IMPACT OF BOTANICAL SPICES IN CONTROL OF BAMBARA NUT PESTS *CALLOSOBRUCHUS SUBINNOTATUS* (COLEOPTERA, BRUCHIDAE)

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Abstract

The present study evaluated the effect of extracts of three spices in control of *Callosobruchus subinnotatus* (Pic). The experimental design used was completely randomized design (CRD). Ginger, scent leaf and curry leaf were obtained and screened for phytochemical and proximate composition using standard laboratory techniques. The Bambara nut was subjected to three treatments (T_o, T_1, T_2 and T_3) which were replicated 4 times. T_o was used as control while the rest were treated with the spices. Results from the study showed that the highest mortality rate was recorded on 100g of Ginger extract having percentage mortality of 93.33% (T_3). It was followed by scent leaf with a mortality rate of 43.33% (T_1). The result also showed that Ginger powder extract gave the lower mean number of holes (41) and with lower weight loss of 4.9% of nuts amongst the extracts used. Bambara nuts that were not treated with plant spice extracts (T_o) gave the highest mean number of holes or punctures (211) and the highest weight loss 25.5% of nuts. Conclusion of this study is that the plant extracts were effective at controlling *Callosobruchus subinnotatus*, though at varying degrees. These biopesticides are part of humans and animals food, often are used as ethno-medicines, and are more environmentally friendly being biodegradable, so all these things recommend to be used in the detriment of chemical pesticides.

Keywords: Botanical spices, Bio-insecticides, *Callosobruchus subinnotatus*, Biodegradable

Introduction

World's population stands at about 8 billion (FAO 2015) and it is predicted to increase with 2.2% per year to around 11.5 billion bin2100, with 87% living in the developing countries of Africa, Asia and Latin America (Penning de Vries 2001). The high population growth rate, particularly in the developing countries, and the changing diets will lead to a much higher quantity of food demand by 2020 (Penning de Vries 2001). Enhancing food availability in sub-Saharan Africa could be realized not only by increasing agricultural productivity through the use of sustainable good agricultural practices, but also by reducing pre- and post-harvest crop losses (Tscharntke et al. 2012). In the dry African Saharian countries agricultural production is seasonal while demands for agricultural commodities are more evenly spread throughout the year (Mikolo et al. 2007). In this circumstance, grains need to be stored from one harvest to the next one in order to maintain its constant supply all year round and to preserve its quality until required for use (Nukenine 2010). The reduction of postharvest grain losses, especially those caused by insects, microorganisms, rodents, and birds, can increase available food supplies, particularly in less developed countries where the losses are largest and the need is greatest. Amongst these living organisms, insects are responsible for the greatest storage losses in cereals and pulses (Kosini and Nukenine 2017). Bambara nut [*Vigna subterranean* (L.) Verdc] is an indigenous African legume crop which is cultivated

Received 1 August 2022; Accepted 26 January 2023; Published Online 31 January 2023; Published 3 April 2023

throughout sub-Saharan Africa, especially in the drier driest? parts of the continent (Mkandawire 2007).

Bambara nut is produced mainly as a subsistence crop, usually by small-scale female farmers. The crop is grown primarily for its seeds which are eaten fresh when semi-ripe and as a pulse when dry and mature, or ground into flour. Bambara nut is a major source of vegetable protein in sub-Saharan Africa where it constitutes an important part of the local diet, culture and economy. The seed is regarded as a completely balanced food (Rowland 1993, Anchirina et al. 2001). Bambara nut seeds, haulm and dry leaves have been used to feed livestock and poultry (Ancchirina et al. 2001). It is a rich source of minerals, energy and protein, with as much as 25.2% protein, 65% carbohydrates and 6% lipid, on a dry weight basis. Its tolerance to drought and poor soils which makes it ideally suited to production in marginal areas where low-input arable agriculture is the norm (Amarteifio et al. 2006).

Traditionally, the grain weevils, *Sitophilus sp.* (Coleoptera: Curculionidae), the Angoumois grain moth, *Sitotroga cerealella* (Olivier) (Lepidoptera: Gelechiidae) and three genera of bruchids, *Acanthoscelides, Zabrotes,* and *Callosobruchus spp.* are the most important pests of stored grains in Africa (Abate et al. 2000).

Identifying the specific pest found within a sample is the first step in controlling insect pests, because insects have different damage potentials, biology, behaviors, growing temperatures, moisture requirements, and reproductive potentials (Mason and McDonough 2012).

Toxic synthetic insecticides being applied in solid and liquid forms against these insect pests are generally accepted as effective but carcinogenic, hazardous to non-target organisms and the environment. There is therefore, the growing interest in adapting naturally existing plant in crop protection to stand the trend of food shortage as a result of insect infestation. In recent years, researchers have been focusing on the secondary compounds of plant extracts to be used as alternatives for chemical insecticides (Adeyemi 2010).

Materials and Methods

Study Area

This study was conducted in the Department of Biology Laboratory, Federal University of Technology Owerri (FUTO) which lies between the coordinates 5.3892° N, 6.9916° E. *Callosobruchus subinnotatus* was identified by an entomologist in the Department of Biology, Federal University of Technology Owerri, Imo State.

Procurement of Experimental Area

The spices (Curry leaf, Scent leaf and Ginger) and Bambara nut were procured at Ihiagwa market, Owerri-west, Imo state. The stored pest *(Callosobruchus subinnotatus)* was procured from infested Bambara nut from Ihiagwa local market.

Experimental Design

The experimental design used was completely randomized design (CRD) replicated four times with four treatments given a total of 16 plates.

Preparation of the Powdered Extracts of Spices

Fresh curry leaf, scent leaf and ginger were collected, washed and chopped up into pieces to facilitate drying and were dried in a well-ventilated area at room temperature for 4 weeks. The dried botanical samples were grinded into powder using mortar and pestle.

Experimental Treatments

The Bambara nut was subjected to three treatments which were replicated 4 times:

T_o = control which includes the Bambara nut grains and *Callosabruchus subinnotatus.*

T_1 = consists of the powdered curry, Bambara nut grains and *Callasobruchus subinnotatus.*

T_2 = consists of the powdered scent leaf, Bambara nut grains and *Callosobruchus subinnotatus.*

T_3 = consists of ginger, Bambara nut grains and *Callosobruchus subinnotatus.*

Parameters /Data collection

Number of Holes

The number of holes bored by the weevil were counted and recorded.

Mortality

The mortality was recorded by counting the dead weevils on daily basis.

Weight Loss

The weight loss was obtained by subtracting the final weight of Bambara nut seeds from the initial weight of Bambara seeds.

Phytochemical Analysis

Phytochemical analysis was carried out on the scent leaf, curry leaf and ginger in the laboratory in order to obtain the phytochemical constituents using standard procedures of Nwachukwu et al. (2018) and Nwachukwu et al. (2020).

Statistical Analysis

Data collected was subjected to analysis of variance procedure ANOVA using SPSS version 20 and the mean difference were determined using least significance difference (LSD) at 0.05% probability level.

Results

Mortality Rate of Bambara Beetle (*Callosobruchus subinnotatus*) on Extracts of Three Spices

The mortality rate was recorded highest on 100g, of ginger powder extract having percentage mortality of 93.33% and was significantly higher than other treatments applied at P=0.05 level. The results also showed that curry leaf powder extracts did not differ significantly in mortality of Bambara nut beetle (Table 1). There was no mortality recorded on control treatment.

Table 1. Effect of powdered extracts of three different spices on Bambara groundnut beetle

Powdered Extracts (g)	Mean number of beetle introduced	Mean number dead	Mean number alive	Mortality (%)
Control 0	$30^a \pm 0.01$	$O^c \pm 0.00$	$30^a \pm 0.01$	0.00
Curry 100	$30^a \pm 0.01$	$ll^b \pm 0.16$	$19^b \pm 1.23$	36.67
Scent 100	$30^a \pm 0.01$	$13^b \pm 0.18$	$17^b \pm 1.20$	43.33
Ginger 100	$30^a \pm 0.01$	$28^a \pm 0.21$	$2^c \pm 0.03$	93.33

Mean along the column having a different superscript of letters differ significantly at P = 0.05

Mean Number of Holes and Weight Loss of Bambara nut Seed

Table 2 shows the results on the mean number of holes and weight loss of Bambara nut seeds treated with different plant spices extract. Ginger powdered extract gave the lower mean number of holes (41) and with lower weight loss of 4.9 g. The Bambara nuts that were not treated with plant spice extracts gave the highest mean number of holes (211) and the highest weight loss 25.5 g of the nuts.

Table 2. Effect of three different spices on Mean number of holes and weight loss of Bambara seeds

Powdered Extract (g)	Initial weight of seeds (g)	Final weight of seeds (g)	Mean number of boles	Weight loss of seeds (g)
Control 0	$250^{a} \pm 0.01$	$224.5^{b} \pm 12.10$	$211^{a} \pm 20.16$	$25.5^{a} \pm 3.23$
Curry leaf 100	$250^{a} + 0.01$	$234.2^{c} \pm 19.12$	$98^{b} \pm 11.0$	$15.8^{b} \pm 2.07$
Scent leaf 100	$250^{a} \pm 0.01$	$239.3^{c} \pm 19.22$	$87^{c} \pm 8.24$	$10.7^{c} \pm 1.62$
Ginger 100	$250^{a} \pm 0.01$	$245.1^{a} \pm 22.14$	$41^{d} \pm 4.35$	$4.9^{d} \pm 0.98$

Mean along the column having different superscript of letters differ significantly at P= 0.05 level.

Phytochemical Screening of Curry Leaf, Scent Leaf and Ginger

The result on proximate composition of curry leaf, scent leaf and ginger powdered extracts shows a high constituents of dry matter (%), followed by Nitrogen free extracts (%), others were ash, crude protein, crude fibre and ether extracts; All expressed in percentages (Table 3). The phytochemical analysis of curry leaf, scent leaf and ginger powdered extracts shows that terpenoids was absent in all. In curry leaf and scent leaf powdered extracts saponins and cardiac glycosides were absent. The most common in the three different spices were flavonoids and alkaloids (Table 4).

Table 3. Proximate composition of curry leaf, ginger and scent leaf

Constituents (%)	Curry leaf	Ginger	Scent leaf
Dry matter	91.01	81.87	89.82
Crude protein	8.68	9.62	8.96
Crude fibre	7.32	10.57	7.87
Ash	10.73	8.16	9.11
Ether extract	4.38	7.33	6.24
Nitrogen free	32.76	42.98	36.43

Table 4. Phytochemical analysis of curry leaf, ginger and scent leaf

Parameters	Curry leaf	Ginger	Scent leaf
Alkaloids	+	+	+
Tannins	++	-	++
Flavonoids	+ +	++	++
Saponins	-	+	-
Terpenoids	-	-	-
Cardiac glycosides	-	+	-

Key: + = Present, - = Absent, ++ = Present in large quantity

Discussion

The present study evaluated the impact of botanical spices powdered extracts in control of Bambara nut pest (*Callosobruchus subinnotatus*). The result showed that mortality rate was recorded highest on 100g of ginger powder extract having percentage mortality of 93.33%. It was followed by scent leaf with a mortality rate of 43:33%. The pesticidal effect of ginger has been studied by Kubra et al. (2013). He reported that ginger and other plants could be used for the control of pest of stored products. The high mortality rate observed in this present study when ginger was used could be as result of the bioactive compounds which were not friendly to *Callosobruchus subtinnotatus.* The result of the photochemical components of ginger is in agreement with the result of research work of Najim (2017) who observed the presence of alkaloids, flavonoids, saponims and cardiac glycosides in varying concentrations. The result from this study also showed that Ginger powdered extract gave the lower mean number of holes and with lower weight loss. The Bambara nuts that were not treated with plant spice extracts gave the highest mean number of holes and the highest weight loss 25.5g of the nuts. Considering this, the plant extracts were effective at controlling the pests at varying degrees.

Conclusions

This study has shown that ginger powdered extract was active against *Callosobruchus subinnotatus* with mortality rate above 90%. The ginger powdered extract was significantly effectively to Bambara nut weevil. The ginger powdered extract reduced grain weight loss, but curry and scent leaf powdered extract had lesser effect.

References

Abate T, van Thais A, Ampofo JKO. 2000. Pest management in traditional agriculture: an African perspective. Annual Review of Entomology, 45: 631-659.

Adeyemi MMH. 2010. A review of secondary inetabolites from plant materials for post-harvest storage. International Journal of Pure Applied Science and Technology, 6: 94-102.

Amarteifio JO, Karikari SK, Modise JO. 2002. The Proximate and Mineral Composition of Six Landrace of Bambara Groundut. Tropical Science, 42: 188-191.

Anchirina VM, Yiridoe EK, Bennett-Lartey SO. 2001. Enhancing Sustainable production and Genetic Resource Conservation of Bambara Groundnut. A Survey of Indigenous Agricultural Knowledge Systems. Outlook in Agriculture, 30(4): 281-288.

FAO. Food and Agriculture Organization. 2015. Regional overview of food insecurity: African food insecurity prospects brighter than ever. FAO, Accra.

Kosini D, Nukenine EN, Tafel KH. 2015. Efficacy of Cameroonian Odin urn can mi Sims (Lamiaceae) leaf extract fractions against *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae), infesting Bambara groundnut. Journal of Entomology and Zoological Studies, 3: 487-494.

Mkandawire C. 2007. Review of Bambara groundnut (*Vigna subterranea* (L.) Verde. Production in sub-sahara Africa. Agricultural Journal, 2(4): 465-470.

Moreira MD, Picanc, L., Almeida Barbosa, R.N.C. Guedes, M. Ribeiro de Campos, G., Silva A, Martins JC. 2012. Plant compounds insecticide activity against Coleoptera pests of stored products. Brazilian journal of agriculture, 42: 909-915.

Najim EN. 2017. Screening of Bambara groundnut (*Vigna subterranea*) lines for *Callosobruchus* macula Ins resistance in the Far North Region of Cameroon. Journal of Renewable Agriculture, 2: 18-22.

Nwachukwu MO, Okoro LC, Nwaiche CB, Ikeh SGI, Amaechi AA, Azorji JN. 2018. Evaluation of Efficacy of Marble Dust for the Control of Sitophilus zeamais Motsch. Coleoptera: Curculionidae of Stored Maize. Futo Journal Series (FUTOJNLS), 4(1): 263-269.
Nwachukwu MO, Azorji JN, Adjero LA, Belonwu AC, Green MC, Akpovbovbo DP. 2020. Efficacy of Alligator Pepper (Aframomum Melegueta) L. Seed Powder against Maize Weevil (Sitophilus zeamais) of Stored Maize, International Journal of Innovative Research & Development, 9(2): 342-347
Nukenine EN. 2010. Stored product protection in Africa: Past, present and future. In Proceedings, 10th international Working Conference on Stored Product Protection, Julius-Kulin-Archiv, pp. 26-41.
Penning de Vries FWT. 2001. Food security? We are losing ground fast. In: Nosberger H, Geiger HH, Struik PC, editors. Crop Science: progress and prospects. CAB International, Wallingford, UK. pp. 1-14.
PROTA. 2006. Plant Resources of Tropical Africa 1: Cereals and Pulses. Editors: M. Brinks and G. Belay, pp. 213-218.
Rowland JRJ. 1993. Bambara Groundnut. In: Rowland J.R.J. (ed). Dryland Farming in Africa, Macmillan Ltd, pp 34.
Tscharntke T, Clough Y, Wanger TC, Jackson L, Motzke I, Perfecto I, Vandermeer J, Whitbread A. 2012. Global food security, biodiversity conservation and the future of agricultural intensification. Biological Conservation, 151: 53-59.