ° 46'52" North, 17 ° 13'40") and *Annona senegalensis* in Sangalkam in February 2008. These two villages are in the area of Dakar. Four kilograms of fresh leaves of *A. senegalensis* and two kilograms of fresh leaves and stems of *L. camara* were processed by steam for 1 hour. Essential oils obtained after decantations were dried with anhydrous sodium sulphate and kept cold.

Rearing

The insects used came from pods of *Piliostigma reticulatum* and *Arachis hypogaea*. They were raised in the laboratory in glass jars fitted with screen cover. In each jar, seeds of *A. hypogaea* and *P. reticulatum* were introduced, a sufficient number of male and female, and cotton soaked in distilled water. After 48 hrs, the seeds were collected in glass Petri dishes and left at room temperature.

Purification of kaolin

The method of Keita et al. (2000) was used with some modifications. Three kilograms of dry kaolin were dissolved in deionised water and placed in an autoclave at 110° C for 20 min. The solution obtained was cooled to room temperature and filtered successively with sieves of 50 µm and 40 µm diameter. After pH measurement, the filtrate was covered with a fine mesh metal screen and left to rest for three days. The deposit was collected, covered and sun dried. The dry material was pulverized with a porcelain mortar then sieved with a 40 µm diameter sieve. The fine powder obtained was stored under vacuum in plastic bags.

Aromatization of kaolin

The powder was dried beforehand in a desiccator with silica gel. For each plant, two grams of powder were placed in pill tile with 5 ml of pentane. In each pill tile, 25, 50 or 100 µl of essential oil was added. The solutions were homogenized with a vortex and the solvent was aspirated with a vacuum desiccators. The flavoured powders were wrapped with aluminium foil and kept cool.

Adulticide test

The tests were performed in Petri dishes on 12 insects aged 24 hrs at most. They were placed in dishes with 0.1 g of powder flavoured with 25, 50 or 100 µl of essential oil corresponding to concentrations of 12.5, 25 and 50µl / g. Insects treated with 0.1 g of unflavoured kaolin powder and untreated insects served as control. The dishes were placed at room temperature. Mortality was recorded one hour after treatment and every 12 hr for 48 h.

To evaluate the insecticidal efficacy, mortalities obtained with the treated samples were corrected by comparison with those of untreated samples according to the Abbott's formula (Abbot, 1925). This correction allows excluding the natural mortality observed in our experimental conditions. It is calculated using the following formula:

$$\text{Efficacy \%} = \frac{\text{Om} - \text{Bm}}{100 - \text{Bioassay mortality}} \times 100$$

With Om = Observed mortality
Bm = Bioassay mortality

Comparative statistical analyses were performed using the Statview 5 software. The raw data were subjected to an analysis of variance (ANOVA). Averages were compared using the Fisher PLSD. P values less than 0.05 were considered as significant.

RESULTS

The essential oil yield obtained after 1 hr of hydro distillation stood at 0.21% for *A. senegalensis* and 0.04% for *L. camara*.

Adulticide effect of kaolin powder flavored with essential oil of *A. senegalensis*.

For the same exposure time, the histograms carrying the same alphabetical letter were not statistically different (p> 0.05).

During the first 12 hours of treatment, no mortality was noted whatever dose of *A. senegalensis* essential oil was used for flavouring the kaolin. After 24 h, the powders flavoured with 25 and 50 µl/g caused respective mortalities of 11.11 and 8.33%. The powder flavoured with 25 µl/g eliminated half of the insects within 36 hours of contact. After 48 hours, all insects were eliminated with 50µl/g (Figure 1).

Adulticide effect of kaolin powder flavoured with essential oil of *Lantana camara*

For the same exposure time, the histograms bearing the same alphabetical letter were not statistically different (p > 0.05).

Kaolin powder flavoured with *L. camara* essential oil acted from the first 12 hours of contact and eliminated 22% of insects with 12.5µl/g. After 24 h, for each concentration tested, an increase in the mortality rate was observed and reached 97.22% after 36 hrs with 50µl/g. It should be noted, however, that after 48 hours of contact the indicator (kaolin powder) induced the same effect as the 50 µl/g concentration.

Comparison of the efficacy of the two flavoured powders

On the same column and for the same concentration, the values marked with same alphabetical letter were not statistically different.

The statistical comparison of values obtained between the two powders showed that the one flavoured with essential oil of *L. camara* was on the whole significantly different from that flavoured with essential oil of *A. senegalensis* (p <0.05). However, there was no statistical difference between the concentrations if they were compared in pairs by treatment duration.

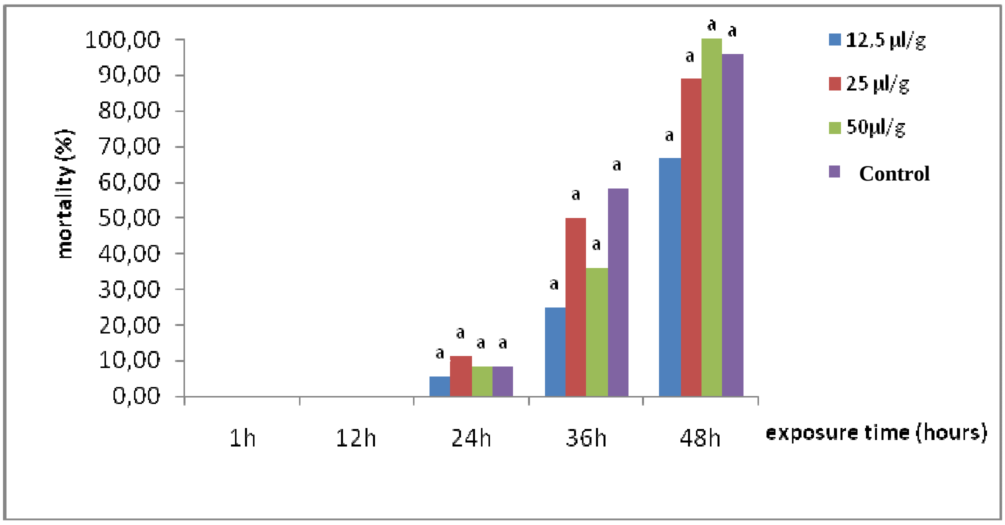

Figure 1: Adulticide effect of the kaolin powder flavored with *A Senegalensis* essential oil.

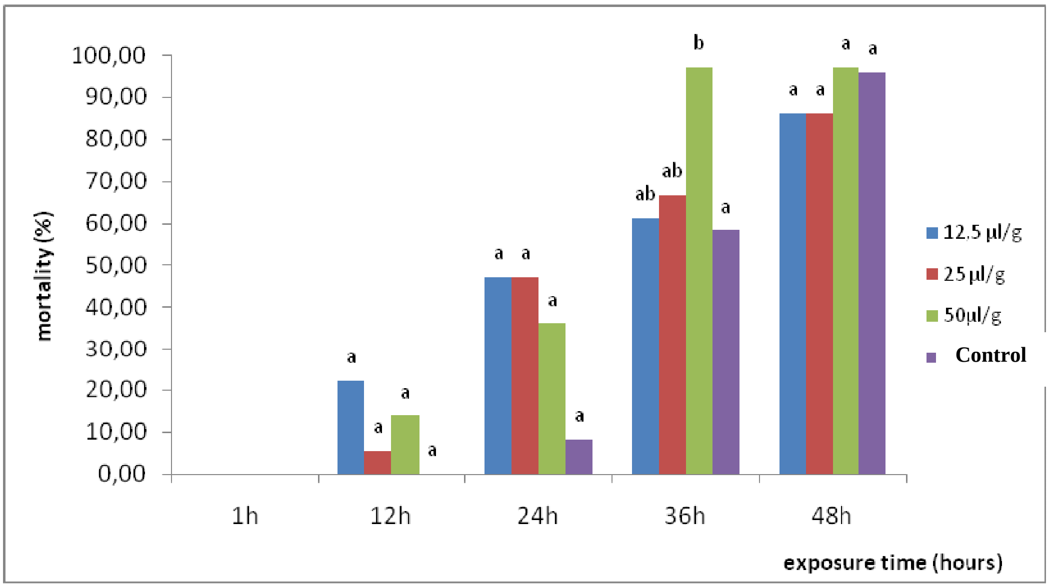

Figure 2: Adulticide effect of kaolin powder flavoured with *L. camara* essential oil.

Table 1: Comparative effect of powders flavoured with essential oils from leaves of *Lantana camara* and *Annona senegalensis.*

Plants	Concentrations	Exposure time (hours)				
		1	12	24	36	48
AS	12,5 µl/g	0,00	0,00[a]	5,56[a]	25,00[a]	66,67[a]
LC	12,5 µl/g	0,00	22,22[a]	47,22[a]	61,11[a]	86,11[a]
AS	25 µl/g	0,00	0,00[a]	11,11[a]	50,00[a]	88,89[a]
LC	25 µl/g	0,00	5,56[a]	47,22[a]	66,67[a]	86,11[a]
AS	50 µl/g	0,00	0,00[a]	8,33[a]	36,11[a]	100,00[a]
LC	50 µl/g	0,00	13,89[a]	36,11[a]	97,22[a]	97,22[a]

AS: *Annona senegalensis* ; LC: *Lantana camara*

DISCUSSION

The point in using a carrier for essential oils lies on the fact that their extraction yields are generally low. Moreover, according to Ramaswamy (1995) in Keita et al. (2000), the use of powders flavoured with essential oils has a double advantage because of a combination of mechanical action by blocking the articulations of insects at high doses by filling inter granular spaces and chemical action, primarily affecting the glandular cells. This could explain the mortality observed after 48 hrs on the insects with kaolin powder. In addition, kaolin powder could be used as an adhesive powder in case of insecticide formulation as is the case of Granox used in Senegal. Granox is made up of Captafol, Benomyl, Carbofuran and adhesive powder consisting of talc or attapulgite.

With *A. senegalensis*, low mortalities recorded may be due to a release of all the oil in the early hours of application because of the volatility thereof. Indeed, according Ngamo et al. (2007), the essential oils contaning oxygenated monoterpenes are less volatile. So the essential oil of *A. senegalensis* composed of only 7.4% of oxygenated monoterpenes (Jirovetz et al., 2002) would be very volatile. An investigation on the chemical composition of the *A. senegalensis* species growing in Senegal would bring some response elements. One might think that the effects observed after 36 hrs were mainly due to the action of the powder that acts mechanically on the articulation of insects.

The adulticide action of the kaolin powder flavoured with the essential oil of *L. camara* occurred after 12 hrs of contact. It was noted that after 24 hrs, the powder flavoured with a large volume of oil was not more effective. One would think that a great deal of the oil was captured by the kaolin, leading to an increased degree of compactness of the powder that only leaves a small amount of oil. The latter could act either by contact by diffusing first in the insect's body especially as at that moment the action of the powder is not yet effective, that is to say by inhalation. At 36 hrs, the high mortality observed could be attributed to the combined action of the oil and powder. This may have a more advanced mechanical mode of action.

Furthermore, Keita et al. (2000) observed within 48 hrs 20% mortality by treating adults of *Callosobruchus maculatus* with kaolin powder, while our results showed a mortality of 95% over the same period of exposure in *C. serratus*. The groundnut weevil would therefore be more sensitive to kaolin powder than the cowpea weevil. This sensitivity may be due to anatomical or morphological difference in epidermal cells and inter granular spaces between the two species, but also to the biology of the species. *C. maculatus* not forming a cocoon during its development cycle could be affected "external attacks" contrary to *C. serratus* that happens to be "protected" at its entire nymphal stage. The slight difference in pH of the two powders, (7.01) for the powder used by Keita et al. (2000) could also be the cause of this difference of sensitivity.

Conclusion

The *L camara* essential oil mixed with kaolin is effective against *C. serratus* and could be used for seed protection. The kaolin powder could be used as a ligand but it would be interesting to determine the amount of oil released by the powder.

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