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# Evaluation of phyto tablet formulation against key insect pests of stored produce under laboratory conditions

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**Abstract**
In the present study, certain plant species like Sweet basil, *Ocimum basilicum* L., Sweet flag rhizome, *Acorus calamus* L., Worm wood, *Artemisia vulgaris* L., Mint *Mentha piperita* L., and Indian privet, *Vitex negundo* L. were tested for their insecticidal properties in the formulation of tablets in laboratory conditions against Rice weevil, *Sitophilus oryzae* (Linnaeus) and red flour beetle *Tribolium castaneum*, (Herbst). These plant materials were dried under shade and ground into powder and the tablet formulation was synthesised by mixing with rice gruel and carrier materials *viz*. chalk powder (CP), kitchen ash (KA) and fly ash (FA). Among the combinations of tablets formulated and tested against the *S. oryzae*, *O. basilicum* + CP performed better in causing maximum mean mortality of 43.88% which is closely followed by, *O. basilicum* + KA, *A. vulgaris* + FA and *A. vulgaris* + KA with 40.55% mortality each. The least percent mortality was observed with *A. calamus* + KA, which caused 17.22%. The results shown that a maximum mean mortality of *T. castaneum* was witnessed in *A. vulgaris* + CP and *A. calamus* + FA caused 28.88%, followed by *O. basilicum* + KA (27.22%). The least percent mortality was found in treatments of *M. piperita* + FA caused 19.44%. The results of the weight loss by *S. oryzae* was noticed less in the grains treated with *A. vulgaris* + KA combination, which caused 10.67% loss, followed by *O. basilicum* + CP with 11.33% and *A. vulgaris* + CP and *V. negundo* + CP with 11.66% each. The results of the weight loss by *T. castaneum* was obtained less in the treatment with the tablets formulated using *A. vulgaris* + CP (11.66%) followed by *A. vulganis* + FA with 13.00% of weight loss, whereas the treatment *A. calamus* + FA evidenced with 24.66%. Hence, the selected plant materials and carriers formulated as tablets are recommended for the small scale storage of stored products safely from weevil and beetles.

**Keywords:** Formulation, plant species, stored produce, tablets

## Introduction
In developing countries, post-harvest loss of foods grain due to insect pests becomes a significant nutritional and economic problem to subsistence farmers (Firdisa and Abraham, 1999) [6]. The rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae) is considered as one of the common pests and causes both quantitative and qualitative losses to the storage grains worldwide (Madrid *et al*., 1990; Park *et al*., 2003) [11, 14]. Female weevil deposits eggs into grain, larvae are legless and remain in the grain kernel for their entire duration. Freshly emerged adults may extend several days within the grain, before chewing outlet holes to appear (Benhalima *et al*., 2004) [1]. *Tribolium castaneum* (Herbst) is also the most important and serious destructive primary insect pests on stored cereals. It has been treated as one of the main targets to control the insect pests of stored products (Liu and Ho, 1999) [10]. It is the most common insect pests of flour mills, grocery shops, and warehouses in many of the countries (Garcia *et al*., 2005 and Jemaa *et al*., 2012) [7, 9].
Since the 1950s, synthetic insecticides have been extensively used in stored grains to manage the insect pests. Fumigants such as methyl bromide, phosphine, cyanogens, ethyl formate, or sulfuryl fluoride which kills the various stage of insect pests of stored product in commodity or in storage structure. Fumigation is one of the effective management practices to prevent the insects of stored produce. But the pests can develop resistance against the synthetic compounds. Even the synthetic insecticides are effective and their frequent use has led to the development of residual toxicity, pollution to environmental and an unfavourable effect on food besides side effect on consumers. The continuous and blanket use of synthetic insecticides not only has led to the resistant strains development but also to accumulate the toxic residues on food grains which have been used for human consumption. In view of all problems, numerous insecticides have been either prohibited or restricted to use. The resistance development and residue of pesticides have became an increasing serious problems

and which contaminate the biosphere related with large-scale use of broad spectrum synthetic pesticides that have led to the need for efficient biodegradable pesticides with better selectivity. This awareness has been created to develop an alternative strategy for controlling insects and that encourages the introduction of newer insecticides. Hence, it is a need for introducing plant products that possess potential alternatives to currently used synthetic insecticides as they constitute a rich source of bioactive compounds (Rajashekhar *et al.*, 2012) [15]. These concerns have been promoted the researchers to discover an alternate solutions to synthetic pesticides.

Botanical insecticides have long been touted as alternative to synthetic insecticides for insect pest management. And the exploitation of plant based insecticides has more attention (Mishra and Dubey, 1994) [13]. Nowadays, the bioactive compound from natural origin have been used for the management of stored product pest, is subjected more on research (Derbalah and Ahmed, 2011) [4].

The direct application of grain protecting plant powders or oils on stored food grains are injurious as they may bind to the seed coat of grains, that creates problems like cleanness, leaving high pungency, bitterness, oiliness and may harmful for human consumption. The tablets formulated with botanicals usually considered as safer than the direct application of active compounds on stored grains, the formulation may manipulate the bioactivity of most promising plant products (Cox, 2004) [3]. The main aim of this study is to evaluate the most effective tablet formulation using different combinations of potential plant products along with carrier materials against *S. oryzae* and *T. castaneum.*

## Materials and Methods

The test insects namely Rice weevil, *Sitophilus oryzae* (L.) and red flour beetle *Tribolium castaneum*, (Herbst) adults were procured from the storage insects culture from Dept. of Entomology, Annamalai University and were mass reared in glass jars of 1kg capacity with the size of 15×10 cm holding respective food materials (500g) as a nutritional source at 60-70 per cent relative humidity and temperature range from 30-35$^0$ C. Then the glass jars were closed with a fine muslin cloth and protected with a rubber band. The infested grains/flours by insects were changed with the same quantity of healthy uninfested materials. Thus, a constant culture was retained throughout the study period. Fresh pesticidal plant species namely, Indian privet, *Vitex negundo* L., Vasambu, *Acorus calamus* L., Menthol, *Mentha piperita* L. and Sweet basil, *Ocimum basilicum* L., *Artemisia vulgaris* L. were collected from in and around Annamalainagar area. They were washed and cleaned to any other debris or dusts then shade dried for three months. Shade drying was to prevent the loss of active principle from the plant. Then the plant materials were grounded into powder form with the help of electric blender. The carrier materials *viz.* Chalk powder (CP), kitchen ash (KA) and fly ash (FA) were also obtained for preparation of tablet formulation. These carrier materials were further sized through fine dust (35 micron) and made as fine powder so as to enable to mix properly with the formulation. The method of preparing tablet formulation was developed in the PG laboratory, Department of Entomology, with the use of an electric blender. The shade dried plant leaves were ground to fine powder. The raw materials were then homogenized separately by electric blender. The powdered plant materials were used to make tablet formulation @ 55:40:5 ratios of plant materials, carriers and rice gruel respectively. Distilled water was added to prepare a consistent thick paste to formulate the tablet (55mm×15mm) with an average weight of 7.63g manually with a wooden plank prepared separately for making appropriate sized tablets. By using the wooden roller the dough was spreaded, punched with cork and then the formulated tablets were shade dried at room temperature. Blank tablet was also prepared from carrier agent and rice gruel and used as untreated check.

Hundred grams of healthy, fresh clean, unbroken and untreated seeds of rice and flour were placed separately in clean and dry plastic containers for each treatment. One tablet of each treatment was placed inside the petriplates sealed with cello tape so as to avoid the leakage of volatiles. Ten unmated freshly emerged adult test insects, rice weevil and red flour beetle from the insect culture of respective hosts were kept in jars and covered with lids. Each treatment was replicated thrice. Mortality was recorded in all the treatments twice a day up six days. The experiments were set up using Randomized Block Design method. Estimation of loss in weight of grains fumigated with different combination of tablets was done. Ten pairs of newly emerged adults of the test insect were selected and allowed in to the containers with 100 gm of respective food materials. The experiment was replicated thrice. A control was set up with carrier alone was maintained. After six days of treatment, both dead and alive insects were recorded from each treatment. The grains were maintained for two months and weighed using weighing balance and the percentage loss in weight was determined using the following formula.

$$\% \text{ weight loss} = \frac{\text{Intial weight} - \text{Final weight}}{\text{Intial weight}} \times 100$$

The data on the efficacy of the formulated tablets against various test insects were analysed as per Goulden (1952).

## Results and Discussion

The data obtained from the experiment using tablets formulation against *S. oryzae* and their effect is presented in Figure 1. The results explored that the maximum mean mortality of weevil was found in the treatment, *O. basilicum* + CP causing 43.88% followed by *O. basilicum* + KA, *A. vulgaris* + FA, and *A. vulgaris* + KA with 40.55% mortality each followed by 40% due to the *V.negundo* +CP treatment. There was no difference found with the treatments *O. bassilicum* + FA and *A. calamus* + FA. The least percent mortality was observed with *A. calamus* + KA caused 17.22%. There was no mortality observed a day after treatment whereas in the second day, the mortality was noticed in the treatments *O. basilicum* + FA and *M. piperita* + CP with 13.37% each and the death of insects were observed in all the treatments after 3$^{rd}$ day after treatment. In the 4$^{th}$ day onwards, there was a good increase in the mortality of test insects, and continued upto six days after treatments.

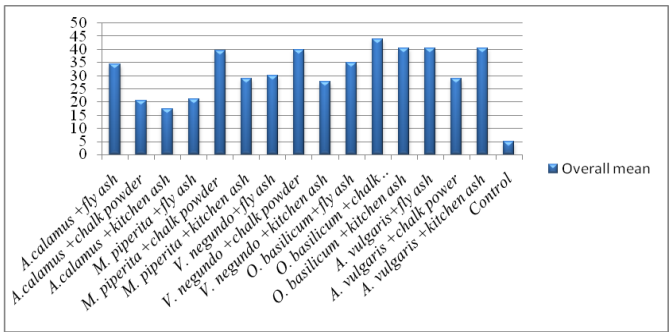


**Fig 1:** Efficacy of tablet formulation of plant species against *S. oryzae* in the laboratory conditions

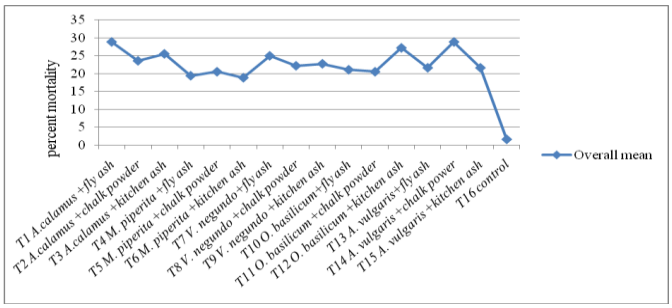


**Fig 2:** Efficacy of tablet formulation of plant species against *T. castaneum* in the laboratory conditions

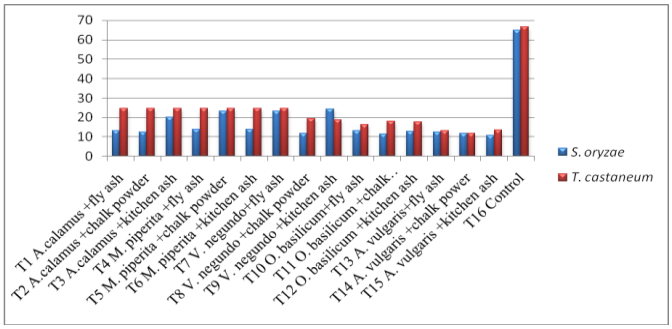


**Fig 3:** Loss of weight in grains treated due to tablet formulation of plant species tested against *S. oryzae* and *T. castaneum*

The results of the biofumigant tablets tested against *S. oryzae*, revealed that a good control of insects in the seeds treated with *O. basilicum* + CP in the laboratory condition. The effectiveness of the sweet basil in causing mortality of the test insect might be due to volatile emitted frequently may choke the spiracles and lead to death of insects. Similar results were also obtained by Dwijendra Singh *et al.* (2010) [5], who reported that a natural menthol based tablet formulation possessing natural binder and carrier agent, liquid preservation - acetic acid and solid powder preservative applied once has found to be effective for the control of adzuki bean beetle, *C. chinensis* adults. Further, Mahendiran *et al.* (2009) [12] reported that *A. vulgaris* at 5% concentration caused 83.56% mortality.

The laboratory data on the mortality of *T. castaneum* due to various combinations of formulated tablets are presented in Figure 2. Among the treatments with various combinations of the formulation revealed that a maximum mean mortality of beetles was recorded in the *A. vulgaris* + CP and *A. calamus* + FA caused 28.89%, close on the heels of the treatment, *O. basilicum* + KA had caused 27.22% mortality. The treatments namely, *A. calamus* + KA with 25.55% and *V. negundo* + FA with 25.00% were followed suit and there was no significant difference between the treatments, whereas the least mortality of the beetles was found with *M. piperita* + FA caused 19.44% mortality. The efficacy of the treatment was recorded once in 12 hours interval which explored that there was no mortality of the beetles observed after 12 hours of treatment. It was found that mortality rate was less in *T. castaneum* when compare to other test insect, *S. oryzae*.

In *S. oryzae*, the lowest damage was found in the treatment *A. vulgaris* + KA with 10.67% and it was followed by *O. basilicum* +CP with 11.33%. *A. vulgaris* + CP and *V. negundo* + CP treated seeds were found with 11.66% weight loss. The highest weight loss was evidenced in the seeds treated with *V. negundo* + KA with 24.33 % followed by *V. negundo* + FA (23.33%) and there was no significant difference found between the treatments and the 65% weight loss was found in untreated control (Fig. 3). It was almost more than 40% of damage than the lowest result obtained from the treatment, *V. negundo* combinations. The laboratory data on the mortality of *T. castaneum* due to various combinations of tablets revealed that *A. vulgaris* + CP and *V. negundo* + FA have caused 28.99% mortality when compare to the other treatments tested against the insect. The results are supported with the findings of Bihi Zahra Sahaf and Saied Moharramipour (2008) [2] determined the fumigant activity of dry leaves of *V. negundo* caused more than 50% mortality after 12-16 hrs. Further, it was noticed that the mortality increased with increased concentration.

The loss of weight in grains due to test insect, *T. castaneum* in the seeds treated with various combination of biofumigant tablets are furnished in Fig. 3. The results revealed that there was a lowest damage was observed in the seeds treated with *A. vurlgaris* + CP with 11.66% followed by

*A. vulgaris* + FA (13.00%) and *A. vulgaris* + KA (11.33%). Close on the heels of the results, 16. 33% of damage was recorded in *O. basilicum* + FA, whereas the treatment *A. calamus* + FA evidenced with 24.66%. When observing the control, there was a heavy damage of 66.66 %. This is almost more than 40% of damage that of the highest damage observed in the treatments.

The weight loss of seeds/flours were found ranging from 24.67% to 11.33% due to the test insect. The volatile substance emitted from all the plant species which were utilized for their effectiveness against test insects proved their potency in reducing the damage level caused by the insects to stored grains/ flours in the treatments. The results are supported with the findings of Ravi nandi *et al.* (2008) [16] who stated that weight loss of seeds were minimum in seeds treated with sweet basil and *Acorus* rhizome made tablets at 15% concentrations reduced 9.8% weight loss after 180 days of storage. Ileke and Oni (2011) [8] reported that the plant products of certain species reduced the percent weight loss caused by *S. zeamais* which was in accordance with our study.

The formulated tablets were found consistent till the end of the experiment and the order of preference as follows: kitchen ash< fly ash < chalk powder. In case of tablet is broken accidently during application and storage, the molecule is attached to seed coat of grain in/on side it may not be harmful because of its medicinal value and may enhance surface area for beetle's management during storage. The vapours emitted from tablets made of plant powders may affect the respiratory system. Owing to this, inactiveness in receiving the signals may occur in beetles. The plant based formulations of tablets was found as promising measure to the grains during storage. When the plants used as fumigants, there will be no fear of poisoning, easy handling, may be safer to the human health.

However, more research work is needed at the field level for the evaluation plant based biofumigant tablets against stored product pests and there will be good scope for this kind of formulation. Further works in the same line of study may enhance its effectiveness and usage in the farmer's level.

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**References**

1. Benhalima HQ, Chaudhry KA, Price NR. Phosphine resistance in stored-product insects collected from various grain storage facilities in morocco. Journal of Stored Products Research. 2004; 40:241-249.
2. Bibi Zahra Sahaf, Maharramipour S. Comparative study on deteffency of *Carum copticum* and *Vitex pseudonegundo* essential oils on nutritional behaviour of *Tribolium castaneum* (Herbst). Iranian Science, 2008; 81(4):213-220.
3. Cox PD. Potential for using semiochemicals to protect stored products from insect infestation. Journal of Stored Products Research. 2004; 40:1-25.
4. Derbalah AS, Ahmed SI. Oil and powder of spearmint as an alternative to *Sitophilus oryzae* chemical control of wheat grains. Journal of Plant Protection Research. 2011; 51:145-150.
5. Dwijendra Singh, Sucheta Mehta. Menthol containing formulation inhibits adzuki bean beetle, *Callosobruchus chinensis* L. (Coleopteral Bruchidae) population in pulse grain storage. Journal of Biopesticides. 2010; 3(3):596-603.
6. Firdisa E, Abraham T. Effect of some botanicals and other materials against the maize weevil, *Sitophilus zeamais*, Motschulsky on stored maize. Maize Production Technology for the Future: Challenge and Opportunities: Proceedings of the Sixth Eastern and Southern Africa Regional Maize Conference. Addis Ababa, 1999; 101-104.
7. Garcia M, Donael OJ, Ardanaz CE, Tonn CE, Sosa ME. Toxic and repellent effects of Baccharis salicifolia essential oil on *Tribolium castaneum*. Pest Management Science, 2005; 61:612-618.
8. Ileke KD, Oni MO. Toxicity of some plant powders to maize weevil, *Sitophilus zeamais* (motschulsky) [Coleoptera: Curculiondae] on stored wheat grains (*Triticum aestivum*). African Journal of Agricultural Research. 2011; 6(13):3043-3048.
9. Jemaa JMB, Tersim N, Toudert KT. Insecticidal activities of essential oils from leaves of *Laurus nobilis* L. from Tunisia, Algeria and Morocco, and comparative chemical composition. Journal of Stored Product Research. 2012; 48:97-104.
10. Liu ZL, Ho SH. Bioactivity of the essential oil extracted from Evodiarutaecarpa Hook f. ET Thomas against the grain storage insects, *Sitophilus zeamais* Motsch, and *Tribolium castaneum* (Herbst). Journal of Stored Product Reasearch. 1999; 35:317-328.
11. Madrid FJ, White NDG, Loschiavo SR. Insects in stored cereals and their association with farming practices in southern Manitoba. Canadian Entomologist. 1990; 122:515-523.
12. Mahendiran M, Ravivarman B, Kathirvelu C. Effect of leaf dusts of certain plant species against pulse beetle, *Callosobruchus chinensis* Linn. in blackgram. Pest management in store grains (Eds). P. Narayanasamy, S. Mohan and J.S. Awaknavar. Sathish serial publishing house, New Delhi, India, 2009.
13. Mishra AK, Dubey NK. Evaluation of some essential oils for their toxicity against fungi causing deterioration of stored food commodities. Applied and Environmental Microbiology. 1994; 60:1101-1105.
14. Park IK, Lee SG, Choi DH, Park JD, Ahn YJ. Insecticidal activities of constituents identified in the essential oil from leaves of *Chamaecy parisobtusa* against *Callosobruchus chinensis* (L.) and *Sitophilus oryzae* (L.). Journal of Stored Products Research. 2003; 39:375-384.
15. Rajasekhar Y, Bhakthavatchalam N, Shivanandappa T. Botanicals as grain protectants. Hindawi Publishing Corporation. *Psyche* Vol. 2012, Article ID 646740, 2012, 13.
16. Ravi Nandi, Naganagoud, Patil. Effect of sweet flag rhizome, *Acorus calamus* L. Formulations with cow dung ash as a carrier against *Callasobruchus chinensis* Linn. in pigeonpea. Karnataka Journal of Agricultural Science. 2008; 21(1):45-48.