EFFECT OF SOME SPICES ON SURVIVAL AND DEVELOPMENT OF ADULT HIDE BEETLE, *DERMESTES MACULATUS* DEGEER INFESTING DRY FISH

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ABSTRACT
Effects of varying amounts of selected spices namely Hot pepper, Black pepper, Sweet basil, African Nut-meg and Ginger against the development of adults of Hide beetle, Dermestes maculatus, was studied under ambient conditions. The plant spices were pulverized into powders and applied as 1.0, 2.0 and 3.0 g per 25 g of dry fish along with 5ml of conventional pesticide Dichlorvos. Five pairs of newly emerged adults of Hide beetle were inoculated into each of the beakers, which were then arranged in a Complete Randomized Design (CRD) in the laboratory. The Black pepper was observed to be highly effective causing longest delay in oviposition (6.67 – 9.33days) and Ginger resulted in least delay (5.00 -6.00days) still significant if compared to untreated ones. Females fed on fish treated with Sweat basil powder had shortest oviposition period of 26.00-0.00 days followed by Black pepper, Pepper fruits., African Nut-meg and Ginger with longest duration of 42.00 – 38.00 days, all significant (P<0.05) when compared to control. The fecundity of female was also significantly affected by varying amounts of the spices. The Sweet basil was observed to be the most effective spice resulting in least fecundity (125.00 – 0.00) while Ginger resulted in highest fecundity (749.67 - 372). All tested spices thus drastically shortened the life span of adults with significance differences. These results have shown that tested spices demonstrated protective ability against adults hide beetle and confirm the activities of these plant powders.

Keywords: Dermestes maculatus , Development, Survival , Smoked fish

1. INTRODUCTION:

Most of the dried fish available to consumer in tropics are smoked, dried and provide an excellent source of protein (Eyo, 2001).The smoked fish is highly favored item of many traditional dishes in Nigeria (Osuji, 1976). It provides about 20% of proteins and essential amino acids, vitamins, poly-unsaturated fatty acids and minerals comparable with that of eggs, milk and meat in nutritional value (FAO, 2004). Dried fish is a highly favored item of many traditional dishes; it is a condiment that greatly enriches the flavor of various dishes and a good alternative to fresh fish which in many part of the country is not readily available (Osuji, 1976). The fish protein compares favorably with eggs, meat and milk in its amino acid content has a high level of essential lysine and methionine both of which are lacking in a cereal base diet (Eyo, 2001; Amusan and Okorie, 2002). Fish fat is characteristically high in unpoly unsaturated fatty acids; so that it provides diet low in cholesterol (Odeyemi *et al*., 2000). Dried fish oils contain fairly high quantities of vitamin especially A, B, and D, (retinol, thiamin, riboflavin, nicotinic acid and calciferol), making them more important in vitamin deficient diet. Dried fish is rich in mineral which are important in human diet, the main minerals constituents present are calcium and phosphorus, in bone, iron in liver, others are; magnesium, copper which are important trace elements (Baba *et al*., 2014).

Dried fish is a readily source of energy which is available in areas where the overall calorie per head is sufficient (Baba *et al*., 2014). Dried fish is also very important in terms of income generation, poverty alleviation and provision of raw materials for animal feed industries (FDF, 2005).

Nigeria has a total annual consumption of 1.2 million metric tons, with 45% of the total fish catches used as smoked fish (FAO, 2002; FDF, 2005). However large scale deterioration and losses in quality of processed fish results from insect infestation (Eyo, 2001). In Nigeria these quantitative and qualitative losses to fish have been due to infestation by Dermestid beetles viz., *D. frishchii*, *D. lardarias. D, maculatus* and *Nacrobia rufipes* with *D. maculatus* as major pest (Osuji, 1974). These insect pest generally infest dried fish during storage, transportation and marketing, thus responsible for extensive damage to marketed fish leading to enormous weight loss (Denpedro, 1989). The larval stages of Dermestid beetle have been found to cause up to 93% infestation of dried fish and up to 62.7% loss in dry weight (Adebote *et al*., 2006).

Attempt have been made by several workers to control this destructive beetle on dried fish, and these based on the use of physical and synthetic chemical control (Muhamed and Yusuf, 2001; Ashamo and Ajayi, 2003). Although many synthetic chemical are effective the general use of such

chemicals to protect stored fish has been hampered by the report of health hazard, high cost of purchase, lack of availability illiteracy of fish handler for right application and less susceptibility of dermestid larvae (Booke, *et al*., 2001; Amusan and Okorie, 2002).However, alternative to these synthetic chemicals, Insecticides of plants origin were particularly valued for application against insect pests of stored produce(Okonkwo, and Okoye, 2001; Owoade, 2007). The need to protect smoked fish from the said pest is imperative. Efforts have been made to screen the selected spices as alternative to synthetic chemicals in controlling the adult hide beetle's development and in reducing the damages to dried fish by their adults (D. *maculatus)*.

2. MATERIALS AND METHOD

2.1 Collection of Plant and Preparation of Plant Powders

Dry fruits of African Nut-meg (*Monodor myristica* Dunal, seeds), Black pepper (*Piper guineense* S and T, seeds), Ginger (*Zingiber officinale* Ross, stem), Hot pepper (*Capsicum annum* L., fruits) and Sweet basil (*cannum* Sims, fruits) were purchase from the Sokoto Central Market. Each of the plant materials was washed with distilled water, dried in the laboratory drying- cabinate at 40°C for 8hrs and milled into fine powders using mortar and pestle. There were sieved through 0.2mm mesh size following the methods of Adedire and Lajide, (1999); Akinwumi *et al.(2006)*. Each of the plant powder was labeled and kept in a separate plastic container and placed in cool dry place prior for use. The sample of conventional insecticides, dichlorvos purchased from the same market in form of liquid and kept in cool dry place, away from sun light.

2.2 Preparation of Fish samples

Smoked dried Tilapia fish was purchased from fish mongers at Sokoto Central Market. The fish samples were disinfected by heat treatments in the Laboratory in an incubator at 60°C for 1 hour and allowed to cool at room temperature as adopted by (Onu and Baba, 2003; Akinwumi *et al*., 2006).

2.3 Collection of Hide Beetle and Maintenance of Culture

The different stages of Hide Beetle were obtained from naturally infested dried fish collected from Sokoto Central Market fish-stalls. Several adult pairs of *D. maculatus* were obtained for culture and kept in glass jars and fed on dried smoked- tilapia fish. The jars were covered with muslin cloths, wet cotton wool were supplied in each jar to provide water requirements for oviposition as suggested by Hill, (1990). The adults laid eggs which hatched into larvae and change to pupae. These pupae were picked up and transferred to separate jars to obtain newly emerged adults which were used for the experiment. The culture was maintained for regular supply of newly emerged adults for the experiment.

2.4 Effects of Plants Powders on adults D. *maculatus*

To study the developments of adults *D. maculatus* reared on dried fish treated with varying amount of selected plant spices. Twenty five gram (25g) of dried smoked tilapia fish was dusted with 1.0, 2.0 and 3.0g of each plant spices powders and the corresponding amount of dried smoked fish was also treated with 5ml of 1.0, 2.0 and 3.0 percent solution of dichlorvoss (2-3- dichlorovinyl, dimethyl phosphate). The variously treated dried fish were air dried for 1-2 hrs following Akinwumi *et al*. (2006). Five (5) pairs of newly emerge adult of *D. maculatus* were introduced in each of the beaker, a cotton wool soaked in distilled water was provided to cope with the water requirements of adults. These beakers were covered with a muslin cloth to allow gaseous exchange and prevent insect from escaping. The beakers were arranged in a completely randomized design (CRD) on a table under laboratory condition of temperature and relative humidity which fluctuated between 27 - 33°C and 65 - 70 percent relative humidity respectively. Observations were made on pre-oviposition, oviposition, post oviposition period, daily rate of eggs laying, total fecundity of female and total life span of adults. The experiments were replicated three times.

2.5 Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) using General Linear Model (Univired procedure of statistical packages for social science SPSS., 2007), and means found to be significant were separated using Duncans multiple range test, at 5% level of significant. ($P<0.05$).

3. RESULTS

The Results obtained on the effect of spice powders on survival and development of *Dermestes maculatus* infesting dried fish are shown in Table 1. The Table shows pre oviposition period of female *D. maculatus* at application rate of 1g of different spice powders, as 6.67, 6.33, 5.66, 5.33 and

5.0 days as pre-oviposition period for females reared on fish treated with Black pepper, Pepper fruit, African nut-meg, Sweet basil and Ginger powder respectively, with 4.66 days as maturation period of adults in untreated control. The results indicate significant different between Black pepper, Pepper fruit and control at (P<0.05). The Table (1) also showed that female fed on dried fish treated with Sweet basil powder on dried fish treated with Sweet basil powder has the least oviposition period of 26.0 days, followed by Black pepper (31.66), Pepper fruit (31.66), African nut-meg (40.66) and Ginger (42.00) with the highest oviposition period. These was found to be statistically significant (P<0.05) except in African nut-meg which was statistically similar with control (40.33). The post oviposition period at application rate of 1g of powder (Table 1) also differed significantly (P<0.05) among the various spices; African nut-meg (22.00), Ginger (37.00), Pepper fruit (33.33), Black pepper (45.00) and Sweet basil (34.00) and Control (39.67).).

The result in (Table 1) shows the life span of *D. maculatus* reared on dried fish treated with 1.0g of various spice powders; Ginger (84.00), Black pepper (83.66), Pepper fruit (76.33), African nut-meg (68.33) and Sweet basil (65.33 days), these showed a very significant effect (P<0.05) when compared with life span of adults in untreated control (88.00). While adults reared on fish treated with Dichlorvos did not survive more than 24hr. The fecundity of females *D. maculatus* was also observed to be significantly affected when reared on dried fish treated with 1g different spices powders (Table, 1). The least fecundity was observed on Sweet basil (125.00) followed by Black pepper (190.00), Pepper fruit (288.66), African nut-meg (749.00) and Ginger (749.67) respectively. All these values were observed to be significantly different (P<0.05) when compared with the control (883.33).

When the amount of powder applied to treat the same quantity (25g) of dried fish was raised to 2g, it was observed (Table 1) the maturation period (pre-oviposition) period was observed to be statistically similar between Ginger (5.67), Sweet basil treatment and control (41.66). But the results, also indicate significant difference (P<0.05) between the pre-oviposition period of females on dried fish treated with African nut-meg (6.00), Pepper fruit (6.66) and Black pepper fruit (7.66) with the control. The application rate of 2g also strongly affected the oviposition period of females *D. maculatus*. The least oviposition period of 5.00 days was observed among the females fed on dried fish treated with Black pepper followed by Pepper fruit (20.66), Sweet basil (21.66), African nut-meg (21.33) and Ginger (32.66). These were statistically difference with control (37.33) at (P<0.05), while no egg was laid by females on dried fish treated with insecticide Dichlorovos. The post oviposition period was also statistically different (P<0.05) with control with higher post- oviposition period of 31.66 for females on dried fish treated with African nut-meg, while the least post-oviposition was obtained on Pepper fruit, (18.00 days) with control having post oviposition period of 34.00 days.

When the amount of powder applied to treat the same quantity (25g) of dried fish was raised to 2g, it was observed (Table 1) that an increase in the amount of spices powder significantly affected (P<0.05) the life span of adults *D. maculatus* on dried fish treated with Black pepper (34.00) as the shortest longevity, followed by Pepper fruit (33.33), Sweet basil (45.33), Ginger (53.66) and African nut-meg (55.66) with longest longevity among the various spices treatment, with untreated control having mean longevity of 77.33 days, while the adult in treated control Dichlorvos survived for only a period of 24hrs. The fecundity was also affected by the increase in the amounts of powder of various spices. The least fecundity was observed on female fed on dried fish treated with powder of Black pepper (21.33) followed by Pepper fruit (41.66), Sweet basil (72.33), African nut-meg (122.00) and Ginger (625.00) as the highest fecundity, these values were statistically different (P<0.05) with control (728.33).

When the same quantity of dried fish (25g) was treated with 3g of various spices powders Table 1. It was observed that application of 3g of powder of Black pepper, Sweet basil and Pepper fruit were efficacious as Dichlorvos with no single egg laid by female, on these treated food; all adults died before maturation without oviposition. While Ginger and African nut-meg had a mean oviposition period of 10.33 and 3 days respectively, these values were statistically different when compared with the control (41.00) at (P<0.05).

When the same quantity of dried fish (25g) was treated with 3g of various spices powders a significant effect on longevity of the *D. maculatus* was observed (Table (1). The adults fed on dried fish treated with Black pepper survived only for a period of 9.33 days as shortest longevity, followed by Sweet basil (11.00), Pepper fruit (15.66), African nut-meg (32.00) and Ginger (61.33) days respectively. These values were statistically different (P<0.05) with untreated control (71.67).No eggs were laid by *D. maculatus* fed on dried fish treated with 3g of Black pepper, Pepper fruit, Sweet basil and Dichlorvos. Thus there were significant difference (P<0.05) between fish treated with African nut-meg (53.00) and control (3.88).

4. DISCUSSION

The pre-oviposition, oviposition and post oviposition of female *D. maculatus* on dried fish treated with different amount of various spice powders was significantly affected when compared with untreated control. The results have shown that many of the beetles died before oviposition when fed on fish treated with higher amount of black pepper, sweet basill, and pepper fruits powder. While oviposition was not affected among the beetles fed on fish treated with African nut-meg and Ginger, this could be attributed to their low toxicities. Among all the plant spices tested, black pepper was the most effective in preventing oviposition of *D. maculatus.* Fasakin and Aberajo (2002) also observed that black pepper powder prevented oviposition in *Callosobrunchus maculatus* and *D. maculatus* respectively. Adedire and Lajide (1999) reported black paper extract as the most effective agent against oviposition of *C. maculatus.*

Opareke and Dike (2005) reported reduction in oviposition of *C. maculatus* on seeds treated with powder of *M. myristica* at high concentration compared with Onion bulb powder. Ofuya *et al.* (1992) also reported the ovicidal and larvicidal and anti ovipositional effect of *M. myristica* on *C. maculatus* the bioactive constituent found in M. myristica include eugenol, limonene, tannic acid, asarone and citral (Golob *et al*.,1999) The reduction observed in oviposition observed may be due to early mortality and partial or complete retardation of embryonic development as reported by Dike and Mbah (1992).

The longevity of *D. maculatus* was also observed to be affected significantly by powders of black pepper, sweet basill and pepper fruit and the effect was observed to be dose dependent. This agree with observations of lsman *et al.* (1990) who found that the bioactivities of neem products were proportional to the azadirachtin content used.All the plants powders used, significantly affected the fecundity of adult female *D.* maculatus. A progressive decrease in fecundity was observed in the trials with increased in concentration (l -3g). The *D. maculatus* laid fewer number of eggs on fish treated with different spices while female in untreated fish had significantly (P>0.05) higher number of eggs. There was no egg laid on dried treated with high dose (3g) of Black pepper, pepper fruit and sweet basil, this could be as a result of high adult mortality thereby disrupting mating and sexual communication. The result is an agreement with the findings of Fasakin and Aberajo (2002) who observed that, black pepper powder prevented oviposition on *Callosobrunchus maculatus* and *D. malculatus* respectively. The marked potential effect of black pepper powder was also attributed to the presence of camphene, Limonene and beta- pinene as suggested Lale (1995) ; Golob *et al.* (1999)

5. CONCLUSION

The results obtained from this study demonstrate attractive potentials of spices powder as plant derived insecticides against *D. maculatus* on dried fish. Among the five selected spices powder tested, black pepper and Basil powders were more efficacious, at higher amount (3g). These powders were as efficacious as conventional insecticides (Dichlorvos) in all the parameters observed. The other spices, African nut-meg ginger and pepper fruit also show significant differences with control. Thus, spices powder can be used as botanical insecticides as chemical alternative.

6. REFERENCES

Adebote, D. A., Abolude, D. S., Oniye. S. J., Oladodo, S. S. and Hassan, M. M. (2006).Larvicidal and repellant action of *Detarium microcarpum* seed oil against the larvae of *Dermestes lardarius* (Coleopteran: Dermestidae) in dried C*larias gariepinus* fish. *Journal of Entomology* 38(3)245-253

Adedire, C. O. and Lajide, L. (1999). Effect of pulverised plant materials on fish damage and growth performance of fish beetle. *Dermestes maculatus* (Degeer). *Journal of Entomology.* 32:215-218.

Akinwumi, F. O., Fasakin, E. A and Adedire, C.O. (2006) Progeny inhibiting effect of four plant product against the leather beetle and copra beetles on smoked African mud cat fish *Clarias gariepinus* Burchell . *Journal of Biological Science.* 6(6): 1023 -1028,

Amusan, A. A. S. and Okorie, T. G. (2002). The use *of Piper guineense* Fruit oil (PFO) as protectant of dried fish against *Dermestes maculatus* (Degeer) infestation. *Global. Journal of Pure and Applied Sciences,* 8: 197-201..

Ashamo, M. O., and Ajayi O. E. (2003) Effect of Processing and Storage Method on the Shelf Life and Incidence of Insect Pest on Smoked Fish*; Global J. Pure APPL Sci*. 9 (3) 319-324.

Baba, G. O., Ayandande, F. A., Erhabor, T. A. Majolagbe, M. O., Sulaiman, Y. D., Fodoyin, A. S. and Musa, K. (2014). Potential of Neem Product as Protectant against Adult Mortality; Rate of Oviposition and Emergence of F1, Generation of *Dermestes Maculatus* Degeer on Dried Fish. *International Journal of Applied Research and Technology* 3 (4): 53-62.

Booke, S. J., Vanlon, J. J. A., Vanttuis, A., Kossou, D. K. and Dicke M. (2001). The Use of Plant Material to Protect Stored Leguminous Seed Against Seed Beetle: A Review. The *Netherlands: Backhuys* Publish P. 108.

Don-Pedro, K. N. (1989). Mechanism of action of some vegetables oils against *Sitophilus zeamais* Motschulky, (Coleopteran: Curculionidae) on wheat, *Journal of Stored Product Research*, 29: 40: 217-223.

Eyo, A. A. (2001). *Fish Processing Technology in the Tropic:* NIFFR New Bussa, Nigeria. Pp 193-349.

Ezeuh, C. E. (1982). Pest of dried fish in Nigerian Markets. *Nigerian Stored Product Research Institute, Technical Report Series 2:* 6-15.

FAO (1981). The preservation of looses in cured fish. FAO Fish Tech. Paper FAO. Rome.No.219.Pp87

FAO, (2002). *Year Book Fishery Statistics* Food and Agriculture. Organization, 92 (2) 186 p.

FAO, (2004). The State of World Fisheries and Aquaculture (SOFIA) Part I: World Review of Fisheries and Aquaculture: Food Agricultural Organization. Fish Rep. Romep 1-27.

FDF, (2005). Federal Department of Fisheries: Federal Ministry of Agriculture and Rural Development Report of Presidential Committee on *Fisheries and Aquaculture Development.* P 1-60.62

Fasakin, E. A. and Aberajo, B. A. (2002) effect of some pulverized plant material on developmental stages of fish beetle Dermistes *maculatus* Degeer in smoked cat fish (*Clarias gariepinus*) during storage Biosci Tech nol. 85: 173-177.

Golob, P., C. Moss, M. Dales, A, Fidegen, J. evans and I. Gudraps (1999), The use of spices and medicinal as bioactive protectants for grains, Food Agriculture organization Agric Service Bull., 137pp.

Hill, D. S. (1990). *Pest of Stored Products and their control.*Belhaven Press London,74-75

Isman, M.B., D. Koul, A. Luczynski, and J. Kaminski. (1990). Insecticidal and anti feedant bioactivities of neem oils and their relationship to azadirachtin content. *Journal of Agriculture and Food Chemistry* 38: 1406-1411.

Lale, N. E. S. (1995). An overview of the use of plant products in the management of stored product Coleopteran. *Post Harvest News Inform.* 6: pp. 69

Mohammed, A. A. K. and Yusuf S. A. K. (2001). Insect infestation and preventive measure in dry fish storage of Chittagong. Bangladah. Asian Network for scientific information on line *Journal of'Biological Sciences* 1 (10); 963-965

Odeyemi, O. O., Owoada, R. A. and Akinkurolere, R. (2000). Toxicity and population suppression effect of *Parkia clappertoniana* on dried fish pest (*Dermestes Maculatus)* and *Necrobia rufupes. Global Journal of Pure and Applied Sciences, 6:* 191-195.

Merchants, M. (2001). Stored products pest and their control. House and landscape pest series. Texas AM University, Texas, USA. http .7/citybugs .tarnu. edu/fastsheet/ento-1045.html

Ofuya, T. I., B.C. okoye and A. S., Ololo, (1992), efficacy of crude extract from seeds of *Monodora Mynstica* (Gaertu) Dunal as surface protectant against *callosobrunchus maculatus* (F) attacking legumes seed in storage *Journal of Plant Protection*,(99) 528-532.

Okonkwo, E. U. and Okoye, W. I. (2001) Insecticidal activity of *Dennettia tripetala Baker* (F) and *Piper guineense* Schum. and Thonn against *Dermestes maculatus* Degeer (Coleoptera; Dermestida) and *Necrobia rupies* Degeer *(Coleptera)* on dried Tilapia against *Dermestes maculatus* Degeer infestation. *Insect. Sci. Applied,* 11:

Olaifa, J. I. and Erhun, W.O. (1988). Laboratory evaluation *of Piper guineense* for protection of cowpea against *Callosobruchus maculatus. Insect Science and its Application,* 7 (4): 521-524.

Onu, I. and Baba, G. 0. (2003). Evaluation of neem products *(Azadrachta indica* (A. Juss; Melaceae) for the control of Dermestid beetle. *Dermestes maculatus* (Coleoptera Dermestidae) on dried fish. *Nigerian Journal of Entomology,* 20: 105-115

Oparaeke, A. M. and Dike, M. C. (2005). *Monodora myristica* (Gaertn) Dunal and *Allium cepa* L. (Liliacace) as protectants against cowpea seed bruchid *callosobrunchus Maculatus* (F) infesting Stored cowpea seeds. *Nigerian Journal of Entomology*, 22:84-92

Onu, I. and Baba, G. 0. (2003). Evaluation of neem products *(Azadrachta indica* (A. Juss; Melaceae) for the control of Dermestid beetle. *Dermestes maculatus* (Coleoptera Dermestidae) on dried fish. *Nigerian Journal of Entomology,* 20: 105-115

Oparaeke, A. M. and Dike, M. C. (2005) *Monodora myristica* (Gaertn) Dunal and *Allium cepa* L. (Liliacace) as protectants against cowpea seed bruchid *callosobrunchus Maculatus* (F) infesting Stored cowpea seeds. *Nigerian Journal of Entomology*, 22:84-92

Osuji, F. N. C. (1973). Studies on the biology of beetle pests infesting dried fish in Nigeria. With special reference to *Dermestes maculatus* Deger and *Necrobia rufipes* Degeer Ph.D. Thesis,

University of lbadan, Ibadan, Nigeria 387P.
Osuji, F. N. C. (1974). Beetle infestation of dried fish purchased from a Nigerian Market, with special reference to *Dermestes macultus* Deger. *Nigerian Journal. Entomology.* 1:69-79.
Osuji, F. N. C. (1975). Recent studies on the infestation of dried fish in Nigeria by *Dermestes macultus* and *Necrobia rufipes,* with special reference to the Lake Chad District. *Tropical Stored Products Information. 29:* 21-32.
Osuji, F. N. C. (1976). Recent Trends in stored products. Entomology in Nigeria: Proceeding of 9th *Annual Conference of Entomological Society of Nigeria,* Ibadan. 113p.
Owoade, R. A. (2007). Mortality Growth and Development of *Dermestes maculatus* Larvae exposed to dry *clarias sp*. Treated with four local species. Nigerian: African *Scientist* 9(1): 3
SPSS (2007). Statistical, Packages for the Social Science Ver. 16 SPSS Inco.
Toye, S. A. (1970). Studies on the humidity and temperature reaction of *Dermestes maculatus* Degeer (Coleopterta: Dermestidae). With reference to infestation in dried fish in Nigeria. *Bulleting of Entomology* Research 60:23-31.

Table 1. Development of adults of Dermestes *maculatus* DeGeer reared on dried fish treated with some selected spices and conventional insecticide (Dichlorvos).

Test Powders	Amount applied (0g/25g fish)	Number Of Adults inoculated	Pre-ovi position Period(days)	Oviposition period (days)	Post oviposition period (days)	Total Life Span (days)	Total eggs Laid (fecundity)
African	1	10	5.66^{d}	40.66^{ab}	22.00^{f}	68.33^{c}	749^{b}
Nut-meg	2	10	6.00^{cd}	21.33^{g}	31.66^{d}	55.66^{h}	122^{h}
(*M.myristica)*	3	10	6.33^{cd}	10.33^{h}	15.33^{h}	32.00^{k}	53.00^{i}
Ginger	1	10	5.00^{d}	42.00^{a}	37.00^{b}	84.00^{b}	794.66^{b}
(Z officinale)	2	10	5.67^{d}	32.00^{e}	16.66^{h}	53.66^{h}	625.66^{d}
	3	10	6.00^{cd}	38.00^{cd}	17.33^{h}	61.33^{g}	372.00^{e}
Pepper	1	10	6.33^{cd}	36.66^{d}	33.33^{d}	76.33^{d}	28.66^{f}
Fruit	2	10	6.66^{cd}	20.66^{g}	18.00^{gh}	41.33^{j}	41.66^{jk}
(C. annum)	3	10	15.66^{a}	0.00^{j}	0.00^{i}	15.66^{kl}	00.00^{l}
Black pepper	1	10	6.67^{cd}	31.66^{e}	45.00^{a}	83.66^{b}	190.00^{g}
(*P.guineense)*	2	10	7.66^{cd}	5.00^{i}	21.33^{fg}	34.00^{k}	21.33^{kl}
	3	10	9.33^{bc}	0.00^{j}	0.00^{i}	9.33^{l}	0.00^{l}
Sweet basil	1	10	5.553^{d}	26.00^{f}	34.00^{cd}	65.33^{f}	125.00^{h}
(*O.canum*)	2	10	5.56^{d}	21.66^{g}	18.00^{gh}	45.00^{i}	72.00^{i}
	3	10	11.00^{b}	0.00^{j}	0.00^{i}	11.00^{l}	0.00^{l}
Dichlorvos	1	10	1.00^{e}	0.00^{j}	0.00^{i}	1.00^{m}	0.00^{l}
	2	10	1.00^{e}	0.00^{j}	0.00^{i}	1.00^{m}	0.00^{l}
	3	10	1.00^{e}	0.00^{j}	0.00^{i}	1.00^{m}	0.00^{l}
Control	1	10	4.66^{d}	40.33^{ab}	39.67^{cd}	88.00^{a}	883.33^{a}
	2	10	4.66^{d}	37.33^{cd}	34.00^{b}	77.33^{c}	728.33^{bc}
	3	10	5.00^{d}	41.0^{ab}	25.67^{e}	71.67^{c}	388^{e}
S. E			±1.06	± 1.15	±1.19	± 0.99	± 7.88

Note: Means in each column followed by the same letter are not significantly different (P<0.05) 6