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Detection of stored products pests by pheromone traps In seven warehouses in Luanda/Angola

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Abstract

The detection of arthropods species was conducted in seven warehouses containing several stored food products, namely, rice, maize flour, wheat flour, beans, pasta and sugar, and in a milling factory that processed rice, dried cassava and maize, located in the Luanda region, in Angola. During storage the main effect of the activity of arthropods species on food products is related to the damage they cause and the reduction of product quantity and quality that can lead to the rejection of contaminated lots.

The arthropods species recorded in the survey are mentioned. A total of 27 arthropods species including insects and arachnids were identified. The insects species *Sitophilus zeamais* Motschulsky, *Tribolium castaneum* (Herbst) and *Ephestia cautella (*Walker) were common to the seven warehouses and in the milling factory, while *Ahasverus advena* (Waltl) and *Oryzaephilus surinamensis* (L.) were found in the seven examined warehouses.

Key words: Warehouses, food products, arthropods, damage and traps.

Introduction

The trade globalisation of the food industry has presented a new challenge in the food security guarantee. The storage of food products has constituted the fulcrum of the food security for the populations, guaranteeing their access to sufficient, safe and nutritious food (Pacavira, 2004).

The main arthropods species considered stored-food pests are cosmopolitan in distribution, with a range extending from the tropics to temperate areas. The dispersal of storage species is due to evolutionary adaptations (morphological, physiological, and behavioural) and also to the actions of man, who carried them around the world through commercial exchanges (Pereira, 1998).

In tropical areas of the world insects are the main sources of stored products deterioration causing significant quantitative and qualitative losses. Insect species are adapted to develop in dried foods, through metabolic processes that preserve the low moisture content of the products. The insect species that attack stored products have a high intrinsic rate of increase. They are characterized by their ability to increase in numbers rapidly and are able to colonize a

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new environment with a few individuals (Pereira, 1998).

The presence of arthropods in dry stored products is a serious risk of contamination with their excrements, uric acid, exuvias, cocoons and fragments of dead insects that make the products and its derivatives unacceptable and can lead to the rejection of contaminated lots, with consequent qualitative reduction (Haines, 1991). Pheromones are odours produced by pests and may be used in traps as early warning detection methods, in storage.

In this work a questionnaire was carried out in seven warehouses of food products and in a milling-processing factory, situated in Luanda region, in Angola. This work also reports the identification of the arthropods species found in residues samples (residual infestation), by direct visual observations and through captures in traps with and without pheromones, in the studied places.

Materials and methods

Questionnaire

In July/August of 2002 a questionnaire has been carried out, through interview, directed to the responsible of five warehouses and the milling factory. In March/June of 2005, another questionnaire was made to the responsible of the two warehouses also situated in Luanda. The questionnaire, consisted of the fulfilling of a fiche, where the place, capacity of storage, type of stored product, capacity of the bags and type of used material, average period of storage, treatments carried through, information on the occurrence of infestations, applied treatment and if had knowledge on traps with pheromones, were asked.

Detection of arthropods

The detection of arthropods was conducted in seven warehouses, numbered from 1 to 7, and in a milling factory in the milling processing section and in the storage section, situated in the Luanda region. By direct visual observations it was possible to capture insects inside the warehouses and on the stacks of bags. The detection of infestations caused by arthropods was also done by collecting samples of product with about 100 g each (white maize flour, yellow maize flour, rice, beans, wheat flour and cassava flour) and from residues samples (sweepings) with about 10 to 100 g each. The samples were placed in covered glass bottles and observed in the laboratory.

In the studied places the moths were captured using sexual pheromone traps for Ephestia/ Plodia, namely, “delta trap”, “pherocon II” and “funnel trap” (Table 1). These traps were suspended the 1-2 m of height and have been distributed in accordance with the dimensions of the storage places. The “delta” traps (Figure 1a) were constructed in corrugated plastic (28 cm high x 20 cm x 12 cm), using a replaceable sticky insert and polythene vials containing pheromone. The “pherocon II” traps (Figure 1b), consisted of two glued surfaces with 8,5 cm of side, opened laterally and the pheromone capsule was placed in the centre of the inferior internal surface.

The “funnel” traps (Figure 1c) consisted of rigid plastic with 11cm of diameter covered with a lid where the capsule with pheromone was placed and the insects caught were collected inside the trap. For the capture of arthropods, as Coleoptera, Psocoptera and Mites “dome” traps were used (Figure 1d) with pheromone for *Tribolium* spp. These traps were constructed in rigid plastic, and constituted by two circular modules, an interior with 10,5 cm of diameter and an exterior that served as cover (11,5 cm of diameter) where the pheromone was placed. In the interior module some drops of an attractive liquid was added where the arthropods were collected. These traps were placed under the wooden pallets. The collected insects and the adhesive plates of the traps “delta”, “pherocon II” and “funnel”, as well as the arthropods captured in the “dome” traps and also the material from direct observations were counted and identified in the laboratory. The arthropods

identification was based on several works (Carvalho, 1979a, 1979b; Mound, 1989; Haines, 1991). The average temperature registered in the seven warehouses ranged between 20,1 ºC in warehouse 3 and 29,4 ºC in warehouse 7 while the average relative humidity ranged from 55,3 % in warehouse 3 to 78.3 % in warehouse 6 (Table 2). In the milling processing factory the mean temperature varied from 21,7 ºC in the milling section to 22,1 ºC in the storage section while the average values of the relative humidity varied from 59,7 % to 60,7 %, respectively (Table 2).

Table 1. Localization, type and number of traps used in the seven warehouses and in the milling factory.

	Type and number of traps			
Local	"Delta"	"Pherocon II"	"Funnel"	"Dome"
Warehouse 1 – Terra Nova	1	0	0	1
Warehouse 2 – Terra Nova	1	0	0	1
Warehouse 3 – Terra Nova	2	0	0	2
Warehouse 4 – Boavista	1	0	0	1
Warehouse 5 – Boavista	1	0	0	1
Warehouse 6 – Boavista	5	5	5	5
Warehouse 7 – Roque Santeiro	5	5	5	5
Milling factory – Terra Nova				
Storage section	1	0	0	1
Milling section	1	0	0	1

Figure 1. Pheromone traps using to catch insects, a) Delta trap; b) Pherocon II, c) Funnel trap, d) Dome trap

Table 2. Mean values of temperature and relative humidity in the seven warehouses and in the milling factory.

Local	Temperature (º C)	Relative humidity (%)
Warehouse 1	22.5	57.8
Warehouse 2	21.4	66.5
Warehouse 3	20.1	55.3
Warehouse 4	21.2	59.7
Warehouse 5	22.4	63.8
Warehouse 6	26.5	78.3
Warehouse 7	29.4	71.2
Milling factory		
Storage section	21.7	59.7
Milling section	22.1	60.7

Results

Questionnaire

The total capacity of the warehouses varied from 250 tonne (warehouse 1) to 17000 tonne (warehouse 7). In relation to the percentage of occupation used during the questionnaire, the warehouses were occupied from 25 % to 95 %. The average period of storage, varied between 30 days and 60 days. In three warehouses treatments were performed with fumigation (Table 3). The warehouses contained several stored products, namely, rice, sugar, pasta, beans and different flours (Table 4). All the warehouses referred the presence of beetles, rodents, moths, cockroaches, cats and birds. Warehouses 1, 2, 3 and 7 did not carry any type of treatment against infestations. In warehouses 4, 5 and 6 fumigations were done, when great amount of rodents and cockroaches were observed. The responsible for the warehouses and the milling factory did not know pheromone traps.

The final products of the milling-processing factory were rice flour, cassava flour, and maize flour that were stored in the storage section with 200 tonne of capacity. The final products remained only 7 to 15 days in the milling factory where treatments were not performed and they did not know pheromone traps.

Detection of arthropods

The list of the arthropods species identified in the seven studied warehouses and in the milling factory is indicated in Table 5. Twenty-five insects species, representing 14 families belonging to four orders of Insecta had been detected. In the Arachnida two species of two families, belonging to two orders, were found. The presence of 18 species of Coleoptera, namely, *Lasioderma serricorne* (F.), *Anthicus floralis* (L.), *Rhyzopertha dominica* (F.), *Cryptolestes ferrugineus* (Stephens), *Cryptolestes* spp., *Sitophilus zeamais* Motsch., *Dermestes maculatus* Degeer, *Trogoderma* spp., *Typhaea stercorea* (L.), *Carpophilus dimidiatus* (F.), *Carpophilus marginellus* Motschulsky, *Ptinus* spp., *Ahasverus advena* (Waltl), *Oryzaephilus surinamensis* (L.), *Palorus subdepressus* (Wollaston), *Tribolium castaneum* (Herbst), *Tribolium confusum* J. du Val and *Tribolium* destructor Uyttenboogaart was registered (Table 5).

Five insect species of Lepidoptera were identified, *Corcyra cephalonica* (Stainton), *Ephestia cautella* (Walker), *Ephestia kuehniella* Zeller, *Ephestia elutella* (Hübner) and *Plodia interpunctella* (Hübner) (Table 5).

Insects of the orders Psocoptera (*Liposcelis* spp.), and Hemiptera, *Xylocoris flavipes* (Reuter)

were also identified (Table 5). Mites found in the stored products belonged to the Astigmata order, Acaridae family (*Acarus siro* L.) and to the Prostigmata order, Cheyletidae family (*Cheyletus* spp.) (Table 5).

Eighteen insect species were detected in the "dome" traps, 3 species were found by visual observation and 4 insects species in the pheromone traps for *Ephestia/Plodia*. All the Coleoptera and Psocoptera captured in the "dome" traps were also found by visual observations, as well as in the product samples. *C. cephalonica* was only captured by visual observation. The other Lepidoptera were captured only in the pheromone traps. The mites were detected in the samples of residues/ sweepings. The percentage of insects species found in the survey considered pests of stored products, belonged to Coleoptera, Lepidoptera and Psocoptera (Figure 2).

Table 3. Capacity (t), occupation (%), mean period of storage (d) and treatments.

Local	Capacity (t)	Occupation (%)	Mean period of storage (d)	Treatment
Warehouse 1	250	25	30	No
Warehouse 2	700	50	45	No
Warehouse 3	1 000	75	60	No
Warehouse 4	800	75	45	Yes
Warehouse 5	800	90	45	Yes
Warehouse 6	15 000	95	45	Yes
Warehouse 7	17 000	95	60	Yes

Table 4. Different products stored in the seven warehouses.

Local	Sugar	Rice	Rice flour	Maize flour	Wheat flour	Beans	Pasta
Warehouse 1				*	*		
Warehouse 2		*				*	*
Warehouse 3	*	*		*			
Warehouse 4			*	*	*		
Warehouse 5	*	*					*
Warehouse 6	*	*		*	*	*	*
Warehouse 7	*	*		*	*		

Table 5. List of species of arthropods found in the seven warehouses and in the milling factory, the presences are marked (*).

Species	Warehouse							Milling factory	
	1	2	3	4	5	6	7	Storage section	Milling section
Coleoptera									
Anobiidae									
Lasioderma serricorne *(F.)*		*		*		*			
Anthicidae									
Anthicus floralis *(L.)*						*			

Continue...

Table 5. Continue.

Species	Warehouse							Milling factory	
	1	2	3	4	5	6	7	Storage section	Milling section
Bostrychidae									
Rhyzopertha dominica *(F.)*					*			*	*
Cucujidae									
Cryptolestes ferrugineus *(Stephens)*						*	*		
Cryptolestes *spp.*	*	*						*	
Curculionidae									
Sitophilus zeamais *Motsch.*	*	*	*	*	*	*	*	*	*
Dermestidae									
Dermestes maculatus *Degeer*						*			
Trogoderma *spp.*							*		
Mycetophagidae									
Typhaea stercorea *(L.)*							*		
Nitidulidae									
Carpophilus dimidiatus *(F.)*						*			
Carpophilus marginellus *Motsch.*						*			
Ptinidae									
Ptinus *spp.*							*		
Silvanidae									
Ahasverus advena *(Waltl)*	*	*	*	*	*	*	*		
Oryzaephilus surinamensis *(L.)*	*	*	*	*	*	*	*		
Tenebrionidae									
Palorus subdepressus *(Wollaston)*						*			
Tribolium castaneum *(Herbst)*	*	*	*	*	*	*	*	*	*
Tribolium confusum *J. du Val*						*	*		
Tribolium destructor *Uyttenboogaart*						*	*		
Lepidoptera									
Pyralidae									
Corcyra cephalonica *(Stainton)*				*		*	*		
Ephestia cautella *(Walker)*	*	*	*	*	*	*	*	*	*
Ephestia kuehniella *Zeller*							*		
Ephestia elutella *(Hübner)*	*					*	*		
Plodia interpunctella *(Hübner)*		*	*		*	*	*	*	*
Psocoptera									
Liposcelidae									
Liposcelis *spp.*				*	*	*	*		
Hemiptera									
Anthocoridae									
Xylocoris flavipes *(Reuter)*						*			
Astigmata									
Acaridae									
Acarus siro *L.*						*	*		
Prostigmata									
Cheyletidae									
Cheyletus *spp.*						*	*		

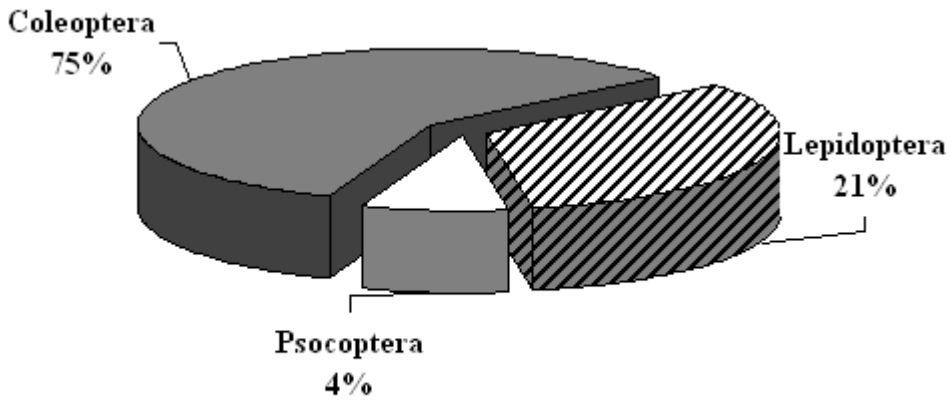

Figure 2. Percentual distribution of Coleoptera, Lepidoptera and Psocoptera species found in the survey.

Discussion

The importance of Lepidoptera species can be subestimate when other methods of detection are used instead of using pheromone traps. One of the problems in detecting insects it is their reduced size. The main insect species found in the survey, belonged to the orders Coleoptera, Lepidoptera and Psocoptera. In the Coleoptera, species of Anobiidae, Bostrychidae, Cucujidae, Curculionidae, Dermestidae, Nitidulidae, Silvanidae and Tenebrionidae families were found in studied warehouses.

The insects of the Curculionidae family (*Sitophilus*) (2,4-4,5 mm) are able to attack whole cereal grains. Other species belonging to Cucujidae, Silvanidae and Tenebrionidae families prefer the germ region of the whole grains, and may consume damaged grains. A. advena (2,0-3,0 mm) and *T. stercorea* are more frequent when the stored products are infected by fungi. The Lepidoptera species consume broken grains and the germ of the whole grains and flours. *X. flavipes* (2 mm), is a predator, pricking the eggs and nymphs of many species to suck the content. Psocoptera with incomplete metamorphosis, are very small (1 mm long), and feed mainly on cereal products with high moisture content and infected by fungi (Haines, 1991).

The entomological survey carried out by Amaro and Gouveia (1957), in warehouses containing several products, in Angola, allowed to identify insects that belonged to the following orders: Thysanoptera, Dictyoptera, Dermaptera, Psocoptera, Coleoptera, Lepidoptera and Hymenoptera. The Coleoptera species belong to the families Cucujidae, Curculionidae, Dermestidae, Nitidulidae, Ptinidae, Silvanidae, Tenebrionidae and Trogossitidae. In the Lepidoptera the families Gelechiidae, Pyralidae and Tineidae were identified.

The survey conducted in the region of Luanda/ Angola, in 2002 (Pacavira, 2004; Pacavira et al., 2005a) to five warehouses and a milling factory, allowed to identify Coleoptera, Lepidoptera and Psocoptera species.

In 2005 (Pacavira et al., 2005b) Coleoptera, Lepidoptera, Psocoptera and Hemiptera species and Arachnida (Astigmata and Prostigmata orders) were identified in two warehouses.

The environment conditions verified in the warehouses between July and August of 2002, corresponded to the dry season, characterized for low relative humidity, while the verified ambient conditions in the warehouses between March and June of 2004, corresponded to the rainy season. Thus, the ambient conditions verified, either in the dry season or in the rainy season, were favourable for the development of these

arthropods species.

According to Haines (1991), the optimum conditions of temperature for development of stored products pests, are between 25-35 ºC, while temperatures below 20 ºC reduce its development. As for the temperature, there are also suitable values for relative humidity generally, between 50-70 % (Howe, 1965). The development of arthropods also depends on the availability of dry food products and due to possibility of these species to be able to attack several products, its presence in the storage places can lead the contamination and deterioration of the food products, reducing the quality of those products affecting the food security of these populations.

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