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A preliminary study on the pesticidal potencies of sweet orange (*Citrus sinensis*) peels on beans and maize weevils

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ABSTRACT: Insects act as both pests and vectors of disease-causing organisms to man and animals, thereby exposing them to secondary attacks. As grain pests, weevils cause harm, damage, destruction, reduction in grain quality and great economic loss. The use of synthetic insecticides have, over the years resulted in development of physiological resistance in the insects, environmental hazards as well as health problems to man and animals alike. The purpose of the study is to investigate ways of preserving food grains in a natural condition that could improve food security, maintain grain quality for a longer post-harvest period and provide alternative storage measure safer and less harmful to the environment, man and animals. This study assessed the pesticidal potencies of sweet orange (*Citrus sinensis*) peels on beans and maize weevils. The phytochemical screening of *C. sinensis* fruit peels revealed the presence of tannins, terpenes, anthraquinones, glycosides, resins, steroids and flavonoids. The beans and maize weevils upon treatment with varying concentrations of both the fresh and dried peels extracts (100mg/kg, 200mg/kg and 400mg/kg) showed a dose dependent significance ($p<0.05$) in the toxic activity on the weevils. The tannins and anthraquinones abundant in the fruit peel extracts of *C. sinensis* are known to exhibit acaricidal properties. The observed toxic effects could also be attributed to combined effects of various phytochemicals. These findings validate the traditional claims pertaining the use of orange peels in beans and maize preservations.

Key Words: *Citrus sinensis*, Pesticidal , Potencies, Weevils.

Introduction

The sweet orange, (*Citrus sinensis) (L.*), is the most commonly grown tree fruit in the world (Morton *et al*, 1987; http://plants.usda.gov/java/profile? Symbol = CISI3; Wikipedia, 2012). The sweet orange *Citrus sinensis* is believed to have been first cultivated in the Southern China, northeastern India, or perhaps Southern Asia (formerly known as Indochina, (Morton *et al*, 1987). Orange trees are widely cultivated in tropical and subtropical climates for the sweet fruit, which is peeled or cut (to avoid the bitter rind) and eaten whole or processed to extract orange juice, and also for the fragrant peel (Wikipedia, 2012). The peel of an orange has increased vitamin C and fiber (http://plants.usda.gov/java/profile?symbol=CISI3).

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Insects act as both pests and vectors of disease-causing organisms to man and animals thereby exposing them to secondary attacks. As grain pests, weevils cause harm, damage, destruction and reduction in grain quality and great economic loss (Salunke *et al*., 1985; WFP, 1994; Manu, 1997; Dawit and Bekelle, 2010). Insect pests caused heavy economic losses to stored grains throughout the world and their impacts are more in devastating in poor countries (Boxall, *et al* 2002). Control of stored products insects pest rely heavily on hazardous synthetic products.
Reports documented indicated that globally, a minimum of 10% of cereals and legumes are lost after harvest (Boxall *et al*. 2002; Dawit and Bekelle, 2010).

Control of stored product insect pests, rely heavily on hazardous synthetic products. According to WHO (1971); Emeasor and Okorie,(2008); Dawit and Bekelle, (2010), the use and continued application of synthetic insecticides to control maize weevils and other stored product pests has a lot of attendant problems, notably, high mammalian toxicity, high level of persistence in the environment, insect resistance and health hazards to workers.

The increasing problems associated with the use of synthetic chemicals for the control of stored product insects necessitates the quest for development of safe repellent agents against stored product pests by several researchers (Jilani *et al*, 1988; Tadesse, 1995; Bekelle, *et al*, 1997; Emana, 1999; Emeasor and Okorie, 2008; Dawit and Bekelle, 2010) in many parts of the world including developing countries.

The efficacy of some plants and plant products used in the control of stored product pests would depend on the phytochemicals present in the plants under study. Phytochemicals have been described as chemical compounds that occur naturally in plants that may have biological significance but are not established as essential nutrients (http://www.phytochemicals.info). They are also described as chemical substances found in plants that can help prevent diseases and cell damage (http://www.naturalegacy.com/blog/general-healthcare/what-are-phytochemicals/). Zimmerman(2005); http://www.phytochemicals.info/phytochemical.php; http://www.naturalegagy.com/blog/ general-healthcare/what-are-phytochemicals/; http://www.cliffbelleau.com/ap/pdf_nutrition_resources/List of phytochemicals in food.pdf; http://en.wikipedia.org/wiki/List_of_phytochemicals in food; http://www.phytochemicals.info) presented a list of phytochemicals as follows; Phenol compounds (Monophenols, Flavonoids, phenolic acids, Hydroxycinnamic acids); Terpenes (Monoterpenes, Saponins, Lipids); Betalains; Organosulfides; Indoles, glucosinolates; protein inhibitors; Alkaloids; Anthrocyanins; Carotenoids; tannins; Phytosterols; Coumestans; and Other organic compounds. Peleg (1991), stated that fruit parts of the grapefruit and oranges contained free and bound phenolic acids while the peels contained major portion of cinnamic acids compared to the endocarp.

Aim of the study: The aim of this study is to investigate ways of preserving food grains in a natural condition that could improve food security, maintain grain quality for a longer post-harvest period and provide alternative storage measure that is cheaper, safer and less harmful to the environment, man and animals.

Materials and Methods

The study was conducted at the Federal College of Animal Health and Production Technology (FCAH & PT), Vom, Plateau State.

Plant material collection and extraction: The plant material used for insecticidal activities against beans and maize weevils was *Citrus sinensis* peels, and it was collected from orange sellers in the month of July between 9am and 10am. The peels were later washed in water and sun-dried for 2 hours to reduce the moisture content. The peels were divided into two (2) sets. The first set was dried in the hot air oven at 50^{o}C for 72 hours and pulverized using mortar and pestle. The second set was not dried but pulverized using an electric blender. 1.5 liters of water was added to each pulverized material in different containers. Both materials were left overnight to soak and sieved, first, with ordinary sieve and later with filter paper. The solvents were then poured into a stainless steel plates and put into hot air oven for 72 hours after which extracts from both fresh and dried peels were recovered and subjected to phytochemical screening by adopting the method of Harbone (1973).

Pesticidal potency tests of the extracts: The tests were carried out on both the beans and maize weevils using extracts from both fresh and dried orange peels at 100mg/kg, 200mg/kg and 400mg/kg concentrations and mortality of the weevils observed each day for 9 days. The method of Ihekoronye and Ngoddy (1985); Cobbinah *et al* (1999) and Emeasor and Okorie (2008) was adopted in the pesticidal potency tests.

Clean and apparently healthy beans and maize seeds were bought from the market.Weevils were allowed to naturally infest the beans and maize seeds. After much infestation, the experiments were carried out by dividing the grains containing weevils into 4 groups of 3 sets each. First group, 3 petridishes each containing 2kg of viable beans seeds containing 10 weevils each visa-vis-maize seeds respectively and labeled as A,B and C. Each petridish had different concentrations of 100mg, 200mg and 400mg of the orange peel extracts (fresh and dried separately) added and mixed thoroughly for uniform distribution of the extracts. The infested grain-extract mixtures were left for 24 hours after which mortalities were observed on a daily basis at different concentrations.
Mortality rate was calculated using Robert and Williams (1991) postulated formula:

$$\frac{\text{Total No of dead weevils}}{\text{Total No of weevils}} \times 100$$

Results

The phytochemical analysis in table 1 revealed the presence of Tannins, Resins, Glycosides, Flavonoids, Anthraquinones, Steriods and Terpenes and absence of Saponins and Alkanoids in both the fresh and dried peel extracts. The degree of occurrence of each phytochemical is symbolized by (+) indicating not much present and (++) indicating much present. Tannins and Anthraquinones are found to be more abundant in both fresh and dried extracts, while steroids and terpenes were found to be much more present in fresh extract only.

Tables 2 and 3 showed the effects of fresh and dried peel extracts on beans weevils at different concentrations. The effect of the extracts on maize weevils are shown in tables 4 and 5. The 400mg concentration for both the fresh and dried extracts is shown to be more lethal to the weevils recording 100% mortality on days 5 and 6 for the beans weevils and on days 7 and 9 for the maize weevils respectively. Tables 6, 7, 8 and 9 revealed the effectiveness of the extracts on the weevils when diluted with distilled water.

From the result, it was observed that the beans and maize weevils upon treatment with varying concentrations of both the fresh and dried extracts (100mg/kg, 200mg/kg and 4oomg/kg), showed a dose dependent significance ($p<0.05$) in the toxic activity on the weevils, but no significant difference in the mortality of weevils when comparing the fresh and dried extracts.

Table1: Phytochemicals of aqueous extracts of dried and fresh *Citrus sinensis* peel

Phytochemicals orange peels	Fresh peel	Dried peel
Saponnins	-	-
Tannins	++	++
Resins	+	+
Alkanoids	-	-
Glycosides	+	+
Flavonoids	+	+
Anthraquinones	++	++
Steroids	++	+
Terpenes	++	+

Table 2: Effect of fresh extract on beans weevils

Days	Concentrations of extracts (mg/kg)			Control
	100 Mortality (%)	200 Mortality (%)	400 Mortality (%)	Mortality (%)
1	40	40	50	00
2	50	60	70	00
3	60	60	90	00
4	80	80	90	00
5	90	80	100	00
6	90	90		00
7	100	90		00
8		100		00
9				00

Table3: Effect of dried extract on beans weevils

Day(s)	Concentrations of extracts (mg/kg)			Control
	100 Mortality (%)	200 Mortality (%)	400 Mortality (%)	Mortality (%)
1	40	40	50	00
2	50	50	60	00
3	50	60	70	00
4	0	70	90	00
5	60	80	60	00
6	70	80	100	00
7	80	90		00
8	90	100		00
9	100			00

Table 4: Effect of fresh extract on maize weevils

Day(s)	Concentrations of extracts (mg/kg)			Control
	100 Mortality (%)	200 Mortality (%)	400 Mortality (%)	Mortality (%)
1	30	40	50	00
2	50	50	60	00
3	50	60	60	00
4	60	60	80	00
5	70	70	80	00
6	70	80	90	00
7	80	90	100	00
8	90	100		00
9	100			00

Table5: Effect of dried extract on maize weevils

Day(s)	Concentrations of extracts (mg/kg)			Control
	100 Mortality (%)	200 Mortality (%)	400 Mortality (%)	Mortality(%)
1	30	30	40	00
2	40	50	50	00
3	50	50	60	00
4	50	60	70	00
5	60	60	70	00
6	60	60	80	00
7	70	70	90	00
8	70	80	90	00
9	80	90	100	00
10	90	100		00
11	100			00

Discussion

A preliminary study into the insecticidal effects of sweet (*Citrus sinesis*) peel on bean and maize weevil was carried out. The phytochemical analysis of both fresh and dried peels revealed some vital ingredients in the peel as Tannins, Anthraquinones, Steroids, Resins, Glycoside Flavonoids, Cardiac glycoside and Terpenes. These conform to the list of phytochemicals of Zimmerman (2005).

The mortalities observed in both beans and maize weevils when treated with extracts from fresh and dried peels could be an indication of the systemic and contact actions of the active ingredients of the phytochemicals identified on the weevils. This agrees with the report of Frank (1985), Steinmetz and Potter (1991), Akpata (1998), Chariandy (1999), Zimmerman (2005) who stated that the actions of some of these phytochemicals could be physiological thereby protecting against various human diseases including cancer and heart diseases, could disrupt microbial membrane, inhibit respiratory virus. Although there work seemed to be more on the control of human diseases, it is possible however that these phytochemicals may have adverse effect on the lives of the weevils with resultant deaths of the weevils.

This study also recognizes the importance of high concentrations of these phytochemical on the mortality rates of the weevils. The fresh and dried extracts had no mush difference in the mortality rates following the simple percentage observation. However, it was observed that it took only few days for a 100% mortality to occur at high concentrations as compared to the more days taken at lower concentrations.

This study noted also that when extract from both fresh and dried peels were diluted in distilled water at 400mg concentration, there was 100% mortality rate at day one. This further confirms the work of Okogun (2000) who reported that the type of solvent used for the extraction plays vital role on the effect of active ingredient on the target organism.

Conclusion

It could be concluded here that sweet orange peels have some vital active ingredients which actively affected the lives of both beans and maize weevils. We further conclude that the concentrations of the extracts as well as the diluents plays important an role in the killing actions of the active ingredients on the weevils. Conclusion is made also that since some phytochemicals from other plants extracts can be used to control certain human diseases, having identified similar phytochemicals in the sweet orange peels, same may be deleterious to the pests, hence, may be applied in the control of storage grain pests.

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