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Biological activities of some plant materials against two stored product insect pests of wheat

A. T. Ande

Department of Biological Sciences, University of Ilorin, Ilorin, Nigeria

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ABSTRACT: Leaves of *Acalypha sp.*, *Caripa papaya*, *Santalum album* and *Calotropis gigantica* were screened for toxicity, ovipository inhibition and reduction in F_1 adult progeny in *Sitophilus oryzae* and *Rhyzoperta dominica. A. indica* showed remarkable biocidal and antiovipositant activities against *S. oryzae* adults, but was only slightly toxic to *R. dominica* adults. It also reduced the progeny emergence rate of *R. dominica*. *C. papaya* leaf was also very toxic to *S. oryzae* adults, but no mortalities were recorded with *R.. dominica* adults. *S. album* and *Calotropis gigantica* did not show any biological activity. The possibility of *A. indica a*nd *C. papaya* harbouring toxic principles which elicit adult mortality and slight ovipository deterrence against some storage pests of wheat and its limitations are discussed.

Key Words: Wheat; Insect pests; Biocidal properties; Antioviposition properties; *Carica papaya*; *Azadirachta indica.*

Introduction

Wheat, an important world crop, needs to be protected particularly in storage (1). Whole wheat grains are destroyed extensively by *Sitophilus oryzae* and *Rhyzoperrtha dominica* (2). Synthetic insecticides, though highly effective and relatively easy to apply against these stored product insect pests; have attendant problems which include restricted product usage time, environmental degradation and development of resistance in insects. Plants are interesting sources of of biologically active principles (3-7) that do not pose these problems. Indeed Pyrethrium, Rotenone, Nicotene and Azadirachtin which are principles originally sourced from plants (8) have since formed the basis of modern pesticide chemistry. Such principles have reportedly acted as biocides, antifeedants, antiovipositants, repellents and growth regulators, all of which protect stored products. A recourse to other plants for such active principles is therefore desirable, particularly in tropical Africa which presents an interesting array of flora. Such search must however be informed by some clues otherwise it may be costly and inefficient (9). *Acalypha indica, Carica papaya, Santalum album* and *Calotropis gigantica* were enlisted as plants used in different parts of the world for pest control (3), but their actual efficacy, active principles and types of biological activities against *S. oryzae* and *R. dominica* have not been reported. This paper reports the type of activity and compares the efficacy of the plants.

Materials and Methods

Leaves of *A. indica.* (Euphorbiaceae), *Carica papaya* (Caricaceae), *Santalum album* (Santaleceae) and *Calotropics gigantica* (Asclpiadaceae); were collected air dried in a shade, pulverized and kept in screw-capped brown bottles for subsequent use.

Wheat grains of between 12%-14% moisture content, stored in a dessicator after prior treatment of lodging in the refrigerator for two weeks and allowing equilibration for three days were used as substrate.

The leaf powders were mixed with 25g of wheat at a rate of 0.5%, 1.0%, 2.5% and 5% respectively, except in the control experiment. Twenty-five adult insects, collected from an insectary of the Infestation Control and Insect Protectant Department of the Centre for Food Technological Research Institute, Mysore, India, were introduced into each tube and covered with muslin cloth. Four replicates of each treatment were put up. Adult mortality readings were recorded on days 1, 3, 7, 14 and 21 and dead individuals retrieved. All living adults were subsequently removed. Control corrected mortality rate (%) was calculated as:

$$\frac{\text{Treatment mortality} - \text{Control mortality}}{100 - \text{control mortality}} \times 100$$

Oviposition count in *S. oryzae* was taken on 100 randomly selected grains using simmering water and acid fushin stain. Ovipository inhibition rate (%) was calculated as:

$$\frac{\text{Oviposition Rate (control)} - \text{Oviposition Rate (Treatment)}}{\text{Oviposition Rate (control)}} \times 100$$

A record of the F_1 progeny was kept and a progeny per adult day calculated for all treatments.

Results

Of the four plants tested only *A. indica* and *Carica papaya* showed some biological activities against *S. oryzae* and *R. dominica*. With *S. oryzae*, both *A. indica* and *Carica papaya* showed some toxicity against adults even at the lowest dose of 0.5% (Table 1). *A. indica* recorded a corrected mean mortality rate of 69.73% in 21 days at 0.5% leaf concentrration. This improved remakably with concentration to 96.12% mortality at 2.5% leaf concentration, most of which occurred between day 7 and day 14. *Carica papaya* followed closely with corrected mean mortality rate of 58.0% at the lowest leaf concentration after 21 days and the highest value of 92.33% at a leaf concentration of 2.5%. Most of the mortalities, however, occurred between day 14 and day 21. *R. dominica* adults were less susceptible to both *A. indica* and *Carica papaya* (Table 2). Whereas *A. indica* had a highest kill of 25.86% after 21 days at 2.5% leaf concetration, *Carica papaya* was completely inactive against *R. dominica*. *S. album* and *Calotropis gigantica* did not have any toxic effect on the adult insects. Rather, they emhanced their survival as more mortalities were recorded from the control experiments (Tables 1 and 2).

Oviposition inhibition (>10%) were recorded with *A. indica* and *Carica papaya*. The inhibition increased with *A. indica* leaf concentration from 4.85% to 7.67% at 0.5% and 5.0% treatments respectively (Table 3). Although *Carica papaya* constantly showed lower level of inhibition at all treatment levels, there was no visible trend with increasing leaf concentration. *S. album* and *Calotropis gigantica* did not show any remarkable oviposition deterrence.

Progeny emergence per adult day of *S. oryzae* improved considerably with all plants tested (Table 3). Conversely, *R. dominica* showed a considerable reduction in progeny emergence rate with *A. indica*, while all other plants tested improved progeny emergence rates.

Table 1: Corrected mean mortality of *S. oryzae* treated with *A. indica*, *Carica papaya*, *S. album* and *Calotropis gigantica* over 21 days.

Leaf Treatment	Conc.	Corrected mean mortality rate (%) over time (Days)				
	(%)	1	3	7	14	21
A. indica	0.5	– 1.35	– 1.35	– 2.78	44.12	69.73
	1.0	– 1.35	0.00	– 1.38	30.29	84.25
	2.5	– 1.35	– 1.35	19.45	81.43	96.12
	5.0	– 1.35	0.00	5.55	65.71	93.77
Carica papaya	0.5	– 1.35	– 1.35	– 4.17	45.94	58.00
	1.0	2.52	2.52	– 0.16	37.75	63.44
	2.5	– 1.35	– 2.58	6.62	65.87	92.23
	5.0	– 1.35	0.00	2.78	31.36	88.87
S. album	0.5	– 1.35	– 2.18	– 4.36	– 6.13	– 8.24
	1.0	– 2.85	– 3.17	– 5.25	– 6.25	– 10.15
	2.5	– 4.08	– 4.08	– 6.24	– 8.31	– 12.12
	5.0	– 1.35	– 1.35	– 3.17	– 4.54	– 5.78
Calotropis gigantica	0.5	– 4.17	– 5.56	– 5.97	– 6.84	– 9.24
	1.0	– 1.35	– 3.17	– 3.83	– 4.23	– 6.81
	2.5	– 1.38	– 2.46	– 4.88	4.81	– 5.23
	5.0	– 0.16	– 1.35	– 3.31	– 4.24	– 5.84

All readings are means of four replicates.

Discussion

A. indica and *Carica papaya* contain biocidal and antioviposition principles as they were toxic to adults of *S. oryzae*, *S. album* and *Calotropis gigantica*. They, however, did not show any negative biological activity, rather, they supported the insects' productivity with respect to survival and oviposition, hence may not be useful as control agents. This contrasts their enlistment by Secoy and Smith (3).

A. indica was more toxic to *S. oryzae* than *Carica papaya.* Both of them took at least 7 days to effect meaningful biocidal action against adults without any evidence of feeding deterrence. Furthermore, progeny emergence per adult day improved with the use of these plants, an indication that oviposition was enhanced and the destructive larval stage located within the grains were not deterred by the plant materials. The slight oviposition deterrence noticed, therefore, could be explained as due to the adult mortality factor.

The slight biological activity noticed on *S. oryzae* were not recorded on *R. dominica*, except that *A. indica* reduced progeny emergence rate considerably. This confirms an earlier observation of Pereira and Wohlgemuth (10) that *R. dominica* is relatively more hardy. The same observation was reported earlier with neem plant (2). Unlike other plants such as neem and derris (3-5), plants examined in this study harbour some biocidal principles which brought about encouraging *S. oryzae* adult mortality and slight oviposition deterrence. they, however, showed a narrow range of biological activity as they were inactive

against *R. dominica*. They may, therefore, not be a viable source of the much needed protection for wheat grains in storage.

Table 2: Corrected mean mortality of *R. dominica* treated with *A. indica, Carica papaya, S. album* and *Calotropis gigantica* over 21 days.

Leaf Treatment	Conc.	Corrected mean mortality rate (%) over time (Days)				
	(%)	1	3	7	14	21
A. indica	0.5	– 1.30	2.96	3.43	7.08	14.00
	1.0	– 1.54	– 0.42	2.52	– 0.26	– 3.42
	2.5	0.12	4.67	8.50	13.07	25.86
	5.0	– 1.22	0.48	– 0.73	6.27	10.29
Carica papaya	0.5	0.00	– 4.42	– 7.69	– 8.44	– 17.37
	1.0	0.00	– 4.42	– 10.58	– 12.35	– 19.20
	2.5	0.00	– 2.48	– 6.54	– 11.23	– 13.67
	5.0	0.00	– 4.42	– 7.56	– 13.40	– 13.34
S. album	0.5	– 1.35	– 3.38	– 4.55	– 8.24	– 15.23
	1.0	– 1.05	– 4.12	– 6.11	– 9.23	– 17.24
	2.5	– 1.54	– 2.14	– 4.36	– 10.24	– 16.85
	5.0	0.00	0.42	– 1.11	– 7.24	– 8.25
Calotropis gigantica	0.5	0.00	– 1.23	– 3.44	– 4.12	– 7.25
	1.0	0.00	– 0.42	– 2.11	– 6.23	– 8.13
	2.5	– 1.35	– 2.35	– 4.35	– 14.44	– 18.32
	5.0	0.00	– 0.66	– 4.33	– 7.25	– 9.24

All readings are means of four replicates.

References

1. Srivastava, P. K.; Tripathi, B. P.; Grish, G. K. and Krishnamurthy, K. (1973) Studies on the assessment of loses. III. Conventional garnish storage practices and losses in rural areas in Western U. P. Bull. Gram. Tec. 11, 129 – 139.
2. Jotwani, M. G. and Sirkar, P. (1965) Neem seed as a protectant against stored grain pest infesting wheat seed. Indian J. Ent. 27, 160 – 164.
3. Secoy, D.M. and Smith, A.E. (1983) Use of plants in control of Agricultural and domestic pests. Economic Botany 37(1), 28 – 57.
4. Golob, P. and Webley, D.J. (1980). The use of plants and minerals as traditional protectants of stored products. G. 138, Chatham, UK: Natural Resource.
5. Jilani, G and SU, H. C. F. (1983) Laboratory studies on several plant materials as insect repellants for protection of Cereal grains. Journal of the Entomological Society of America, 76(1): 154 – 157.
6. Olaifa, J.J., Erhun, W.O. and Akinbohungbe, A.E. (1987) Insecticidal activity of some Nigerian Plants. Insect Science and its application, 8(2): 221 – 224.

Table 3: Ovipository inhibition rate of *S. oryzae* and mean emergence per adult day of *S. oryzae* and *R. dominica* treated with *A. indica, Carica papaya, S. album* and *Calotropis gigantica*.

Leaf Treatment	Conc. (%)	*Sitophilus oryzae*		*R. dominica*
		Ovipository inhibition rate (%)	Mean emergence per adult day	Mean emergence per adult day
A. indica	0.5	4.85	0.208	0.057
	1.0	5.16	0.145	0.046
	2.5	7.07	0.175	0.078
	5.0	7.67	0.216	0.131
Carica papaya	0.5	2.45	0.200	0.406
	1.0	6.27	0.200	0.340
	2.5	3.47	0.091	0.448
	5.0	5.77	0.251	0.328
S. album	0.5	– 1.02	0.421	0.921
	1.0	– 2.11	0.721	0.813
	2.5	0.14	0.210	0.741
	5.0	– 1.78	0.528	0.621
Calotropis gigantica	0.5	0.04	0.271	0.745
	1.0	0.26	0.421	0.933
	2.5	– 1.02	0.622	1.410
	5.0	– 1.13	0.425	0.817
Control	0.0	0.00	0.080	0.307

All readings are means of four replicates.

7. Morullo-Rejesus, M.B., Maini, H.A., Ohsawa, K. and Yamamoto, J. (1990) Insecticidal actions of several plants to *Callosobruchus chinensis L pp 91 – 100.* Proceedings of the Second International symposium in Brunchids and Legumes, Okayama, Japan.
8. Dales, M.J. (1996) A review of plant materials used for controlling insect pest of stored products. NRI Bulletin 65, Chatham, UK; Natural Resource Institute.
9. Morgan, E. D. (1980) Strategy in the isolation of insect control substabces from plants. Proc. 1st Int. Neem Conf. Rottach-Egern. pp. 43 – 52.
10. Pereira, and Wolgemuth, R. (1982) Neem (*Azadirachta indica*) of West African origin as a protectant of stored maize. Zeitschrift fur Angewandte Entomologie 94, 208 - 214.