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COMPARATIVE STUDIES AND RELATIVE ABUNDANCE OF INSECT PESTS ASSOCIATED WITH STORED FOOD GRAINS IN GUSAU AND KAURA NAMODA MARKET AREAS, ZAMFARA STATE NIGERIA

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ABSTRACT

Insect pests are one of the major challenges faced by grain farmers in Nigeria. These pests can cause significant damage to stored grain, resulting in significant economic losses for farmers and consumers alike. A comparative study was carried out to determine the relative abundance of Insect pests associated with stored food grains between Gusau and Kaura namoda Market areas of Zamfara state. Infested grains were sampled randomly from stores within the Market Areas. In Gusau markets, the relative abundance of a total of 2,612 insect pests was observed to be associated with stored food grains, comprising 494 (19%) millet grains, 1106 (42%) maize grains, 187 (7%) rice grains and 825 (44%) of cowpea seeds. While in Kaura namoda markets, a total of 1,121 insect pests were observed to be associated with 140 (13%) millet grains, 290 (26%) maize grains, 197 (18%) rice grains, and 494 (44%) cowpea seed were recorded. Maize grains stored in both markets surveyed were observed with the highest rate of infestation 1,396 (55%) while Rice grains had the least rate of infestation 384 (25%). Insect pests' rate of infestations were higher in Gusau markets (2,612) than in Kaura namoda markets (1,396). Farmers and businessmen should be enlightened on improved storage practices, particularly in Gusau market, and further research is needed to improve our understanding of insect pest biology and behavior and to develop new and sustainable strategies for controlling these pests in stored food grains.

Keywords: Gusau, Insect pests, Kauran Namoda, Stored food grains, Zamfara State

INTRODUCTION

Insect pests pose a significant challenge to grain farmers in Nigeria, causing significant yield losses and reducing overall crop quality. According to Akinkurolere and Adesoye (2019), Insects are the major cause of post-harvest losses in grains, accounting for up to 50% of total losses in some cases. The most common insect pests in Nigeria's grain fields include the maize or granary weevil (*Sitophilus zeamais*), the rice weevil (*Sitophilus oryzae)*, and the cowpea beetle (*Callosobruchus maculatus*), and lesser grain borer (*Rhyzopertha dominica)* (Odeyemi *et al.,* 2020). These pests can cause significant damage to grain crops, reducing their market value and ultimately impacting the livelihoods of farmers. They are also a source of food contamination and health risks to consumers (Mullen and Koehler, 2019).In addition to these major insect pests, stored grains in Nigeria are also subject to attack by other pests, such as the red flour beetle (*Tribolium castaneum*), the confused flour beetle (*Tribolium confusum*), and the saw-toothed grain beetle (*Oryzaephilus surinamensis*). These pests can also cause significant losses in grain quantity and quality and can pose a risk to human health through food contamination (Abdulmalik *et al.,* 2021).

Nigeria is one of the world's top producers of grains such as maize, rice, sorghum, and

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millet. However, inadequate storage facilities and poor post-harvest handling practices result in significant losses and reduced income for farmers. According to Adegbola *et al.* (2020), one of the major challenges of grain storage in Nigeria is insect infestation. Insects such as weevils, beetles, and moths are known to cause significant damage to grains during storage. In addition, moisture and temperature fluctuations can result in mold growth, which also affects the quality and quantity of grains (Mirabella *et al.,* 2018). Another major problem associated with grain storage in Nigeria is poor storage facilities. Inadequate storage facilities also lead to post-harvest losses due to physical damage. According to Agbaje *et al.* (2019), mechanical damage during transportation and handling can cause grains to break or crack, making them more susceptible to insect infestation and mold growth. In addition, poor handling practices such as improper loading and unloading of grains can also result in physical damage. One possible solution to grain storage problems in Nigeria is the use of improved storage facilities. Adegbola *et al*. (2020) recommended the use of metal silos, which are more effective in protecting grains from pests and moisture. In addition, the use of hermetic storage technologies such as airtight bags can also help to reduce post-harvest losses. Another solution is the adoption of good post-harvest handling practices. Furthermore, training and education of farmers on best practices in grain storage can also help to reduce losses. Oyekale and Idowu (2019) emphasized the need for farmers to be educated on proper harvesting, cleaning, and drying of grains before storage. They also recommended the use of integrated pest management techniques, which involve the use of non-chemical methods such as biological control and cultural practices to control pests. The study aimed to compare the relative abundance of insect pests associated with stored grains in Gusau and Kaura namoda market areas of Zamfara State.

MATERIALS AND METHODS

Study Areas

Gusau is the state capital of Zamfara State, it has a geographical location of latitude12° 9' 51" N and longitude of 6° 40' 0" E. Kaura Namoda has a geographical location of latitude of 12° 36' 0" N and longitude of 6° 35'23" E. Infested grains were sampled randomly from stores within the Markets of Gusau and Kaura Namoda (Figure 1a and b).

Figure 1: (a) Map of Gusau local Government, and (b)Map of Kaura Namoda

Source: (Satellite Panoramic) and Local Government Source: (CityDir.org)

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Grain Samples Collection and Identification of Insect Pests

The infested grains of millet, maize, rice, and beans were collected from farmers' and traders' stores in both Gusau and Kaura namoda markets respectively using cups and polythene bags. 1kg of each of the infested grains was extracted from the randomly selected bags from a different location (top, middle, and down) using local extracting tools and put into polythene bags. All the polythene bags were systematically labeled according to their food warehouses for easy identification. Infested grains were brought to the Department of Biological Sciences, Federal University Gusau for Separation and Identification using the Dichotomous keys (Fasulo, 2018; Triplehorn and Johnson, 2005). Grain samples were sieved, and the insects collected were identified and counted. All grain samples placed in separate plastic jars were laid and then kept in the laboratory for one month. After which, each grain sample was sieved again to recover, identify and count all emerged insects.

Data analysis

Data obtained were analyzed using Descriptive statistics in form of frequency and percentage and principal components analysis (PCA) was used to establish the relationship between the Markets and Insect pest infestation rates.

RESULTS AND DISCUSSION

A total of 3,733 individuals of insect pests of the order Coleoptera were collected from both Gusau and Kaura namoda markets. It consists of four main species which are *Sitophilus granarius* (Granary/wheat weevil), *Rhyzophertha dominica* (Lesser grain borer) *Sitophylus oryzae* (Rice weevils), and *Acanthoscelides obtectus* (Bean weevils). One of the main reasons why coleopterans attack stored grains is the high moisture content of the grains. According to a study by Hassan *et al.* (2017), Coleopterans prefer damp settings and are more likely to attack grains that contain 13% or more moisture. A high moisture content and greater vulnerability to coleopteran infestation result from grains that are frequently not thoroughly dried before storage. Poor storage conditions may also be a factor in coleopteran infestation. A study by Faruq *et al.* (2018) found that insufficient storage facilities, such as poor ventilation, a lack of cleanliness, and high temperatures, provide perfect breeding conditions for coleopterans. These insects spread easily in neglected environments and prosper in hot, muggy conditions.

Rice weevils *(Stophilus oryzae)* recorded the highest abundance of 1403 (54%) while lesser grains borer (*Rhyzophertha dominica)* were captured to be lowest at 422 (16%) (Table 1). Poor storage practices, including inadequate cleaning of storage facilities and lack of proper storage containers, have been identified as major contributors to rice weevil infestations in stored food grains. Ogungbite *et al.* (2014), observed that farmers in northern Nigeria often store rice in poorly constructed, low-quality storage facilities, which provide ideal conditions for the growth and reproduction of rice weevils. Yakubu *et al.* (2013), stated that the average temperature and relative humidity in northern Nigeria during the dry season are 30°C and 25 ° C respectively, which are suitable for the growth and development of rice weevils. Another factor for the high rate of infestation in rice weevils may be the lack of effective pest management. In northern Nigeria, there is a lack of effective pest management practices to control rice weevil infestations. This also supports the study of Oparaeke and Umeozor (2014), that many farmers in northern Nigeria rely on traditional methods of pest control,

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such as the use of ash or smoke, which are ineffective in controlling rice weevils.

There is limited research specifically on the infestation rates of the lesser grain borer in stored food grains in Nigeria, the available literature suggests that the species may have a lower infestation rate compared to other storage pests. This may be due to factors such as feeding habits, reproductive behavior, and resistance to control measures, as well as potential environmental factors. A study by Odeyemi *et al.* (2014) investigated the prevalence and distribution of storage pests in maize, cowpea, and rice in Nigeria. The study found that the most prevalent storage pest was the maize weevil (*Sitophilus zeamais*), followed by the rice weevil (*Sitophilus oryzae*) and the lesser grain borer. However, the study noted that the infestation levels of the lesser grain borer were generally low, which may be due to its feeding habits and reproductive behavior. A similar observation was made by Adejumo and Fajemisin (2019), who examined the efficacy of botanicals and synthetic insecticides for controlling storage pests in maize and cowpea in Nigeria. The study found that the synthetic insecticide deltamethrin was effective against the maize weevil and the rice weevil, but had limited efficacy against the lesser grain borer. This suggests that the lesser grain borer may be more resistant to insecticides**.** Also, a study by Akanni *et al.* (2019) investigated the efficacy of botanicals for controlling storage pests in maize and cowpea in Nigeria. The study found that the botanicals neem (*Azadirachta indica*) and pawpaw (*Carica papaya*) were effective against several storage pests, including the maize weevil and the rice weevil, but had limited efficacy against the lesser grain borer. This further supports the notion that the lesser grain borer may be more resistant to control measures compared to other storage pests.

Table 1: Relative abundance of Insect pests associated with stored food grains in Gusau Markets.

Grains samples/Insect pest	Granary weevil *Stophilus granarius*	Lesser grain *borer (Rhyzoperthe dominica)*	Rice weevils *(Stophilus oryzae)*	Bean-weevils *(Acanthoscelides obtectus)*	Total
Millet	40	74	265	115	494(19%)
Maize	124	270	545	167	1,106(42%)
Rice	0	46	141	0	187(7%)
Cowpea	179	32	452	162	825 (32%)
Grand Total	**343 (13%)**	**422 (16%)**	**1403 (54%)**	**444 (17%)**	**2,612**

Granary weevils (*Stophilus granarius*) were recorded highest at 646 (58%) while Rice weevils (*Stophilus oryzae*) were recorded with the least number of occurrences 122 (11%) (Table 2). Granary weevils (*Sitophilus granarius*) are one of the most common pests affecting stored grain, causing damage to the grain kernels, and reducing the quality and quantity of stored grain (Kahn *et al.,* 2015). These pests are widely distributed and are found in many regions, including Africa, Asia, Europe, and North America (Roe *et al.,* 2011). According to a study by Ibrahim *et al.* (2015), the high temperatures and relative humidity in northern Nigeria, provide an ideal breeding ground for granary weevils, as they thrive in warm and moist environments. This makes it easier for the weevils to reproduce and spread rapidly in stored food grains, resulting in high infestation rates.

In addition to the climate, storage conditions also play a significant role in granary weevil

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infestation. Many farmers and food processors in Northern Nigeria store their grains in traditional storage structures, such as mud-walled silos, which are not well-sealed and ventilated (Oladimeji *et al.,* 2020). This type of storage condition creates a favorable environment for granary weevils to breed and multiply, as they have access to both air and moisture, which is necessary for their survival.

Table 2: Relative abundance of insect pests associated with stored food grains in Kaura Namoda Markets

Grain samples/Insect pest	Granary weevil *Sitophilus granarius*	Lesser grain *borer (Rhyzoperthe dominica)*	Rice weevils *(Sitophilus oryzae)*	Bean-weevils *(Acanthoscelides obtectus)*	Total
Millet	32	0	65	43	140(13%)
Maize	24	73	31	162	290(26%)
Rice	169	28	0	0	197(18%)
Cowpea	42	0	26	47	494(44%)
Grand Total	**646 (58 %)**	**101 (9%)**	**122 (11%)**	**252 (23%)**	**1,121**

Rice weevils (*Stophilus oryzae*) were discovered to be recorded highest from both Gusau and Kaura namoda markets 1504 (40%) and Bean weevils were captured with the least number of occurrences 696 (19%) (Table 3). Bean weevils, may have less of an attack on stored food grains due to the resistance of some grain varieties. Some grain varieties are naturally resistant to bean weevils, which can lead to a lower rate of infestation. For example, studies have shown that certain types of cowpea grains have lower levels of damage from bean weevils (Odeyemi *et al.,* 2018).

A study conducted by Kuyoro *et al.* (2020) demonstrated the use of insecticides can effectively control bean weevil infestation in stored cowpea. The application of insecticides can significantly reduce the infestation of bean weevils in stored grains.

Table 3: Relative abundance of Insect pest species associated with stored food grains in both Gusau and Kauran namoda Market Areas

Common name	Scientific name	Percentage
Wheat/Granary weevils	*Sitophilus granarius*	989 (27%)
Lesser grains borer	*Rhyzopertha dominica*	544 (15%)
Rice weevils	*Sitophilus oryzae*	1504 (40%)
Bean weevils	*Acanthoscelides obtectus*	696 (19%)

Lesser grain borer and Bean weevils are strongly correlated concerning the rate of infestation of stored grains (Figure 2). This may be because, both insects are primary pests of stored grains and are capable of infesting a wide range of cereal crops, legumes, and other stored food products. (Campbell *et al.,* 2016). Another reason may be because both insects prefer similar environmental conditions, such as high humidity and temperatures between 25-35°C, which are common in many regions where stored grains are produced and stored. (Campbell *et al.,* 2016). According to Johnson and Campbell (2013), the presence of bean weevils can attract lesser grain borers, as they produce chemical cues that are attractive to the borer. This can result in an increase in the

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rate of infestation by the borer in stored grains that are already infested by bean weevils.

The Granary weevils were found to be more positively correlated in Gusau Markets than in Kaura namoda (Figure 2). However, they are still found in Kaura namoda market. Gusau being the state capital is more densely populated than Kaura namoda, and it may lead to several factors. In cities, where space is often limited, wheat is often stored in poorly ventilated and humid conditions, which provide an ideal environment for the growth and reproduction of wheat weevils. On the other hand, in villages, wheat is often stored in open spaces with good ventilation, reducing the risk of infestation. (Source: "The use of indigenous storage systems to reduce losses caused by the rice weevil, *Sitophilus oryzae* in Nigerian maize" - https://link.springer.com/article/10.1007/BF02926345). Another reason may be because of high Pesticide Usage in cities and state capitals where there is a higher demand for food and larger agricultural production, there is often a greater use of pesticides, which can lead to the development of pesticide-resistant wheat weevils. In contrast, in villages, where pesticide use is often limited or non-existent, wheat weevils are less likely to develop resistance to natural control methods such as manual removal and the use of botanicals. (Source: "Farmers' knowledge, perception and practices in the management of rice pests and diseases in the dry savannah of Togo") https://www.sciencedirect.com/science/article/pii/S1871141310000529)

Lastly, Hygiene, in cities, where there is a higher population density and more food waste, the risk of wheat weevil infestation is increased due to poor hygiene practices. On the other hand, in villages, where there is less food waste and a lower population density, the risk of infestation is reduced. (Source: "A review of integrated pest management in small-holder tropical agriculture" - https://www.sciencedirect.com/science/article/pii/S004835750000064X).

The high rate of granary weevil infestations in cities is the increase in global trade and transportation. According to a study by Rodriguez and colleagues (2014), international trade has led to an increase in the movement of grains and seeds across borders, which in turn has led to the spread of granary weevils to new locations. As a result, granary weevils are now found in many cities around the world.

In Gusau market, Maize grains were found to be more prone to attack by insect pests than other stored food grains sampled for this study. This may be due to several factors, including the attractive food source provided by maize kernels, the conducive environment provided by bulk storage structures, and the ability of maize to provide a suitable habitat for insect pests. Kfir *et al.*(2004), opined that maize kernels are high in starch and carbohydrates, which are the preferred food source for many insect pests, including beetles, moths, and weevils. For example, the maize grain weevil can bore into the kernel and lay eggs, which then hatch into larvae that feed on the kernels. This results in significant reductions in quantity and quality, as the kernels become infested and are no longer fit for human or animal consumption. Secondly, maize is often stored in large quantities in bulk storage structures, such as silos, which provide a conducive environment for insect development, such as warmth and high humidity (Kfir *et al.,* 2004).

Kaura namoda markets were observed with good storage practices of food stored grains than Gusau markets, hence, the reason why infestation rates of insect pests are low as compared to Gusau Markets. According to a study by Hossain *et al.* (2019), a temperature

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of 20-25°C and relative humidity of 60-70% is optimal for the storage of grains, as they discourage the growth and reproduction of many insect pests. In addition, proper ventilation and cleaning can help to prevent the buildup of moisture and debris that can attract pests. Another important factor is the use of insecticides. Both natural and synthetic insecticides can be effective in reducing insect pest populations in stored grains. For example, the use of diatomaceous earth (DE) is an effective method for controlling pests in stored grains (Fields *et al.,* 2020). DE is a natural, non-toxic substance that damages the exoskeletons of insects, leading to dehydration and death. Other methods such as hermetic storage, which involves the use of airtight containers, can also be effective in preventing infestations. A study by Navarro *et al.* (2018) found that hermetic storage reduced the populations of several insect pests in stored beans and maize.

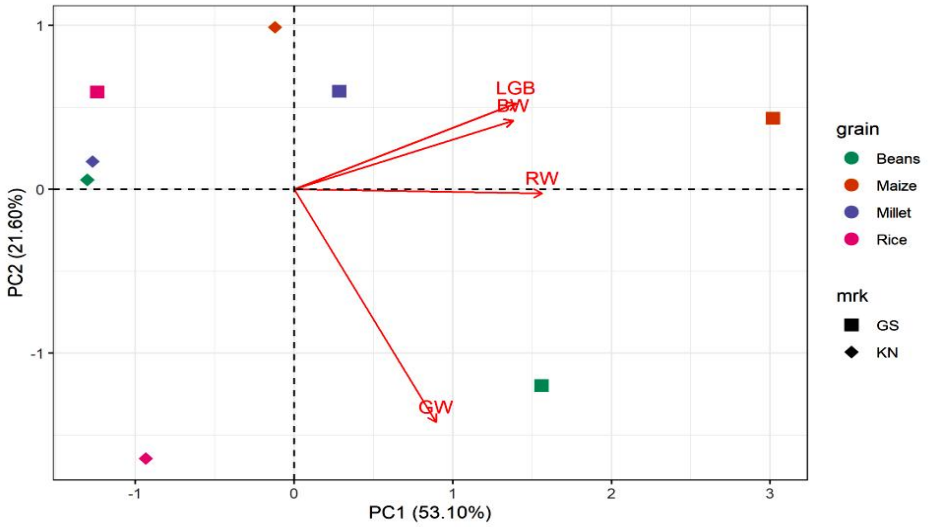

Figure 2: Comparison between Infestation rates of Insect pests in Gusau and Kaura namoda Markets.

Keys: BW- Bean weevil, GW- Granary weevil, RW- Rice weevil, LGB- Lesser grain weevil, GS- Gusau market, KN- Kaura namoda market.

CONCLUSIONS

Findings from this study show Gusau market with the highest rate (2,612) of insect pest infestation in stored food grains as compared with the Kaura namoda market with a low infestation rate (1,121) of insect pests. Insect pests of the order Coleoptera were collected in both Gusau and Kaura namoda markets, consisting of four main species which are *Sitophilus granarius* (Granary/wheat weevil), *Rhyzophertha dominica* (Lesser grain borer) *Sitophylus oryzae* (Rice weevils), and *Acanthoscelides obtectus* (Bean weevils). In Gusau market, Rice weevils were found to have the highest rate of infestation 1,403(54%) in stored food grains while in Kaura namoda market, Granary weevils were found to have the highest rate of infestation 646 (58%). In food-stored grains, maize grains were recorded with the highest rate of insect pests' attack (1,106) in the Gusau market while cowpea seeds were found to be more prone to insect pests' attack (494) in Kaura namoda market. It is therefore recommended that farmers in northern Nigeria particularly in Zamfara state need to adopt better storage practices, implement effective pest management strategies, and ensure the quality

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of stored grains. Further research is needed to improve our general understanding of insect pest biology and behavior, and to develop new and sustainable strategies for controlling these pests in stored food grains.

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