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Mosquitocides of *Argeratum conyzoides*, *Boscia salicifolia* and *Grewia monticola*

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A. conyzoides, B. salicifolia and *B. monticola* plants used by some of the indigenous rural people of Hurungwe district, Mashonaland West Province, Zimbabwe could be developed into useful mosquitocides. The dried, powdered leaves of *A. conyzoides* and *B. monticola,* and the dried powdered bark of *B. salicifolia* were each burnt on glowing charcoal to produce smoke that knocked down or killed laboratory-reared *A. aegypti* mosquitoes. *B. salicifolia* achieved 100% knockdown of the test mosquitoes within 20 minutes of application, whilst *A. conyzoides* and *G. monticola* achieved the 100% knockdown within 30 minute*s*. The plants could be used as bases for the production of mosquitocides.

Keywords: Mosquitocides, Traditional medicine, Zimbabwe

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Malaria is one of the most dangerous parasitic diseases in the world. Its global incidence in 1994 was estimated at 300-500 million clinical cases annually, causing 1.5 to 2.7 million deaths each year, more than 90% of this burden being in sub-Saharan Africa, where severe malaria disease and death mainly occurs among young children of rural areas with little access to health services[1]. The disease accounts for an estimated 25% of all childhood mortality below the age of 5 yrs excluding neonatal mortality in sub-Saharan Africa. It has also been estimated that 40% of all fever episodes in sub-Saharan Africa are caused by malaria and the epidermiological situation of malaria is worsening with the spread of drug resistance in the parasite and the insecticide resistance in the vector. The most successfully used mosquitocide is DDT[2]. However, some countries have discontinued its use as a result of environmental concerns. The interest in anti-mosquito products of plant origin is being revived because of the drawbacks associated with the continued application of synthetic compounds, some of which have led to widespread development of insecticide resistance[3]. Some people mainly in rural areas burn plant materials using glowing charcoal to produce smoke which repels or kills mosquitoes and flies[4-12]. In the study, some evaluations carried out on the potential of *Argeratum coyzoides***,** *Bosia salicifolia,* and *Grewia monticola* as mosquitocides have been reported. A mini survey revealed that these plants are widely used in the district of Hurungwe in Mashonaland West Province, Zimbabwe[13].

Argeratum coyzoides

Argeratum coyzoides (Asteraceae) has various traditional medicinal uses, such as treatment for fever and headache (symptoms of malaria), and rheumatism[14]. Leaves are burnt to produce smoke used for mosquitocidal purposes in Hurungwe district, Zimbabwe[13]. Flavonoids, essential oils, and tannins have been identified in the plant[15]. Thus, the plant could also be used for mosquito repellence purposes, but the people of Hurungwe rely on it for mosquitocidal purposes as well. The plant is also used against maize weevils in agriculture.

Boscia salicifolia

Boscia salicifolia (Shona: *Mungezi*; Capparidaceae) grows into a shrub or small tree with rough, scaly bark. In the management of mosquitoes, stem bark is dried at room temperature and ground to powder, then 1-2 gm of the powder is placed on to a hot metal or glowing charcoal to produce smoke that repels or kills mosquitoes.

Grewia monticola

Grewia monticola (Shona: *Mubhubhunu*; Malvaceae) produces edible fruits which are very popular, particularly with children. The people of Hurungwe

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rural use the plant for mosquito repellence and for mosquitocidal purposes. The small branches are also suitable for the preparation of toothbrushes. Dried leaf powder is placed on to a hot metal or glowing charcoal to produce smoke that repels or kills mosquitoes.

Methodology

The stem bark of *Boscia salicifolia* (about 200 gm) and leaves of *Argeratum coyzoides* and *Grewia monticola* (about 200 gm each) were collected from Hurungwe district, Mashonaland West Province, Zimbabwe, in January 2007. The samples shade dried and powdered separately using a mill were used in mosquitocidal experiments at the Blair Research Institute, Ministry of Health, Zimbabwe during February-April, 2007.

The powdered bark of *B. salicifolia* and powdered leaves of *A. coyzoides* and *G. monticola* (about 20 gm each) were used in the evaluation of the potential as mosquitocides, using 50 individual 5-8 day old laboratory-reared female *A. aegypti* mosquitoes for each replicate test. Ten were placed in each of the 3 standard plastic cups. Ten of the remaining 20 were used for the control and the other ten for the standard. The plastic cups were covered with mosquito netting on top. The control and the standard were treated similarly to the test experiments except that there was no addition of plant powder to the glowing charcoal in the control.

The inhabitants of Hurungwe district, Mashonaland West Province, Zimbabwe, burn the plant materials on glowing charcoal or on hot metal sheets to produce smoke that will act as mosquitocide. In the project, powders were burnt on glowing charcoal to release the mosquitocides. Three replicate cups were placed around the glowing charcoal making sure that direct heat from the charcoal did not affect them. The powder of each plant was placed on the glowing charcoal and the set up was quickly covered using a $1m^3$ cardboard box for 3 minutes, and the number of knocked down mosquitoes was recorded, maintaining the recorded knocked down mosquitoes at room temperature. Cotton wool previously soaked in 10% sucrose was placed on top of the cups which were then put in a box covered with a cloth and left for 24 hrs. The number of mosquitoes which died was recorded and the percentage mortality was calculated in both the exposure and control cups. The experimental procedure was repeated with the other replicate experiments changing the position of the cups after each experiment.

The percentage mortality was calculated using the expression: % Mortality= [(Number of dead mosquitoes) / (Total number of mosquitoes)] × 100. The percentage number of dead mosquitoes in the control experiment was represented by C and the percentage number of dead mosquitoes in the exposure experiment was represented by E. If the value of C that was calculated was between or equal to 5% and 20% then a corrected value for exposure mortality was calculated using Abbott's formula[16]: Corrected exposure mortality = [(E-C) / (100-C)] × 100. Mortality rates less than 80% after 24 hrs post-exposure time indicate insect resistance. Rates between 80-90% suggest the possibility of resistance that needs to be clarified and above 98% indicate insect susceptibility[17]. The results were compared using the t-test. Recovery rates of knocked down mosquitoes which were not dead 24 hrs after the experiment were calculated using the expression: Recovery rate= 100– mean% mortality rate. The percentage knockdown was calculated using the expression: % Knockdown= [(C-T) / (10-T)] × 100, where C was the number of mosquitoes knocked down in the exposure experiment, T was the total number of mosquitoes knocked down in the control experiment. The percentage knock down was calculated for all the replicates so that the mean % knockdown could be determined. Commercial mosquito coils which contain transfluthrin as active ingredient was used as the standard and the results were compared using the t-test.

A series of knockdown experiments was run starting with the application of a 0.2 gm dose of the plant bark or leaf powder onto glowing charcoal (Section i) and exposing 10 mosquitoes in a cup for an exposure time of 3 minutes, the experiment being done in replicates, and the number of knocked down mosquitoes recorded. In the next set of replicate experiments, the dose was increased by 0.2 gm to 0.4 gm and the procedure repeated, recording the number of knocked down mosquitoes. The procedure was repeated, increasing the dose by 0.2 to 0.6 gm, then to 0.8 gm, and finally to 1.0 gm calculating the % knockdown after each dose, until a dose that gave 100% knockdown after the 3-minute exposure time was achieved. This dose was the minimum amount of powder that gave complete knockdown of mosquitoes and was used in all experiments. The results indicated that the minimum dose for *A. conyzoides* was 1.0 gm, for *B. salicifolia* the minimum dose was 0.6 gm and for *G. monticola* it was 0.8 gm. Hence, in all experiments involving *A. conyzoides,* 1.0 gm sample was used, and for *B. salicifolia,* and for *G. monticola* 0.6 gm and 0.8 gm were used, respectively.

Results and discussion

B. salicifolia was found to be a very effective mosquitocide, achieving 100% knockdown of the test mosquitoes within 20 minutes of application, whilst *A. conyzoides* and *G. monticola* achieved the 100% knockdown within 30 minute*s*, with mean mortalities: *B. salicifolia* (97.5%), *A. conzoides* (65%) and *G. monticola* (75%) and the recovery rates were *B. salicifolia* 2.5%, *A. conyzoides,* 35% and *A. conyzoides* 25% (**Table 1**). Plants which produced the high knockdown rates also gave the high mortality rates, indicating the link between the compounds that produced the effects. The recovery rates indicate the percentages of the mosquitoes that recovered from the knockdown effects. The high mortality rates show high mosquitocidal activity. High recovery rates indicate that the plant material is more of a repellent than a mosquitocide. Signs of possible resistance to the mosquitocides by the mosquitoes were observed for *G. monticola* and *A. conyzoides*, which gave mortality rates which were less than 80%. Although they managed to knock down some of the mosquitoes, they showed repellent properties with recovery rates which are too high for a mosquito infested area. The 35% mortality for *A. conzoides* may mean that, on average, 65% of the mosquitoes will continue attempting to bite. Thus, the mosquitocides from *A. conzoides* and *G. monticola* can be used to inhibit biting for shorter periods of time, but *B. salicifolia* is a potent, fast acting mosquitocide.

Conclusion

The three plants showed mosquitocidal properties. *A. conzoides* and G. *monticola* are weak mosquitocides as indicated by their knockdown as well as the mortality rates. *B. salicifolia* is a potent, fast acting mosquitocide which could successfully be developed into a commercial product. The effectiveness of the plant mixtures as mosquitocides will in future be included in the test protocols so as to explore the possibility of synergism or potentiation in their activities.

Table 1— Percentage knockdown of mosquitoes by plant extracts

Sample/time in minutes	0	10	20	30	40	50
B salicifolia	0	35	100	100	100	100
B pilosa	0	25	87.5	100	100	100
B alata	0	32.5	92.5	100	100	100
Control	0	0	0	0	0	0

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