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Diversity of Insect Pest on Stored Grains from Keffi Old Market in Keffi Local Government Area of Nasarawa State

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Agricultural Production, Seasonal, Storage, Post-Harvest, Food Insecurity, Grain, Insect Pest, Infestations, Weevils, Curculionidae, Tenebrionidae, Silvanidae, Coleoptera, *Sitophilus sp., Tribolium sp., Oryzaephilus sp., Acanthoscelides sp., Trogoderma sp., Rhyzopertha sp., Tenebroides sp.*, and Pest.

Abstract
In Nigeria, grain losses from insect pests can reach 20-30%, threatening food security and perpetuating poverty. Traditional chemical insecticides are unatainable for many farmers due to cost and health risks. This study investigates the extent and impact of insect pest infestations on stored grains in the Keffi Local Government Area of Nasarawa State, Nigeria. The primary objective is to understand the diversity and prevalence of these pests to inform better storage practices and pest management strategies. Data collected from 50 grain sellers and grain samples from 10 stores identified 527 insect pests across 12 genera and 9 families, with the most dominant species being *Sitophilus sp., Tribolium sp., Oryzaephilus sp., Acanthoscelides sp., Trogoderma sp., Rhyzopertha sp.,* and *Tenebroides sp*. Notably, the Curculionidae family exhibited the highest abundance with 255 individuals (43.81%), followed by Tenebrionidae with 113 individuals (19.42%), and Silvanidae with 61 individuals (10.48%). The order Coleoptera accounted for 94.50% of the total insects found. Store 3 exhibited the highest infestation rate at 41.7% of the total insects collected, indicating variability in storage conditions. The Shannon-Weiner diversity index showed a low diversity (H' = +2.1285) of arthropod pests, with *Sitophilus sp* particularly in maize and sorghum grains, demonstrating significant diversity and prevalence. The study emphasize the importance of proper grain processing, frequent sun drying, and enhanced awareness of effective storage practices to

reduce pest infestations. By identifying key pest species and understanding their impact on grain quality, the research supports the development of specific pest management strategies contributing to improved storage practices, food security, and farmer incomes.

INTRODUCTION

Agricultural production is basically seasonal, while the demand for agricultural commodities remains relatively constant throughout the year (Wright, 2011). This disparity necessitates the importance of effective storage solutions in agriculture. Storage allows for the preservation of surplus produce during harvest seasons for subsequent release during off-season periods, ensuring a steady market supply (Berg, 2018). Post-harvest food losses are a significant issue, particularly in Africa, where they contribute substantially to food insecurity (Lipinski *et al*., 2013). AMCOST (2006) estimated that pre- and post-harvest food crop losses in Sub-Saharan Africa are about 37%, exceeding the global average of 32% (FAO, 2011; Kaminski and Christiaensen, 2014). The World Bank (2011) estimates these losses to be between 20 and 40% in Africa. Grains, a staple in both human and animal diets in the tropics and subtropics, are particularly susceptible to post-harvest losses due to insect pest infestations, in Nigeria, such losses can range from 20-30% of total grain production (Mijinyawa, 2002). These losses diminish farmers' potential income, threaten food security, and perpetuate poverty among rural households. Storage-related issues vary across Nigeria, often influenced by local climatic conditions, with the main objective being the preservation of grain quality over time by protecting it from insects, rodents, and microbial deterioration (Adejumo and Raji, 2007). Storage is crucial for maintaining a constant grain supply and preserving quality. For small-scale African farmers, storage ensures food reserves and seed for planting, with gradual market release during off-seasons helping stabilize prices (Adetunji, 2007). The quality of stored grains depends on various factors including initial seed quality, storage conditions, and insect pest control (Amruta *et al*., 2015). Insect pests, particularly in tropical climates like Nigeria, can cause significant losses during storage, with primary pests like grain weevils initiating infestations that secondary and tertiary pests intensify (Banga *et al*., 2018). Grain losses in Africa due to insect pests are high, with reported losses

reaching up to 50% for cereals and 100% for pulses in some cases (Abraham and Firdissa, 1991; Boeke, 2002). These losses are often greater than those caused by other agents like rodents and microorganisms. Effective post-harvest management is essential to reduce these losses and improve food and nutrition security (Stathers *et al*., 2013). However, the advent of high-yielding pulse varieties, while increasing agricultural output, has also heightened storage losses due to their susceptibility to pest damage. Traditional chemical insecticides, though effective, are often costly and pose health risks, making them impractical for many local farmers. Consequently, stored grains often suffer significant quality and quantity losses due to insect infestations at various stages from processing warehouses to household storage. Identifying and managing the specific insect pests that attack stored grains is vital for developing useful storage solutions. This study aims to investigate the diversity of insect pests in stored grains in the Keffi Local Government Area of Nasarawa State, Nigeria, to aid in the development of specific pest management strategies. Understanding these pest populations and their impact on grain quality and quantity will contribute to better storage practices, thereby improving food security and farmers' livelihoods.

MATERIALS METHODS

Study Area

This research was conducted on grain stored in the old market in Keffi, Nasarawa State, located in the Northern Guinea savanna zone of Nigeria. Keffi is located between latitude 8.51°N and longitude 7.53°E (Ileoje 2015). The town has an annual rainfall of 1500mm, situated at an altitude of 850m, and covers an area of 140.47km² with a population of 92,664 as of the 2006 census.

Experimental Design

Data was collected using a standard questionnaire administered to 50 grain sellers in Keffi old market. The questionnaire gathered information on farmers' perceptions of storage problems, types of insect species damaging their grains, and the extent of loss due to insect pests.

Sample Collection

Grains were collected from three different stores. Pests were isolated from the grains and transported to the Zoology laboratory at Nasarawa State University for further examination.

Identification

Samples collected from stores were identified using the "Stored Grain Insects" identification key by the Federal Grain Inspection Service (USDA, 2016), resources from the National Institute of Plant Health Management (Rajasri, 2020), and Google searches. Laboratory tools from the Zoology Department also assisted in the identification process. After identification, the samples were placed in small transparent containers filled with a solution of 10% formalin and 90% distilled water. Each container was labeled with the store, date, and names of the identified insects, and then stored.

Data Analysis

The data analysis involved using statistical software packages, specifically SPSS Version 23 and Microsoft Excel. Descriptive statistics were employed to analyze the data, producing tables and figures that represent different variables in terms of frequencies and percentages. To evaluate species diversity and distribution, the Shannon-Weiner diversity index was calculated. This index, formulated by Shannon and Weiner (1949), provides insights into species diversity, species index, and evenness. The Shannon diversity index (HI) is calculated as:

$HI = -\sum pi(\ln pi)$

The Shannon diversity evenness (E) is calculated as:

$E = \frac{HI}{In(s)}$

RESULTS

Insects pest in food stores in Keffi

The study recorded a total of 527 insects from different food stores in Keffi, spanning 12 genera and species from 9 families and 3 orders. The species recorded

include *Rhyzopertha dominica, Tribolium confusum, Tribolium castaneum, Trogoderma granarium, Oryzaephilus surinamensis, Sitophilus granarius, Sitophilus zeamais, Sitophilus oryzae, Tenebroides mauritanicus, Acanthoscelides obtectus, Romalea microptera,* and *Plodia interpunctella*. These insects belong to the orders Coleoptera, Orthoptera, Lepidoptera, and Araneae. Analysis of insect abundance by arthropod family revealed that Curculionidae had the highest abundance with 255 individuals (43.81%), followed by Tenebrionidae with 113 individuals (19.42%) and Silvanidae with 61 individuals (10.48%). The family with the least abundance was Muscidae with 3 individuals (0.52%). There was a highly significant variation in the abundance of arthropods among the families ($\chi 2=158.7$, df=11, $p<0.001$, Table 1). Notably, Coleoptera was the most abundant order, accounting for approximately 94.50% of the insects found in the surveyed stores.

Table 1: Insects Pest in Stores in Keffi

Order	Family	Genus	Species	Common name	Number of individual (%)
Coleoptera	Boshichidae	*Rhyzopertha*	*R. dominica*	Lesser grain borer	26 (4.93)
	Tenebrionidae	*Tribolium*	*T. confusum*	Confused flour beetles	42 (7.97)
		Tribolium	*T. castaneum*	Beans weavil	71 (13.47)
	Dermestidae	*Trogoderma*	*T. granarium*	Cabinet beetles	33 (6.26)
	Silvanidae	*Oryzaephilus*	*O. surinamensis*	Saw toothed grain	61 (11.57)
	Curculionidae	*Sitophilus*	*S. grannaries*	Granary weevil	34 (6.45)
		Sitophilus	*S. zeamais*	Maize weevil	213 (40.42)
		Sitophilus	*S. oryzae*	Rice weevil	8 (1.52)
	Trogossitidae	*Tenebroides*	*T. mauritanicus*	Cadelle	22 (4.17)
	Chrysomelidae	*Acanthoscelides*	*A. obtectus*	Beans weevil	40 (7.59)
Orthoptera	Acrididae	*Romalea*	*R. microptera*	Grasshopper	7 (1.33)

Lepidoptera	Pyralidae	*Plodia*	*P. interpunctella*	Pantry moth	10 (1.89)
Total					**527 (100.00)**

Insects Pest in Food Stores in Keffi

A total of 527 insects from 12 genera and species across 9 families and 3 orders were recorded. The most abundant family was Curculionidae, followed by Tenebrionidae and Silvanidae. Coleopterans were the most abundant order, accounting for 94.5% of occurrences.

Diversity of Insect Pest Species

The Shannon-Weiner diversity index revealed a low diversity of arthropod pests in the surveyed stores (H' = +2.1285).

Table 2: Diversity of Insect Pest Species Across the Collection Stores

Species	Number of individual (%)	Pi	Lnpi	p_i (ln p_i)
R. dominica	26 (4.93)	0.044	-3.124	-0.13746
T. confusum	42 (7.97)	0.072	-2.631	-0.18943
T. castaneum	71 (13.47)	0.122	-2.104	-0.25669
T. granarium	33 (6.26)	0.057	-2.865	-0.16331
O. surinamensis	61 (11.57)	0.105	-2.254	-0.23667
S. granaries	34 (6.45)	0.058	-2.847	-0.16526
S. zeamais	213 (40.42)	0.370	-0.994	-0.36778
S. oryzae	8 (1.52)	0.014	-4.269	-0.05977
T. mauritanicus	22 (4.17)	0.038	-3.270	-0.12426
A. obtectus	40 (7.59)	0.069	-2.674	-0.18451
R. microptera	7 (1.33)	0.012	-4.423	-0.05308
P. interpunctella	10 (1.89)	0.017	-4.075	-0.06928
Total	**527**			**-2.1285**

Comparison of Insect Pest Composition

Store 3 harbored the highest insect pest population, with 220 individuals accounting for 41.7% of the total collected from the surveyed food stores. The store

with the least population was Store 166, which had 31.5% of the total insects collected. There was a very significant variation in the proportion of the arthropod population across the stores ($\chi^2 = 8.222$, df = 2, p = 0.016).

Table 3: Comparison of the insect Pest Composition in Different Food Stores in Doma

Insect Species	**Location**			Total (%)
	Store1	**Store 2**	**Store 3**	
R. dominica	11	7	8	26 (4.93)
T. confusum	12	9	21	42 (7.97)
T. castaneum	17	24	30	71 (13.47)
T. granarium	2	17	14	33 (6.26)
O. surinamensis	17	18	26	61 (11.57)
S. grannaries	9	15	10	34 (6.45)
S. zeamais	102	47	64	213 (40.42)
S. oryzae	0	3	5	8 (1.52)
T. mauritanicus	2	12	8	22 (4.17)
A. obtectus	9	4	27	40 (7.59)
R. microptera	0	0	7	7 (1.33)
P. interpunctella	0	10	0	10 (1.89)
Total	**181 (34.4)**	**166 (31.5)**	**220 (41.7)**	**527 (100.00)**

DISCUSSION, CONLUSION AND RECOMMENDATION

Discussion

The study conducted in Keffi Local Government Area of Nasarawa State, Nigeria, revealed widespread infestations of various insect pests in stored grains across all surveyed food stores. Key pests identified included species like *Rhyzopertha dominica*, several *Tribolium* species, *Sitophilus granaries*, and others. Notably, the genus *Sitophilus*, particularly prevalent in maize and sorghum, was the most dominant, corroborating earlier studies highlighting its prominence in grain storage issues in similar agroecological zones within Nigeria and Ethiopia. The results emphasized the higher susceptibility of maize, rice, and wheat to pest attacks compared to millet and sorghum, suggesting that the former group of grains

provides a more favorable environment for pests. Store 3 had the highest pest incidence with a pest population constituting 41.7% of the total pests observed. This suggests a variance in storage conditions and practices across different stores. The study also noted that the diversity of pest species was highest among the *Sitophilus* species, which had a Shannon diversity index (H') of +2.1285. This high diversity index, indicative of a significant presence, points to *Sitophilus* as a critical pest affecting stored grains, especially maize. The persistence and prevalence of these pests underscore the necessity for targeted pest management strategies to ensure the quality and safety of stored grains. Effective pest management and the segregation of different types of grains during storage were recommended to mitigate the risk of infestation and ensure the viability of stored grain. By implementing strategic interventions, the study aims to improve agricultural practices and enhance food security by minimizing grain damage due to insect pests.

CONCLUSION

The study in Keffi Local Area, Nasarawa State, identified 527 insect pests across 10 stores, with dominant species including *Sitophilus, Tribolium, Oryzaephilus, Acanthoscelides, Trogoderma, Rhyzopertha,* and *Tenebroides*. These pests were primarily found in stores with cereals and pulse grains, which provide ideal conditions for their proliferation. The findings emphasize the need for specific pest management strategies tailored to the types of grains stored, to effectively manage and mitigate pest populations in food storage facilities.

Recommendations

Grains should be properly processed before storage to minimize the risk of insect infestation. Additionally, frequent sun drying can help reduce moisture content, making the environment less hospitable for pests. It is also essential for governments, communities, and individuals to raise awareness and increase knowledge about effective food storage practices to further protect grain stores from pest damage.

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