Vol. 9(7), pp.68-71, September 2018
DOI: 10.5897/JSPPR2014.0164
Article Number: F6CC1F158547
ISSN: 2141-6567

http://www.academicjournals.org/JSPPR

Journal of Stored Products and Postharvest Research

Full Length Research Paper

Laboratory evaluation of six new cassava genotypes to *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae) infestation

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Received 13 May, 2014; Accepted 25 December 2014

Two products, chips and flour, processed locally from six new cassava genotypes; 98/0505, 01/1368, 05/1636, 05/0473, 01/1371 and 01/1412 obtained from National Root Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria were evaluated for losses (qualitative and quantitative) caused by rust red flour beetle *Tribolium castaneum* under storage conditions (25 to 30°C and 70 to 90% RH) in the General Laboratory, Faculty of Agriculture, University of Port-Harcourt. The response of each cassava genotype was evaluated by infesting 20 g lots of either chips or flour with 8 pairs of adult *T. castaneum* in 300 ml plastic containers with air tight lids. The trial was arranged in a completely randomized design in which treatments were replicated four times. With a few exceptions, cassava flour supported significantly more adults and immature *T. castaneum* progeny than chips; chips suffered significantly lower quantitative losses than flour. Cassava genotype 98/0505 was infested the most and consequently sustained the most damaged flour derived from it.

Key words: *Tribolium castaneum*, cassava, genotype, infestation, chip, flour.

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is a primary staple food crop for more than 800 million people in the world (Lebot, 2009). In most of the tropics, its production and yield are highly prolific and usually consumed in place of yam and cocoyam as the number one carbohydrate source and it is said to provide up to 40% of all the calories consumed in Africa (Hahn et al., 1987; FAO, 2008). The produce is the net result of all the prior efforts of crop husbandry; it is frequently stored for some period of time before consumption for a variety of reasons (Adesuyi, 1997). During storage, food commodities are usually liable to depredation by pests such as micro-organisms, mites, insects, rodents and birds (Lale and Ofuya, 2001). A processed cassava when available or purchased by households in large quantities is not immediately consumed and is often kept in storage where it is infested by stored product pests (Haines, 1991).

The red rust flour beetle, *Tribolium castaneum,* has

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Table 1. Mean weight loss (g) of two forms (chips and flour) of dried cassava genotypes infested by *Tribolium castaneum* and mean number of adult and immature *T. castaneum* after 30 days.

Cassava genotype	Mean weight loss (g)		Mean number of adult		Mean number of immature	
	Chips	Flour	Chips	Flour	Chips	Flour
98/0505	0.7750^{a}	1.3500^{ab}	4.00^{a}	3.75^{cd}	12.75^{c}	71.50^{a}
01/1412	0.3250^{b}	1.3750^{ab}	0.50^{b}	2.25^{d}	16.25^{bc}	48.75^{ab}
01/1371	0.3000^{b}	1.6500^{ab}	1.25^{ab}	36.25^{a}	17.25^{a-c}	21.75^{cd}
01/1368	0.2500^{b}	0.6500^{b}	2.50^{ab}	16.00^{bc}	27.75^{a}	42.75^{bc}
05/0473	0.2500^{b}	2.4750^{a}	2.25^{ab}	1.50^{d}	24.50^{ab}	16.75^{d}
05/1636	0.1500^{b}	0.6750^{b}	2.50^{ab}	20.75^{b}	24.25^{ab}	31.50^{b-d}

For each parameter and for each product, means followed by the same letters in the same column are not significantly different (P>0.05).

been reported to be a major pest of processed or damaged grain in storage (Haines, 1991). It is a polyphagous and cosmopolitan insect that has beenreported to have a long association with human stored food, but milled grain products such as flour appears to be preferred food (Campbell and Runnion, 2003). *T. casteneum* is a pest both as adults and larvae (Lale and Yusuf, 2001). It is an important secondary pest of most cereal grains especially maize, sorghum, wheat, millet and their products. It is also a serious pest in flour mills and wherever cereal products and other dried products are stored and/or processed. The pest has been reported to be prolific and has the ability to produce millions of progeny within a life span (Haines, 1991).

There is need to have accurate and current information on storage of cassava and its products, losses due to storage pests and the direct effect of infestation by this pest (*T. castaneum)* on stored cassava products. Six new cassava genotypes were subjected to *T. castaneum* infestation to assess their susceptibility as well as to determine quantitative and qualitative losses attributable to *T. castaneum* attack in storage.

MATERIALS AND METHODS

Insect rearing and culture

Adults of *T. castaneum* used to establish the culture were obtained from infested flour in a local market in Rumuokoro, Rivers State, Nigeria. The insects were left to breed in a series of 1-L Kilner jars under laboratory conditions (25 to 30°C and 70 to 90% RH) in the Faculty of Agriculture, University of Port-Harcourt. The age of the insects was standardized by sieving out the parental *T. castaneum* adults and used F_1 generation of known age as a sub culture.

Experimental materials

Chips and flour of six cassava varieties (01/1371 orange, 01/1412 orange, 05/1636 orange, 01/1368 orange, 05/0473 orange and 98/0505 white) were obtained from NRCRI, Umudike, Abia State, Nigeria, and used to evaluate their response to *T. castaneum* infestation in the humid Niger Delta region.

Experimental procedure

Approximately twenty grams of chips or flour of each variety were weighed using an electronic balance (model J2003) and put into jars and infested with eight pairs of *T. castaneum* adults. On day 7, these insects were sieved out and the eggs laid were allowed to develop.

Proximate analysis

Proximate composition of chips and flour derived from the six cassava genotypes was carried out prior to the commencement of the study at the biochemistry laboratory of NRCRI Umudike. The method of AOAC (1990) was used in the proximate analysis and alkaline picrate method (modified after Onwuka (2005) was used in cyanide determination.

T. castaneum progeny development

The adult progenies that developed in each jar after 30 days were counted and removed at the sight of first emergence. The pupae and larvae (immature) were sieved out and counted separately at the end of the experiment. Moisture content (wet basis) (Lale, 2002) was measured as the weight of water expressed as a percentage of the weight of the original material before the insects were introduced.

$$Mc = \frac{X-Y}{X} \times 100$$

Where; X= Original weight of material, Y= Final weight of material, X-Y= Weight of water, Mc=Moisture content.

The final weight of the chips and flour in each jar was taken and the difference between the initial weight and the final weight of the product introduced was regarded as the quantitative loss (g) of material due to *T. castaneum* infestation.

RESULTS

Table 1 shows the mean weight loss (g) of the two forms (chips and flour) of six cassava genotypes infested by *T.*

Table 2. Chemical composition of chips and flour derived from six cassava genotypes.

Cassava genotypes	M.C (%)	Crude fibre (%)	Fat (%)	Ash (%)	DM (%)	Reducing sugar (g/100g)	Cyanide (µg/g)	Total Carotenoid (µg/g)
98/0505 C	12.95	2.13	0.67	2.43	87.05	0.31	27	0.89
98/0505 F	11.60	1.43	1.23	1.40	88.40	-	21	-
05/1636 C	8.40	2.33	1.20	1.07	91.60	2.62	27	5.50
05/1636 F	8.40	1.67	0.40	1.80	91.60	-	30	-
01/1412 C	9.10	1.60	2.53	1.70	90.90	1.47	45	5.25
01/1412 F	9.05	2.07	2.97	1.26	90.95	-	56	-
01/1371 C	9.80	2.00	0.83	2.60	90.20	0.52	30	3.71
01/1371 F	9.90	2.03	1.93	2.10	90.10	-	40	-
01/1368 C	10.50	2.60	0.73	2.27	89.50	1.05	40	6.56
01/1368 F	8.70	2.03	1.23	2.03	91.30	-	28	-
05/0473 C	8.35	1.73	1.17	1.87	91.65	0.84	50	4.19
05/0473 F	8.90	1.57	1.13	1.20	91.10	-	30	-

Key: C= chips; F=flour.

castaneum and the number of teneral adults that developed in all products. There was a significantly higher (P≤0.05) weight loss on cassava genotype 98/0505 chips and variety 05/0473 flour while chips of cassava variety 05/1636 and flour of cassava genotypes 01/1368 and 05/1636 varieties had the least weight loss. Higher numbers of teneral F_1 adults was recorded in cassava genotype 01/1371 flour and chips of variety 01/1412 had the least adult progeny. However, variety 98/0505 flour had a significantly higher (P≤0.05) immature progeny than chips from the other varieties. With a few exceptions, however, cassava flour supported significantly more adults and immature *T. castaneum* progeny than chips; chips suffered significantly lower quantitative losses than flour.

Table 2 shows the chemical composition of the six cassava genotypes. Chips of variety 98/0505 had the highest moisture content while those of variety 05/0473 had the least moisture content. Cassava genotype 01/1368 chips contained more crude fibre than the other varieties. Higher percentage of fat was recorded in cassava genotype 01/1412 flour and the least in genotype 05/1636 flour. Variety 01/1371 chips had high value of ash while cassava genotype 05/0473 chips had higher dry matter content. Reducing sugar content was highest in cassava chips genotype 01/1636 and lowest in 98/0505 variety. Cyanide content was more in cassava variety 01/1412 flour and more carotenoid content in chips of cassava genotype 01/1368.

DISCUSSION

The study has shown that both products (chips and flour) of the cassava genotypes are susceptible to infestation by *T. castaneum* though to varying degrees. Cassava genotype 98/0505 which had high number of immature stages but relatively few adults in flour suffered more damage. This could be attributed partially to the high moisture content of this variety which may have favoured *T. castaneum* activities as earlier reported by Loko et al. (2013) that moisture content is a major constraint in yam chips storage especially in the traditional storage structures.

The result shows that weight loss was lower in chips than in flour in all the cassava genotypes. This could be attributed to the usual trend exhibited by secondary pests which are known to perform better and develop faster in flour than in chips or solid substrates (Lale and Ajayi, 2000). It suggests that storing these cassava genotypes in flour form is likely to aggravate the problem of infestation by secondary storage pests. Haines (1991) reported that *T. castaneum* being a secondary pest develops poorly or slowly on chips in storage. Trematerra et al. (1999) however, reported that damaged grain or flour releases some volatile compounds and these facilitate the attraction of secondary pests. The variation in degree of susceptibility observed across the different cassava genotypes showed that genotype 01/1412 was more resistant than the other genotypes to *T. castaneum* infestation.

Loss in quality ascribable to *T. castaneum* infestation includes reduction in loose and packed bulk densities of stored infested cassava varieties as a result of the activities of insects and micro-organisms (fungi and bacteria) (Zakka et al., 2010) though not evaluated in this research. Others include persistent objectionable odour imparted to the infested commodity due to secretion of benzoquinones from a pair of abdominal defense glands (Haines, 1991), the growth of moulds and caking of flours (Ehisianya et al., 2010; Zakka et al., 2010). However, the level of weight losses recorded in one generation across the genotypes confirms the report that *T. castaneum* is probably the most important secondary pest of a wide range of crop products in tropical storage environment and that its infestation results in colossal weight and quality losses (Haines, 1991).

The study has also shown that the number of adults as well as immature progeny were higher in flour than in chips; this concurs with the observation of Odeyemi (2001) and Turaki et al. (2007) that *T. castaneum* prefers flour for development; the implication of this observation is that cassava processed into flour is likely to enhance the development and survival of *T. castaneum* and that the cassava genotypes investigated in this study probably may not contain significant amounts of secondary compounds that could be anti-biotic against developing stages of *T. castaneum.* Earlier Zakka et al. (2010) reported that milling sweetpotato chips into flour could mean increasing the chances of the pest to pick up harmful amounts of these secondary compounds that will impede their chances of development and survival. This phenomenon does not seem to be of general application to all tropical roots and tubers. In the case of sweet potato more progeny developed in the chips than in the flour.

Conclusion

T. castaneum performed differently on the different forms and genotypes of cassava. It was observed that the insect is capable of posing a threat to processed cassava in store, if left uncontrolled. Control measures to mitigate the activities of the pest should be implemented in order to safeguard cassava products from infestation.

Conflict of Interests

The authors have not declared any conflict of interests.

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