Efficiency of Different Storage Facilities in Reduction of Insect Pest in Sun-Dried Sardines (Dagaa) From Lake Victoria

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Abstract

The study was conducted to assess the efficiency of different dagaa storage facilities used in local markets. Experiment for infestation rate was conducted in Pest Management Centre at Sokoine University of Agriculture (SUA) using four facilities namely; hessian sacks, woven sacks, used boxes and polyethylene bags for eight weeks. Dagaa (dried sardines) samples were collected from Central market in Morogoro municipality Identification and counting of insect pests was conducted under dissecting microscopes. Two major groups of insect pest were identified namely; mites and beetle both at adult and larvae stage. Two species of beetles; namely Necrobia rufipes and Dermestes sp. were identified and recorded. Significant differences were noted in terms of abundance with mites forming more than 90%. Similarly significant differences in abundance of insect pest among the storage facilities (P<0.05) were noted. The highest abundance of beetle larvae (8.1±1.7 no/kg) and adults (1.18±0.7 no/kg) were recorded from hessian sacks. The highest and lowest abundance of mites were recorded from hessian sacks (3105.5±245 no/kg) and polyethylene bag (266.3±34.2 no/kg) respectively. Abundance of beetle larvae varied with time in all facilities except polyethylene reaching peak during the fourth week and declining gradually after the fifth week. No clear pattern was observed for the infestation rate of the adult beetle. Rapid increases in density of mites during the fifth week in hessian sacks, woven sacks, used boxes facilities and in polyethylene bag during the seventh week were noted. The higher abundance and infestation rate of insect pest recorded from hessian sacks followed by woven sacks and used boxes. There was higher number of mites compared to beetles. It can be concluded from this study that polyethylene bags are more efficient in controlling insect pests for dagaa and provide longer shelf life compared to other facilities. Therefore, it is recommended that for lower infestation rate and increased shelf life for dagaa, processors, whole-sellers and retailers should pack their products in polyethylene bags immediately after drying.

***Key words**:* Dagaa, storage facilities, insect pests, infestation

Introduction

The sardine, *Rastrineobola argentea* is commonly known as dagaa, mukene and omena in Tanzania, Uganda and Kenya respectively. Dagaa is rich in vitamin A, B and D as well as minerals such as iron, calcium, potassium, phosphorus copper and iodine (Owaga *et al.,* 2009). It also, provides nutritional security of individual living with HIV/AIDS and those at risk of malnutrition disorders (Kabahenda and Husken, 2009). Dagaa is a raw material for animal feed industries and some of the ingredient in the formulation of animal feeds (Oduho *et al.,* 2005; Bille and Shemkai, 2006;). In Lake Victoria, dagaa can be rated first in terms of employment opportunity and second in terms of economic gain to Nile perch (Bilame, 2012).

Dagaa is a perishable product which is very susceptible to attack by various types of pests including insect and mites during processing, transportation and marketing (Johnson and Esser, 2000). The major insect pests that attack dagaa are mites, blowflies and beetles and are considered to cause post-harvest losses in many developing counties (Johnson and Esser, 2000). It has been reported that 30% and 50% of losses are due to insect pest (flies) during processing and beetles during storage respectively (Haines and Rees, 1989; Sen, 2005). Quality and quantity losses caused by mites and insects are the major losses that occur in sundried dagaa (Ames, 1992). Also, insect and mite pests often transmit mould spores. Generally insect and mites infestation reduces the quality of a product and ultimately makes it unfit for human consumption. Many studies on dagaa products from lake Victoria have been conducted on processing techniques (Masette, 2007; Owaga *et al.,* 2009; Oduor-Odote *et al.,* 2010; Ofulla *et al.,* 2011; Mhongole and Mhina, 2012) but there has been limited study on the efficiency of packaging and storage materials. Therefore, this study aimed at assessing the efficiencies of different packaging materials on reducing insect and mite infestation on sundried dagaa.

Materials and Methods

Description of packaging materials

Four storage packaging facilities namely; hessian sacks, used boxes, woven bags and polyethylene bags were used. Hessian sacks with a capacity of holding 100 kg and woven sacks with a capacity of holding 50 kg have been used for packing large amount of sundried dagaa from Mwanza to various parts of the country and nearby countries. Used boxes are commonly used at market places to hold dagaa for retail business. These used boxes are collected from nearby shops after empting goods and they vary in size and shape. Polyethylene bags are made locally to hold small amount of dagga, these material are available only in market places and small shops, and they can hold the amount ranging from 100 to 1000 g.

Abundance and infestation rate of mite and insect pests

Hessian sacks, used boxes, woven bags and polyethylene bags were filled with 250 g of dagaa obtained from three different dagaa sellers. Each packaging material was replicated three times making a total of 36 containers. Dagaa samples were bought from dagaa dealers at Morogoro Central market. The samples were transported to the laboratory at Pest Management Center in Sokoine University of Agriculture for further analysis. At the onset of experiment rapid assessment was done to observe if there were any insect pests. Insect pests were examined through visual inspection under dissecting microscope and were identified using identification key by Haines and Rees (1989) with the aid of a pair of large plates, petri dishes, sieves with a mesh size of 3 mm, hand tallying counter and forceps. The abundance of pests observed from each facility was recorded weekly and the experiment lasted for eight weeks. The average temperature and humidity in the laboratory during the experimental period were 25.1°C and 72% respectively.

Data Analysis

Differences in abundance of insect pest among the storage facilities were analysed using Analysis of Variance (ANOVA).

Results

Description of identified insect pests

During the present study mites of the family Acaridae and two species of beetles were isolated from dagaa. The two beetles species were *Necrobia rufipes* and *Dermestes* spp. The mites isolated were very small, thin skinned oval bodies, with a translucent creamish-white colour. The adult beetle, *N. rufipes* had a shining metallic bluish-green colour and the abdomen was entirely dark blue, bright reddish-brown. The adult *Dermestes* sp. had a black/dark brown colour with black abdomen but whitish, brown or golden hairs.

Abundance of insect pests

The highest abundance (8.17±1.69) and lowest abundance (4.5±0.93) of beetle larvae were recorded in hessian sacks and sewed polyethylene bags respectively (Figure 1). Significant differences in abundance of beetle larvae among the storage facilities ($P<0.05$) were noted. However, these differences were noted only between polyethylene and the other materials (P<0.05). Figure 2 shows the mean abundance (no/kg) of adult beetles for the four storage facilities used. The highest and lowest densities of adult beetles were observed in hessian sacks (1.18±0.72) and used box (0.83±0.48) respectively. There was significant difference in the number of adult beetle among the four facilities (P<0.05). Following the post hoc test, the differences were obvious between polyethylene and other facilities (P<0.05).

The highest and lowest abundance of mites were recorded in hessian sacks (3106±246) and polyethylene bag (266.3±34.19) respectively (Figure 3). Significant differences in density of mites among the facilities used (P<0.05) were noted. The post hoc test showed that there were significant differences between polyethylene and used box and Hessian sacks and between woven sacks bag and used box and hessian sacks (P<0.05). Neither beetle larvae nor adult beetle were found in the polyethylene bag.

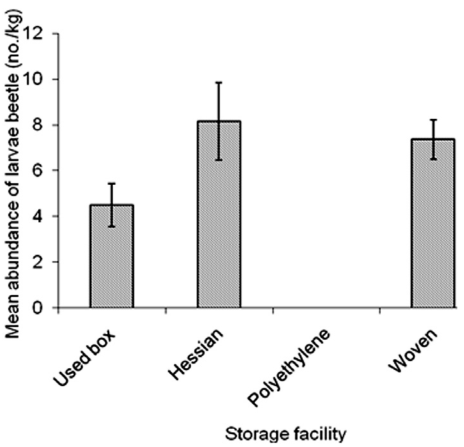

Fig. 1: Abundance of larvae beetle from four storage facilities

Shelf life and infestation rate

Figures 4, 5 and 6 show the infestation rates of beetle larvae, adult beetles and mites. The instance of the beetle larvae was recorded during the first week while no ones recovered from the polyethylene for the whole 8 week of the experiment. The peaks were observed during the fourth week for hessian sacks and used box and 6th week for the woven sacks. The adult beetles were recorded from 3rd week of the experiment in Hessian sacks and used box and during the 6th week for the woven sacks whereas no adult beetles were recorded during the last week of experiment. The highest numbers of adult beetle were observed in woven sacks during the 6th week. No clear pattern on

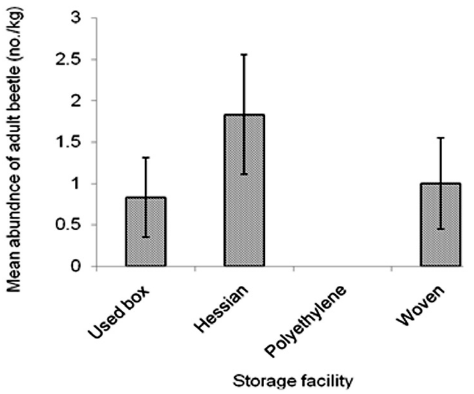

Fig. 2: Abundance of adult beetle from 4 storage facilities

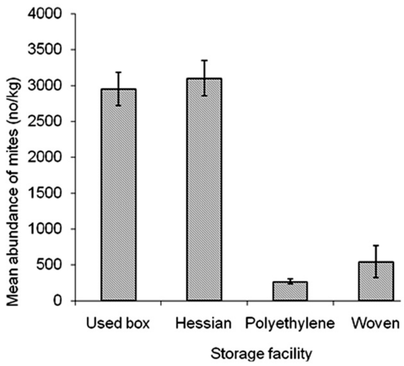

Fig. 3: Abundance of mites from 4 storage facilities

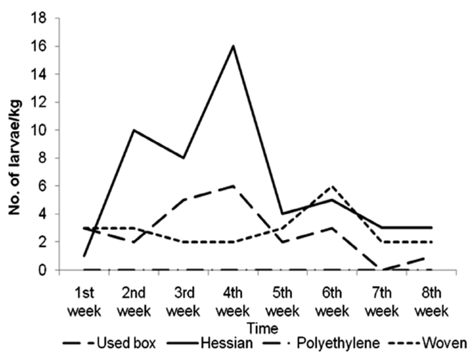

Fig. 4: The infestation rate of larvae in used box, Hessian sack, polyethylene and woven bag

larvae and adult observed for the three facilities harboring pest.

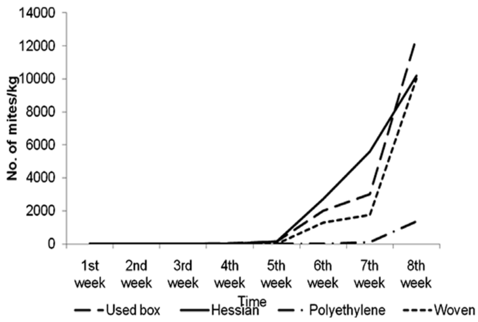

Fig. 5: Infestation rate of adult beetle in storage facilities

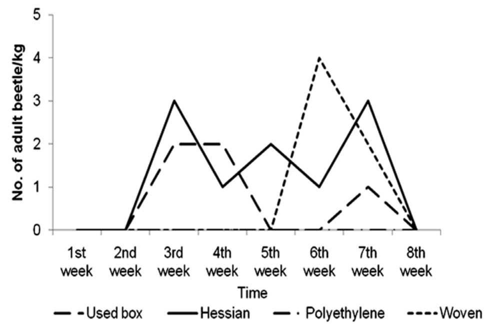

Fig. 6: Infestation rate of mites in the facilities

Figure 5 shows the infestation rate of adult beetles in four storage facilities. For the mites, the infestation rate in used box, hessian sacks, woven bag and polyethylene bag started from fourth, fifth, sixth and seventh week respectively. For each storage facility the numbers increased with time with the highest number recorded during the last month of the experiment.

Discussion

Two kinds of pests were identified during the present study namely; mites and beetles (*Necrobia rufipes* and *Dermestes* sp. *Necrobia rufipes* is the commonest beetle species found on cured fish (Haines and Rees, 1989; Sen, 2005; Idris and Omojowo, 2013). According to Idris and Omojowo (2013) and Esser *et al.* (2003), *Necrobia* spp. and *Dermestes* spp. have been reported from cured catfish in Nigeria and India respectively. The presence of pests from all storage facilities indicated that the samples were already contaminated before the commencement of the experiment probably infested during processing, packing and transporting. Akande and Die-Ouadi (2010) and Mwambazi (1992) reported that pest infestations for cured fish from sub-saharan countries are due to unhygienic processing technique, poor storage facilities, transport and handling during marketing. Occurrence and abundance of pest in cured fish depends on the processing method. In fish preserved by groundnut oil, pest occurred after 12 and 13th weeks under the temperature of 28°C and 70% relative humidity (Idris and Omojowo, 2013). According to Owaga *et al.* (2009) there is zero tolerance for insect contamination in cured fish. Variations in abundance of pest among the storage facilities are probably due to the nature of the facilities. The structure of facilities vary in terms of porosity, Hessian sacks are more porous compared to other facilities hence provide suitable environmental conditions for the survival of the pest. The absence or low abundance of mites in the polyethylene is probably due to lack of pores like in hessian bags. The polyethylene lack pores hence little oxygen and moisture is available for the survival of pests. Temperature and moisture have been identified as major environmental factors which favors the survival of the pest (Haines and Rees, 1989).

The highest abundance of mites observed on all facilities is probably due to its higher reproductive rate compared to beetles. According to Haines and Rees (1989) life cycle of mites is 9 – 11 days and can develop faster at 23°C and 87 % relative humidity, while beetles take about six weeks or longer. During the present study the temperature and humidity in the laboratory were 25.1°C and 72% respectively. The beetle larvae were recorded during the first week of the experiment in the three facilities and peaked during the fourth week and thereafter decline sharply. The decline in number of beetle larvae was probably due to its attaining an adult form. The life cycle of beetles *Necrobia* and *Dermates* is 5-7 weeks (Haines and Rees, 1989). It has been observed that initial contamination by beetles is often due to invasion by flying adult which lay their eggs on the partially or fully dried fish. Furthermore the trend observed for the infestation rate of adult beetle can also be explained by its life cycle. There were no recorded adult beetles during the last week of experiment probably indicating that they had reached the end of their life span thus leaving larvae to continue infesting the product. Mites are usually associated with *Necrobia* and *Dermetes* due to the fact that they survive under similar physical and nutritional requirements but also beetles act as the main agents of dispersal of mites. However, surprisingly, mites were recorded in the 4th week in hessian sacks and 7th week in polyethylene. The reason for this discrepancy cannot be explained thus further research is needed. It has been reported that initial infestation of mites might be caused by its developmental stage (hypopi) that can be carried to the fish by beetle pest (Haines and Rees, 1989) but in the present study no beetle was recorded in the polyethylene bag. The rate of infestation was very high for mites compared to beetles probably due to the differences in life cycle. Under suitable physical and nutritional conditions the number of beetles can increase 25 times per month while mites can increase a thousand times. The present study showed that the polyethylene bags had a high efficiency of reducing significantly the infestation rate compared to other facilities.

The packaging materials used in this study are commonly used for storing sundried dagaa from Lake Victoria under normal situations. The presence of pest in different densities among the packaging materials indicates the variation of suitability for dagaa storage. However, unfortunately dagaa traders do not consider the suitability of the packaging materials; they consider only locally available materials which do not add cost of the product. It is the cost/benefit ratio and the cost which a market can absorb, that decides the issue. Therefore, there is a need to conduct study on the cost benefit analysis of the packaging materials for dagaa. It has been observed that most of the cost benefit analysis has been conducted on the processing techniques (e.g. Ihengwe and Kristófersson, 2012; Esser *et al.,* 2003) rather than packaging facilities. The high number of pest and infestation rate observed in hessian sacks, used boxes and woven sacks indicate that these packages are prone to easy entry of pest. The product in such packages showed high sensitivity to changes in relative humidity and temperature.

Conclusion
Generally large amount of insects were recorded in hessian sacks and lowest in polyethylene bags and the most abundant pest were mites. The highest and lowest rate of infestation was also recorded in hessian sacks and polyethylene bag respectively. Therefore, polyethylene bags are recommended for dagaa storage compared to other facilities.

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