Original Research Article

Effect of the Prevalent Insect Species of Yam Chips on Consumers' Acceptability of Yam Paste

Samuel Adelani Babarinde¹, Grace Oluwakemi Babarinde², Adeola Foluso Odewole¹, Olubukola Omotoyosi Alagbe¹

¹Department of Crop and Environmental Protection, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

²Department of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Nigeria

Abstract

A survey was carried out between March and August 2010 to identify insect pests of stored yam chips in Ogbomoso Metropolis, Nigeria. Dried yam chips were randomly obtained from old stocks in 6 local markets within the metropolis on monthly basis. There was a significant ($P < 0.05$) difference in insect abundance based on month of sampling and insect species. *Dinoderus porcellus* (Coleoptera: Bostrychidae) was the most abundant species. Other species encountered were *Araecerus fasciculatus* (Degeer) (Coleoptera: Anthribidae), *Sitophilus zeamais* Motschulsky (Coleoptera: Curculionidae) and *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae). When chips were infested with *Dinoderus porcellus* and stored for 3 months, reconstituted thick paste (amala) was made from the flour and was evaluated for consumers' acceptability. Sensory characteristics such as odour, colour, texture, appearance, taste and overall acceptability were significantly ($P < 0.05$) affected when compared with the paste prepared from the uninfested chips.

Keywords: Yam chips, insect pests, amala, market survey, *Dinoderus porcellus*, Ogbomoso

INTRODUCTION

Yam (*Dioscorea* species) is annual or perennial tuber bearing and climbing plant. Of the 600 species of *Dioscorea* recognized worldwide (Coursey, 1967), only 10 are grown in various parts of the world (Lebot, 2009). The tubers have organoleptic qualities that make them the preferred carbohydrate staple and can contribute up to 350 dietary calories per person each day (Asiedu et al., 2001). Yams are produced in over 5 million hectares in 47 countries in tropical and subtropical regions of the world. More than 95% of the 47 million metric tonnes of yam produced annually comes from sub Saharan African (IITA, 2007). It is a major staple food crop grown in the humid and sub-humid tropics. In Nigeria and other West African countries, yam is sold either as fresh tuber or dried chips. In both forms, yam can be stored with varying successes and benefits. The farmers' primary objectives in processing yams into chips are reduction of post-harvest losses, removal of inedible and unmarketable parts, earning higher income, production of forms that can store longer than fresh tubers and to provide raw materials for agro-industries (Eze, 1998).

In Nigeria, dehydrated yam chips is the only form in which fresh yam is preserved throughout the year. The production process consists of peeling, blanching and drying the tubers then crushing and milling them (Akingbala et al., 1995; Akissoe et al., 2001). The resulting flour, with a median particle size of 70-75 μm (Okaka and Anajekwu 1990; Akissoe et al., 2001), is mixed with boiling water in ratio 1:4 to produce a coloured gel-like paste called amala. Though

amala is largely eaten by ethnic Yoruba tribe of south-western Nigerian, its popularity as a "Fufu" like meal is increasing amongst non-ethnic. Yam chips are usually spread to dry on the ground rock surfaces, road sides and on old yam vines. The drying yam chips are exposed to insects and fungal attack that could be inadvertently carried to storage.

Ogbomoso is a Yoruba-dominated town with the slogan "...nibi ti won ti njeka, ki won to mu'ko yangan", being translated "...where they eat reconstituted yam paste before taking maize palp". It is almost the most prevalent food item at domestic and ceremonial functions in the ancient town. As much as it is consumed by the masses, its production is also high among the local farmers who have no reliable storage facilities for yam tubers. It is with this background that this study was designed with the objective of determining the abundance and diversity of insect pests' infestation on stored yam chips in Ogbomoso Metropolis and the impact of the prevalent insect species (*Dinoderus porcellus*) on the quality of reconstituted yam paste. This would sensitize the producers and/or merchants of yam chips and the consumers of reconstituted yam paste (*Amala*) made from chips of the threat of storage insect pests.

MATERIALS AND METHODS

Survey of yam chips for insect pest infestation

Survey of yam chips for infestation of insect pests was carried out from March to August, 2010 at six different

markets in Ogbomoso Metropolis. The markets were Iluju Market, Arada Market, Tewure Market, Odo-Oba Market, Gambari Market and Arowomole Market. About 2 kg of yam chips were collected from each market. Five hundred grams chips were weighed into 3 L capacity plastic jars covered with plastic screen net to prevent entrance of other insects or escape of the emerging adults and kept for two months in the laboratory under ambient conditions.

Data were collected on insect abundance and diversity by carefully breaking the chips manually and the insects separated from the chips and flour using a soft camel's brush. Insects species collected were identified in the Entomology Unit of Crop and Environmental Protection Laboratory, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso with the aid of Identification keys highlighted by Haines (1991). The experiment was replicated four times.

Production of yam chips

Yam tubers were purchased from Wazo Market Ogbomoso Nigeria and processed into chips as highlighted in Scheme 1 (Ukpabi et al., 2008).

Fresh tuber → Peeling → Washing → Chopping →
→ Perboiling → Decantation → Drying → Milling →
→ Sieving (0.5 mm sieve) → Bagging

Scheme 1. Production of yam flour from yam tuber

Effect of *Dinoderus porcellus* on consumers' acceptability of paste

The most prevalent species from the survey was *D. porcellus*. Forty mixed-sex *D. porcellus* collected from chips obtained from the markets were used to infest 500 g un-infested sun-dried yam chips prepared as highlighted in Scheme 1 in the laboratory under ambient temperature of 25 – 35 °C and 68 – 80% relative humidity for one month in the Storage Entomology Unit of Crop and Environmental Protection Laboratory, LAUTECH, Ogbomoso, Nigeria. After one month of the set up of the culture, all adults were removed and new adult emergence was observed. Twenty mixed-sex, 1-to-7-day old adults were used to infest 300 g freshly produced un-infested chips and maintained in the laboratory under the same conditions for the rearing of the insect.

Preparation of 'Amala'

The flour was reconstituted into thick paste 'Amala' by mixing the flour sample with boiling water (1:3 w/v approximately) in one litre capacity aluminium heat resistant vessel. The paste was continuously stirred and cooked on an electric stove until it was properly cooked.

Sensory evaluation

Flour from infested and un-infested samples was made into reconstituted yam paste ('Amala') using about 300 g of flour and 100 ml of boiling water for each type of flour. About 10 g of each paste was served in 9 cm diameter Petri dish with the appropriate codes and subjected to evaluation by twenty trained panelists made up of both men and women. Pastes were replicated thrice and coded in such a way to prevent bias by the panelists. The panelists were asked to rate some of the quality attributes which were odour, colour, texture, taste, appearance and overall palatability. Panelists assigned scores to each attribute using 5 point hedonic scale where 1 represented dislike extremely and 5 represented like extremely.

Experimental design and statistical analysis

The experiment on survey of insect abundance and diversity was laid out in a Randomized Completely Block Design (RCBD), with sampling month as block. Data were subjected to analysis of variance (ANOVA) with the aid of SAS Software Package (SAS Institute, 2000). Data on consumers' evaluation of paste were subject to 't-test' to determine the difference between the paste made from the infested and uninfested chips. All analyses were done at 5% probability level.

RESULTS

Abundance and diversity of insect infestation on stored yam chips obtained from different markets in Ogbomoso Metropolis is shown in Table 1. There was a significant difference in insect abundance based on month of sampling ($P=0.02$, $df=6$, $LSD=9.77$) and insect species ($P<0.0001$, $df=3$, $LSD=7.99$). *D. porcellus* was the most abundant species while *S. zeamais* was the least abundant. Percentage mortality of *A. fasciculatus* was significantly ($P<0.005$) higher in March than its percentage mortalities observed in the May- August survey. There was a significantly lower percentage mortality of *D. porcellus* species in June and August.

Table 2 shows the effect of insect infestation on the quality of yam paste prepared from the infested yam chips. *D. porcellus* significantly affected the quality of paste made from infested yam flour. The quality parameter that was most affected by insect infestation was paste-appearance which was scored 3.06 being significantly lower than 4.45 recorded in paste prepared from uninfested yam flour, colour was not much affected as other parameters but was significantly affected by insect infestation when compared with the control.

meteorological differences and farmers/merchants' chips handling methods. Babarinde et al. (2008) had reported the infestation of cassava chips by *S. zeamais*, while Chinjindu and Boateng (2008) also reported *A. fasciculatus* in cassava chips. This survey has shown that seasonal variation affects the population dynamics of insect pests of yam chips. The high number of *D. porcellus* observed from samples collected in April and May compared with low population observed in July across six markets could partly be explained by the meteorological differences in the periods and the length of time chips took in storage prior to sampling. Arthur et al. (2006) reported that the population density of insect pest of stored ginger is related to season and harvesting time. The result followed similar trend as observed by Lale and Igwebuike (2002) who studied the field infestation of *Acacia albida* pods by stored product insects in the savannah region of Nigeria. The study of Lale and Igwebuke (2002) showed that number of beetles was lowest in June while the highest was noticed in February. Also Zakka et al. (2010) reported that high number of arthropod pests was observed from stored ginger collected in March/April while low population was observed from those samples in June/July across 10 market sites.

Month	Insect species	Life count	% Mortality
March	<i>A. fasciculator</i>	2.33 ± 1.2	32.14 ± 20.9
	<i>D. porcellus</i>	96.33 ± 2.3	24.79 ± 4.1
	<i>S. zeamais</i>	2.33 ± 0.3	8.33 ± 8.3
	<i>T. castaneum</i>	2.67 ± 0.3	0.00 ± 0.0
April	<i>A. fasciculator</i>	8.00 ± 1.5	27.29 ± 6.6
	<i>D. porcellus</i>	128.33 ± 14.8	17.31 ± 6.1
	<i>S. zeamais</i>	4.33 ± 1.8	33.53 ± 6.1
	<i>T. castaneum</i>	2.66 ± 0.8	51.11 ± 15.5
May	<i>A. fasciculator</i>	2.66 ± 1.3	6.66 ± 6.6
	<i>D. porcellus</i>	108.3 ± 8.4	18.74 ± 1.2
	<i>S. zeamais</i>	4.33 ± 1.8	15.00 ± 7.6
	<i>T. castaneum</i>	66 ± 1.2	20.63 ± 10.4
June	<i>A. fasciculator</i>	2.00 ± 1.1	6.66 ± 6.6
	<i>D. porcellus</i>	85.00 ± 16.0	9.10 ± 4.5
	<i>S. zeamais</i>	1.33 ± 1.52	0.00 ± 0.0
	<i>T. castaneum</i>	2.00 ± 0.5	0.00 ± 0.0
July	<i>A. fasciculator</i>	12.00 ± 2.5	14.53 ± 4.2
	<i>D. porcellus</i>	12.66 ± 23.3	26.76 ± 9.0
	<i>S. zeamais</i>	2.00 ± 0.5	25.00 ± 14.7
	<i>T. castaneum</i>	3.00 ± 1.05	31.11 ± 5.8
August	<i>A. fasciculator</i>	2.00 ± 1.1	6.66 ± 6.6
	<i>D. porcellus</i>	85.00 ± 16.0	9.10 ± 4.5
	<i>S. zeamais</i>	1.33 ± 0.8	0.00 ± 0.0
	<i>T. castaneum</i>	2.00 ± 0.0	0.00 ± 0.0

Life count	% Mortality
$P = 0.02$, LSD Month = 9.77	$P = 0.005$, LSD Month = 15.14
$P < 0.001$, LSD Insect type = 7.99	$P = 0.62$, LSD Insect type = not significant

The finding from this survey also concurs with Maina and Lale (2006) in their study on bruchids and they indicated that the beetles developed better in the raining season which was characterized by high temperature and humidity. Lower number of insects observed in yam chips sampled in the month of July which is characterized by high humidity (80 – 95%), low temperature and high rainfall did not concur with the findings of Fields (1992) that insects died at low humidity from the effects of desiccation and susceptibility to heat. It is also believed that at low and high moisture contents, the rates of population increase are low but are highest at an intermediate optimum (Haines et al. 1991). Since the scope of this work does not investigate the period of the infestation of the different encountered species, it was not easy to state which of the species was an early colonizer. However, *D. porcellus* was most prevalent; and it is established that the different species of storage insects could co-habitate in the same niche. The sources of infestation could be the farmers' ban or merchants' store or even the open market. With lower percentage mortality of *D. porcellus* in June and August, the possibility of the insect reaching its economic injury level during these months is high. Incidentally, this period corresponds with the peak of yam chips storage, when their market prices are high in the study area. Unprotected yam chips are at higher risk of physical and biophysical deterioration due to the infestation of *D. porcellus* during this period.

Quality Parameter	Infested sample	Control	t-value
Odour	3.43	4.45	0.68
Colour	3.46	4.45	0.84
Texture	3.31	4.45	1.00
Appearance	3.06	4.45	0.74
Taste	3.29	4.45	1.27
Overall Acceptability	3.09	4.45	0.76

Data are average means of the scores of the panel of judges, n = 20.

DISCUSSION

The infestation of yam chips prepared in the laboratory by *D. porcellus* showed that pest infestation affected quality and acceptability of “Amala”. The panel of judges

rated the paste made from infested yam chips lower than the paste from uninfested chips in all the sensory attributes evaluated. This implies that insect infestation of chips has depletive effect of the quality of reconstituted paste made from the infested chips. Babarinde et al. (2010) had reported that infestation of plantain chips by *T. castaneum* caused some physical and biophysical deterioration of the chips. Orkwor et al. (1997) reported that yam processed into yam chips are exposed to insects and fungal attack. Also, Venier (1998) reported that weevil infestation in storage increased losses in terms of dry matter and visual quality of dried yam chips. This study indicates the necessity of providing adequate protection for yam chips against the infestation of insect pests. It is recommended that the pest control strategy to be used should be eco-friendly, without any risk of health hazards to consumers of reconstituted thick paste ('Amala'). Eze et al. (2006) had reported the potentials of using botanicals to protect chips against insect pests. This could be integrated with other methods such as the use of appropriate storage structures in order to reduce the tendency of cross infestations.

REFERENCES

- Akingbala J.O., Oguntimein G.B., Sobande A.O. (1995): Physico-chemical properties and acceptability of yam flour substituted with soy flour. *Plant Foods for Human Nutrition* 48:73-80.
- Akissoe H.N., Hounhouigan D.T., Ericas N., Vernier P., Nagro C.M. Olorunda O.A. (2001): Physical, chemical and sensory evaluation of dried yam (*Dioscorea rotundata*) tubers flour, and "amala" a flour-derived product. *African Journal of Root and Tuber Crops* 3:62-67.
- Arthur F.H. Hagstrum D.W., Flinn P.W., Reed C.R., Phillips, T. W. (2006): Insect populations in grain residue associated with commercial Kansas grain elevator. *Journal of Stored Product Research* 42:226-239.
- Asiedu R., Mignouna H., Odu B., Hughes J.A. (2001): Yam breeding. *Plant Virology in sub Saharan Africa (PVSSA)* in 2001 Conference, International Institute of Tropical Agriculture IITA, Nigeria, p. 466-475.
- Babarinde S.A., Babarinde G.O., Olasesan O.A. (2010): Physical and biophysical deterioration of stored plantain chips (*Musa sapientum* L.) Due to infestation of *Tribolium castaneum* Herbst (Coleoptera: Tenebrionidae). *Journal of Plant Protection Research* 50 (3):302-306.
- Babarinde S.A., Sosina A., Oyeyiola E.I. (2008): Susceptibility of the selected crops in storage to *Sitophilus zeamais* Motschulsky in south western Nigeria. *Journal of Plant Protection Research* 48(4): 541-550.
- Chijindu E.N., Boateng B.A. (2008): Preference of and damage to processed cassava chips by *Araecerus fasciculatus* (Degeer). *Journal of Applied Sciences Research* 4 (8): 939-944.
- Coursey D.G (1967): *Yams*. Longman London. 230 p.
- Eze S.C, Asiegbu J.E, Orkwor G.C, Mbah B.N, Asiedu R. (2006): Effect of four agrobotanical extracts and three types of bags on the control of insect pest and moulds of stored yam chips. *Journal of Tropical Agriculture, Food, Environment and Extension* 5(1):8-12.
- Eze N.O.A (1998): Economics of Technology. In *Food yam: Advances in research*. G.C. Orkwor, R. Asiedu and I.J. Ekanayake (Eds.) NRCR/ IITA, Ibadan, Nigeria, pp. 187-214.
- Fields P.G. (1992): The control of stored product insects and mites with extreme temperatures. *Journal of Stored Product Research* 28: 89-118.
- Haines C.P. (1991): *Insects and arachnids of tropical stored product their biology and identification*. 2nd Edition. Natural Resources Institute Chatham Kent, UK.
- IITA (2007): *Yam research for development*. International Institute of Tropical Agriculture Publication 1, pp. 1-10.
- Lale N.E.S, Igwebuike J.U.A. (2002): Field infestation of *Faidherbia (Acacia) albida* (Del) A. Chew pods by stored product Coleoptera in the Nigerian savannah and effect of infestation on nutrient quality. *Journal of Arid Environment* 51:103-112.
- Lebot V. (2009): *Tropical root and tuber crops cassava, sweet potato, yam and aroids*. Crop Production Science in Horticulture series 17, MPG Books Group.
- Maina T.Y, Lale N.E.S. (2006): Effect of seasonal variations in temperature and humidity on the development of *Callosobruchus maculatus* and the efficacy of neem seed oil applied for its management in the Nigerian Sudan Savannah. *Tropical Science* 46:50-54.
- Nwana I.E. (1993): A survey of storage Coleoptera which attack dried cocoyam chips in Nigeria. *Journal of Stored Product Research* 29(1): 95-98.
- Okaka J.C., Anajekwu B. (1990): Preliminary studies on the production and quality evaluation of dry yam snacks. *Tropical Science* 30:67-72.
- Orkwor G.C., Ugwu B.O, Eze S.C. (1997): *Yam valorization; yam chip for urban market*. Final Report, National Root Crops Research Institute Umudike, Umuahia, Nigeria August 1997.
- SAS INSTITUTE (2000): *Statistical analytical systems SAS/STAT User's guide version 8(2)*. Cary, NC: SAS Institute Inc.
- Ukpabi U.J., Omodamiro R.M., Ikeorgu J.G., Asiedu R. (2008): Sensory evaluation of amala from improved water yam (*Dioscorea alata*) genotypes in Nigeria. *African Journal of Biotechnology* 7(8): 1134-1138.
- Vernier P. (1998): *Yam chip production in West Africa*

In: Post harvest systems. The newsletter for Post harvest system development in Africa. Number 2, pp. 5-7.

Zakka U., Lale N.E.S., Okereke V.G. (2010): A survey of pests of stored Ginger (*Zingiber officinale* (Rose) in some

selected markets in Rivers State, Nigeria. African Journal of Agricultural Research 5 (18): 2529-2534.

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Corresponding author:

S. A. Babarinde

Department of Crop and Environmental Protection

Ladoke Akintola University of Technology

P.M.B 4000, Ogbomoso

Nigeria

E-mail: samdelani@yahoo.com, sababarinde@lautech.edu.ng