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Impact of certain plants on the reduction of weight loss of stored cowpea due to *Callosobruchus maculatus*

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Abstract
This study was carried out under peasant conservation conditions. It intends to assess the effect of the leaves of certain plants (*Crateava religiosa*, *Azadirachta indica* and *Senna occidentalis*) against *Callosobruchus maculatus*, the main pest of cowpea stocks. Our study seeks to assess the impact of these plants on the reduction in weight of cowpea seeds inflicted by *C. maculatus* during storage. The cracking of the dry leaves of these plants was mixed with the cowpea seeds. For each plant, three doses were used. With the highest dose (D_1 (35.71g / kg), *Senna occidentalis* was more effective (1.5%) in reducing cowpea weight loss than other plants. It turns out with this dose that *A. indica* is effective. The holes caused by this insect were counted on 1000 seeds from each test. The dose D_1 is more effective than the other doses (D_2 (25g / kg) and D_3 (12.5g / kg)) on reducing the number of holes with the application of all plants except *S. occidentalis*. This plant proved to be more effective (2.247 holes / seed) than the others with the D_2 dose. Our study also revealed that the number of holes does not always provide information on the weight loss of the seeds. This is explained by the difference in size observed in adults of this beetle emerging from the holes.

Keywords: *Callosobruchus maculatus*, cowpea, weight loss, holes, *Crateava religiosa*, *Azadirachta indica* and *Senna occidentalis*

1. Introduction
The West African diet is based mainly on grains and legumes. For this purpose these seeds constitute a first-rate economic resource for the peasant populations, who have the obligation to conserve them for their food as well as for their commercial activities. This conservation is not often easy because of the effect of pests. Legumes grains such as that of cowpea can suffer considerable damage (100% (Ndiaye, [1])) as a result of these pests. Consequently, farmers use synthetic insecticides to counter this damage. This use often induces harmful effects on the environment and on human and animal health. This prompts scientists to think about the use of alternative methods to chemical pest control. This is how researchers are inspired by the use of the leaves of certain plants by farmers to offset the effect of pests on stored food (Diome *et al*, [2]; Faye *et al*. [3]; Mbaye *et al*. [4]). It is in this perspective that we used the leaves of certain plants native to Senegal (*Crateava religiosa*, *Azadirachta indica* and *Senna occidentalis*) to reduce the weight loss of stored cowpea inflicted by *Callosobruchus maculatus*.
This study uses a technique that is easily practicable by farmers, less expensive and not harmful to the environment.

2. Materials and Methods
The biological material used in this study was collected in Sandiara (Mbour, Senegal). After picking, the leaves of *Crateava religiosa*, *Azadirachta indica* and *Senna occidentalis* were spread on racks sheltered from the sun to be dried. These dry leaves were used in the experiment. For each test carried out, 250g of dry leaves were used.
The cowpea used in the experiment was also bought at the weekly market in Sandiara. This purchase was made in October 2020. Once in the laboratory, the cowpea is put in plastic bags in which it will be stored. To conduct the experiment, cowpea is divided into three weight (20kg, 10kg and 7kg) in these bags in plastic. Each weight cowpea three repetitions were performed and rehearsals were always accompanied by white witnesses (cowpeas without breaking plant leaves).

For each repetition, the 250g of dry leaves were broken in the plastic bags and mixed with the cowpea seeds. The bag openings were then closed with tie wires. The bags were then stacked in the shop of entomology laboratory and acarology of the department of Animal Biology, Faculty of Science and Technology of the University Cheikh Anta Diop in Dakar.
After 7 months of storage, the content of the bags was sifted to separate insects emerges of the seeds of cowpea and were broken dry leaves one hand and on the other hand cowpea seeds broken leaves. These three entities were then weighed separately.

2.1. Weight loss assessment

Weight loss is evaluated by a formula inspired by that used by Béninga Marboua Békoye and Aclé Dadié [5]. They are expressed by the following formula:

$$\%\ \text{weight loss} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} * 100$$

We calculated the weight loss of the weights tested and that of 1000 seeds from each test conducted. For each test carried out, we took a sample of 1000 seeds in order to assess the number of holes induced by the beetle on cowpea seeds after the duration of storage. We had counted the number of holes on each seed, the results were then compiled by batch of 10 seeds to facilitate counting. To do this, the seeds were held by thin tongs to facilitate counting. We determined thereafter the number of holes per seed per 1000 seeds from each test conducted, by the following formula:

$$\text{number of hole by seed} = \frac{\text{total number of holes for 1000 seeds}}{1000}$$

Attributing the loss of mass of the seeds to the holes inflicted by *Callosobruchus maculatus* during its emergence, we had evaluated the loss of mass by holes, therefore by an insect by the following formula:

$$\text{number of hole by seed} = \frac{\text{total number of holes for 1000 seeds}}{1000}$$

3. Result

3.1. Weight loss inflicted by *Callosobruchus maculatus* on stored cowpea seeds

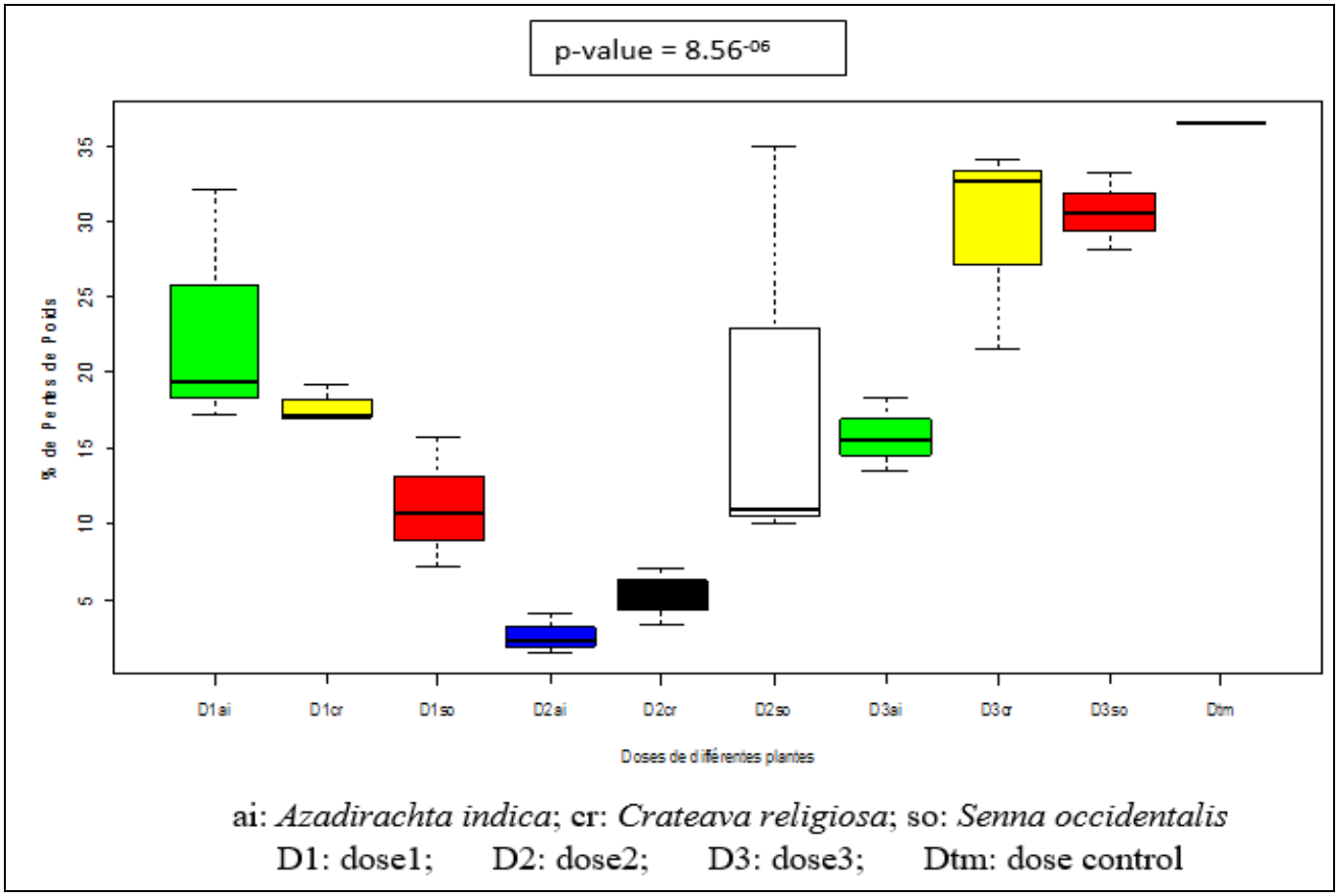

Fig 1: Percentage weight loss of stored cowpea tested

The assessment reduction stored cowpeas weight, revealed that all plants used in the tests attenuated weight loss cowpea inflicted by *Callosobruchus maculatus. Senna occidentalis* was more effective (1.5%) in reducing cowpea weight loss with the impact of the higher dose (D_1 (35.71g / kg)) than the other plants. For the lowest doses (D_2 (25g / kg) and D_3 (12.5g / kg)), *Azadirachta indica* gave the most notable reduction in the weight loss of this legume. Overall of all the doses tested, the D_2 dose was more effective regardless of the plant affected except *Senna occidentalis*. The effectiveness of these plants in reducing the weight of this legume was gauged by the weight loss recorded with the controls (36.5%) (figure1).

3.2. Weight loss of 1000 stored cowpea seeds

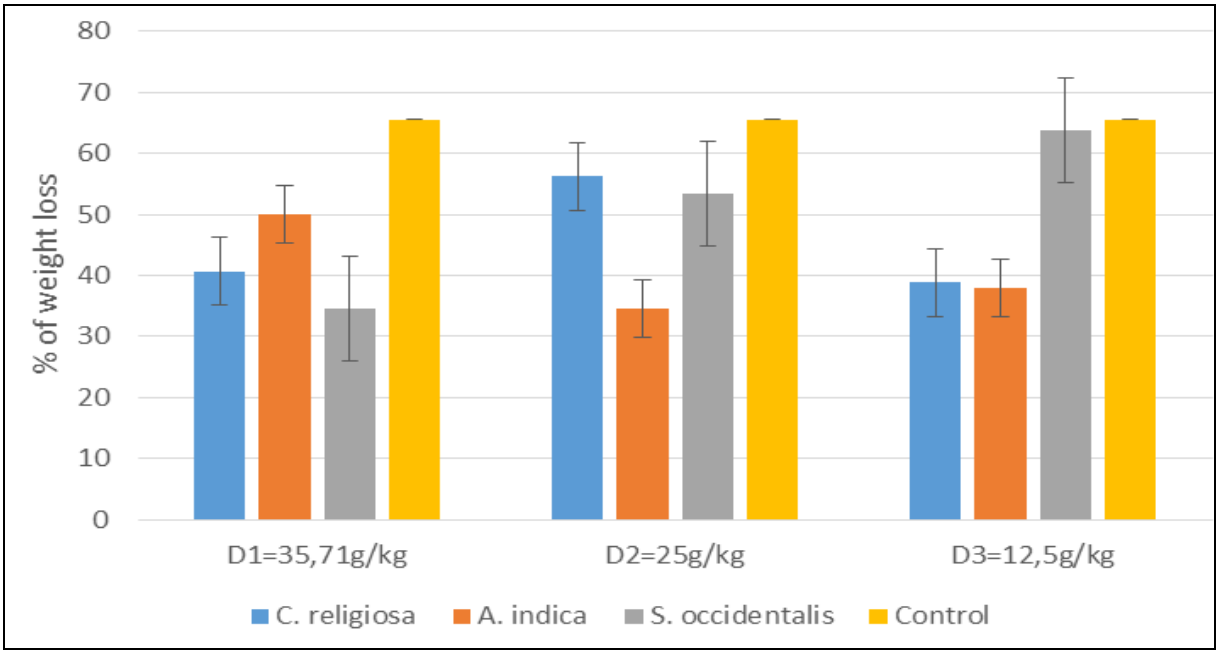

Fig 2: Weight loss of 1000 stored cowpea seeds

The weight losses noted for the 1000 seeds from the various tests follow those recorded for the weights tested. Thus A. indica was less effective (50%) with the higher dose (D_1) and more effective (34.48%) with the dose D_2. Whatever the tested dose, *C. religiosa* induced the most low weight reduction for 1000 seeds than other plants. Of all the plants applied, *S. occidentalis* was found to be less effective with the impact of D_2 and D_3 and more effective with D_1. The evaluation of the weight loss of 1000 seeds coming from the control weight, informs that all the plants reduce this weight loss except *S. occidentalis* with the dose D_3 (figure2).

3.3. Number of holes induced by *C. maculatus* per seed

The cowpea beetle *C. maculatus* lays its eggs on cowpea seeds to allow the larvae to enter the cotyledons. These larvae inflict holes on the seeds by consuming their reserves. The holes caused by this insect were counted on 1000 seeds from each test. Compared to the number of holes per seed recorded on the seeds of the control lot (3,852 holes/seed), it turns out that all the plants made it possible to reduce the number of holes per seed. This reduction in the number of holes is greater with *C. religiosa* by the impact of the D_1 dose. This dose is most effective in reducing the number of holes with the application of all plants except *S. occidentalis*. This plant has been shown to be more effective (2.247 holes/seed) than the others with D_2. The efficacy of *C. religiosa* and *S. occidentalis* is differential according to the doses applied, while that produced by *A. indica* is proportional to the dose affected (figure3).

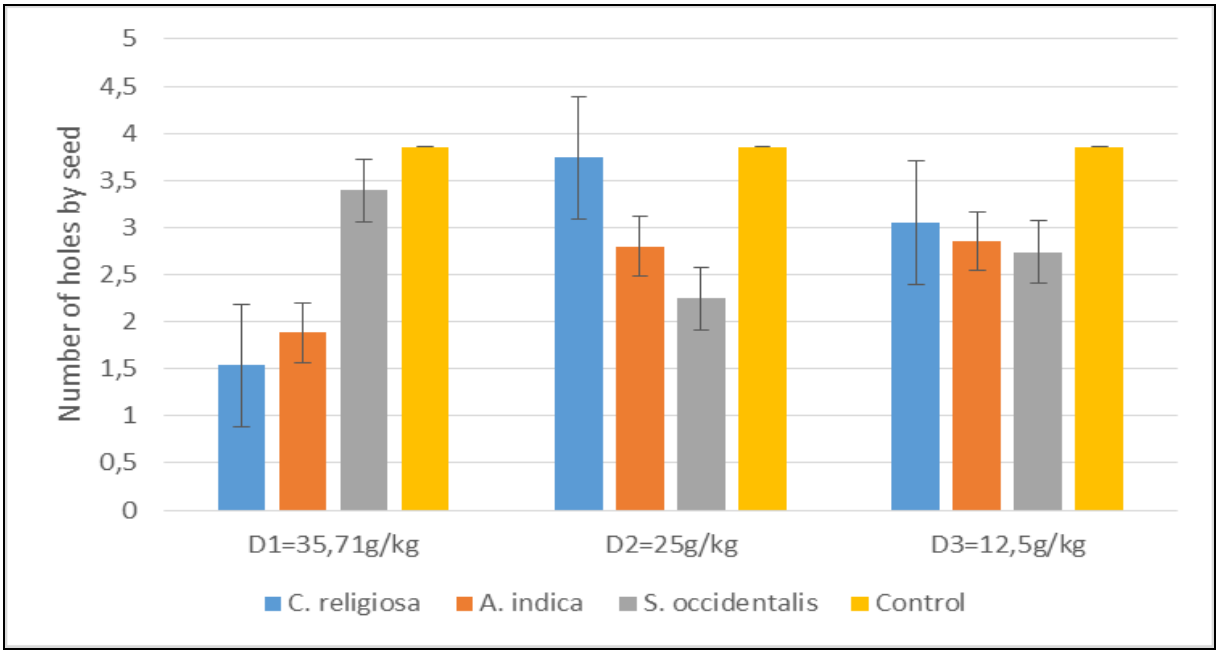

Fig 3: Number of holes caused by *C. maculatus* on cowpea seeds

4. Discussion

In the laboratory, the weight loss of stored cowpeas was evaluated. Cowpea was stored under peasant storage conditions. Several plants have been tested to reduce this weight loss. *A. indica* was more effective than the other impacted plants with the lowest doses (D 2 (25g / kg) and D 3 (12.5g / kg)), while with the highest dose (D_1 (35,71g / kg)), *S. occidentalis* was found to be more reducing the weight loss of stored cowpeas. With low doses, *C. religiosa* has been shown to be more effective in reducing cowpea weight loss than *S. occidentalis*. This loss of weight is due to the holes inflicted by the larvae *of C. maculatus* during their growth in the cotyledons of cowpea seeds. These results show that the insect *C. maculatus* has a differential sensitivity towards these plants. To minimize weight loss, these plants would have reduced egg laying as suggested by Faye *et al* [6]. This opposition to weight loss is also due to the effect of these plants on the external stages (larvae and adults) of the insect. This effect could slow the development of the larvae and consequently decrease the amount of material consumed by the larvae in the cotyledons of cowpea seeds. This suggests that the active substances contained in the leaves of these plants do not have the same impact on the stages of development of this beetle. In the wake of reducing cowpea weight loss inflicted by *C. maculatus* many researchers have used essential oils from plants. Thus, a treatment based on palm oils at a rate of 5mg/kg of cowpea, has induced a considerable protective action to preserve the weight of cowpea seeds with regard to the *C. maculatus* beetle. This treatment made it possible to reduce the destruction rate of cowpea seeds to less than 4.5% after three months of storage (Mukendi *et al*. [7]). Mustard and olive oils made it possible to completely preserve the seeds of *Vigna radiata* against pests after four months of storage (Ahmed *et al*. [8]). Hossain *et al* [9] reported that neem, beaver, sesame and Karnja oils allow a total reduction in weight loss of chickpea seeds at a dose of 4ml / kg. Olive oil mixed with certain acids such as linoleic acid, acid and oleic acid reverse the weight loss of *V. unguiculata* (Kaci, [10]).

In addition, our study also revealed that the number of holes does not always provide information on the weight loss of the seeds. This is explained by the difference in size observed in adults of this beetle emerging from the holes.

The vegetation under aqueous extracts *Thevetia neriifolia* of *Azadirachta neriifolia* to *Maniot esculenta*, of *Hyptis suaveolens* and *Cymbopogon nardus* allowed also significantly reducing attacks cowpea seeds weevils in stock (Bello *and al* [11]). These authors reveal that *Thevetia neriifolia* is more reducing cowpea loss than the other impacted plants. The efficacy results of the aqueous extracts thus obtained specify the points of view such as Nuto in [12], relating to the recommendation of the use of plant extracts or organs with insecticidal and or repellant effects, but also of oils. Vegetable and inert substances such as ash, fine sand, clay, salt, slaked lime, etc.

5. Conclusion

The aim of our study is to set up a technology for the conservation of legumes stored and applicable by farmers. This study aims to effectively preserve cowpea seeds during storage. Among other things, it reveals the effect of dry leaves of certain plants native to Senegal (*A. indica*, *C. religiosa* and *S. occidentalis*) against the cowpea weed. The leaves of these plants reduce the weight loss of cowpea seeds inflicted by *C. maculatus*. It appears that cowpea seeds impacted with the lowest doses (D_2 (25g / kg) and D_3 (12.5g / kg)), *A. indica* is more effective than other plants, whereas with the strong dose (D_1 (35.71g / kg)) *S. occidentalis* is the most effective plant for reducing the weight of cowpea seeds. Overall, *C. religiosa* is the least effective plant on this coleoptera for the reduction of these effects on cowpea seeds stored in peasant conditions. It is thus notable that the effect of the dry leaves of these plants is differential on the reduction in the weight loss of cowpea seeds due to *C. maculatus*. It would be interesting to test the effect of the other organs of these plants on the conservation of stored food. We are also giving ourselves the task of verifying soon the effect of the leaves of these plants on the protection of certain vegetable crops against pests.

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