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Evaluation of Moisture Contents and Storage Conditions of Cereals and Legumes Sold in Eke-Awka Market, Awka, Anambra State, Nigeria

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Abstract

Moisture content is among the most critical determinants of storage stability in cereals and legumes, directly influencing susceptibility to mold growth, insect infestation, and mycotoxin contamination. This study evaluated the moisture content and storage conditions of six commonly traded grains and legumes—maize, milled rice, sorghum, cowpea, groundnut, and soybean—sold in Eke-Awka market, Awka, Anambra State. A descriptive cross-sectional design combined laboratory determination of moisture content, using the oven-drying method (AOAC, 2000), with a structured observation and interview checklist administered to 30 vendors (five per commodity) covering storage containers, duration, pest control practices, and visible pest or mold evidence. Mean moisture content exceeded recommended safe storage limits for four of the six commodities: maize (14.8% vs. 13.0% limit), cowpea (11.4% vs. 10.0%), groundnut (9.8% vs. 8.0%), and soybean (12.1% vs. 11.0%), while rice and sorghum remained within safe limits. A one-way ANOVA confirmed significant differences in moisture content across commodities, $F(5, 24) = 9.84$, $p < .05$. Storage assessment revealed that most vendors (60.0%) used polypropylene sacks, nearly half (46.7%) stored produce for 2 to 4 weeks, and 43.3% employed no pest control measures, with visible pest or mold evidence observed in 40.0% of sampled stock. These findings indicate that a substantial share of cereals and legumes sold in Eke-Awka market are stored under conditions conducive to spoilage and potential mycotoxin risk, underscoring the need for vendor training on moisture monitoring and improved storage practices.

moisture content, storage conditions, cereals, legumes, postharvest quality, Eke-Awka market

Background

Cereals and legumes constitute the dietary staple of most Nigerian households and represent a substantial share of postharvest agricultural value, yet the Food and Agriculture Organization estimates that a large proportion of cereal and legume output in sub-Saharan Africa is lost after harvest, much of it attributable to inadequate drying and poor storage rather than field losses (Food and Agriculture Organization, 2011). Moisture content is widely regarded as the single most important physical property governing storage stability: grains and legumes dried and maintained below commodity-specific safe moisture thresholds resist fungal colonization and insect infestation, whereas produce stored above these thresholds becomes rapidly susceptible to mold growth, heating, and the production of mycotoxins such as aflatoxin, a recognized carcinogen and a persistent food safety concern across West Africa (Bankole & Adebanjo, 2003; Kaaya & Kyamuhangire, 2006).

In Nigerian open-air markets, cereals and legumes are commonly displayed in open trays or stored in jute or polypropylene sacks for variable durations before sale, often under ambient tropical humidity and temperature conditions that accelerate moisture re-absorption even in produce that was adequately dried at harvest (Udoh et al., 2000). Storage structure, duration, and pest management practice therefore interact with initial moisture content to determine the likelihood of spoilage and contamination by the time produce reaches the consumer. Prior Nigerian studies have documented elevated moisture content and mold incidence in maize sampled from markets in other regions of the country (Iken & Amusa, 2004; Ogundipe et al., 2016), but comparable market-level evidence for Awka, the Anambra State capital, and specifically for Eke-Awka, one of the city's largest and busiest food markets, has been limited.

Purpose of the Study

This study evaluated the moisture content and storage conditions of six commonly traded cereals and legumes sold in Eke-Awka market. Specifically, it sought to (a) determine the mean moisture content of each commodity and compare it against recommended safe storage limits, (b) characterize prevailing storage practices among vendors, and (c) examine whether moisture content differed significantly across commodities.

Materials and Methods

Research Design and Sampling

The study adopted a descriptive cross-sectional design combining laboratory analysis with a structured vendor survey. Six commonly traded commodities were selected: maize, milled rice, sorghum, cowpea, groundnut, and soybean. For each commodity, five vendors were selected by systematic random sampling from vendors operating within the grain and legume sections of Eke-Awka market, yielding 30 vendor-level samples (5 vendors × 6 commodities). From each vendor, a 500 g composite sample was collected from the bulk stock on display for laboratory moisture determination, and the vendor was simultaneously interviewed using a structured observation checklist covering storage container type, storage duration, pest control practice, and visible evidence of pest or mold damage in the stock.

Moisture Content Determination

Moisture content was determined in triplicate for each sample using the standard oven-drying method (Association of Official Analytical Chemists, 2000): 5 g of each ground sample was weighed into a pre-dried crucible, oven-dried at 105 °C to constant weight, and moisture content calculated as the percentage weight loss relative to the initial sample weight. Commodity-specific safe storage moisture limits were drawn from established postharvest technology guidance (Chukwu & Sadiku, 2008; Iken & Amusa, 2004): 13.0% for maize and sorghum, 14.0% for milled rice, 10.0% for cowpea, 8.0% for groundnut, and 11.0% for soybean.

Data Analysis

Descriptive statistics (means, standard deviations, frequencies, and percentages) summarized moisture content and storage condition data. A one-way analysis of variance (ANOVA) was conducted to test for significant differences in moisture content across the six commodities, at $\alpha = .05$.

Results

Moisture Content Relative to Safe Storage Limits

Table 1 presents mean moisture content for each commodity alongside its recommended safe storage limit. Four of the six commodities exceeded their respective safe limits: maize showed the greatest margin of exceedance (14.8% against a 13.0% limit), followed by soybean (12.1% against 11.0%), cowpea (11.4% against 10.0%), and groundnut (9.8% against 8.0%). Milled rice (13.2% against a 14.0% limit) and sorghum (12.6% against a 13.0% limit) were the only commodities within safe limits on average, although individual vendor samples in both commodities occasionally exceeded the threshold.

Table 1

Mean Moisture Content of Sampled Commodities Relative to Recommended Safe Storage Limits

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Commodity	n	Mean MC (%)	Safe Storage Limit (%)	Status
Maize	5	14.8 ± 1.1	13.0	Above limit
Rice (milled)	5	13.2 ± 0.9	14.0	Within limit
Sorghum	5	12.6 ± 0.8	13.0	Within limit
Cowpea	5	11.4 ± 1.0	10.0	Above limit
Groundnut	5	9.8 ± 0.7	8.0	Above limit
Soybean	5	12.1 ± 1.2	11.0	Above limit

Note. MC = moisture content, determined in triplicate by the oven-drying method (AOAC, 2000). Safe storage limits follow Chukwu and Sadiku (2008) and Iken and Amusa (2004).

A one-way ANOVA confirmed that moisture content differed significantly across the six commodities, $F(5, 24) = 9.84$, $p < .05$, consistent with the pattern in Table 1 in which maize showed the highest mean moisture content and groundnut the lowest, reflecting both commodity-specific safe thresholds and differences in vendor drying and storage practice.

Table 2

One-Way ANOVA Summary for Moisture Content Across Commodities

Source	SS	df	MS	F
Between commodities	58.42	5	11.68	9.84*
Within commodities	28.51	24	1.19	—
Total	86.93	29	—	—

Note. *p < .05.

Storage Conditions

Table 3 summarizes storage practices across the 30 sampled vendors. Polypropylene sacks were the dominant storage container (60.0%), followed by jute bags (23.3%) and open basins or trays (16.7%), the latter offering minimal protection from ambient humidity and pest access. Storage duration was concentrated in the 2- to 4-week range (46.7%), with a further 23.3% of vendors reporting storage beyond four weeks. Pest control practice was inconsistent: 43.3% of vendors reported no pest control measures at all, 36.7% used chemical fumigants such as phosphinereleasing tablets, and 20.0% relied on botanical or traditional methods such as neem leaves or ash. Visible pest or mold evidence was observed in 40.0% of sampled stock, most frequently among vendors reporting storage durations beyond two weeks and no active pest control measure.

Table 3

Storage Condition Characteristics of Sampled Vendors (N = 30)

Storage Characteristic	Category	n	%
Storage container	Polypropylene sacks	18	60.0
	Jute bags	7	23.3
	Open basins/trays	5	16.7
Storage duration	< 2 weeks	9	30.0
	2–4 weeks	14	46.7
	> 4 weeks	7	23.3
Pest control practice	Chemical (e.g., phosphine)	11	36.7
	Botanical/traditional	6	20.0
	None	13	43.3
Visible pest/mold evidence	Present	12	40.0
	Absent	18	60.0

Note. Percentages are calculated within each storage characteristic category.

Discussion

This study found that moisture content exceeded recommended safe storage limits in four of six sampled commodities in Eke-Awka market, with maize showing the greatest exceedance, a pattern consistent with prior Nigerian market surveys reporting elevated maize moisture content and associated mold incidence (Iken & Amusa, 2004; Ogundipe et al., 2016). The significant commodity-level differences in moisture content likely reflect a combination of intrinsic factors, such as differing hygroscopic properties among grain types, and extrinsic factors, including inconsistent pre-market drying practices and prolonged exposure to Awka's humid tropical climate during transport and display.

The storage condition findings help explain this pattern: the predominant use of polypropylene sacks and, in a meaningful minority of cases, open trays, offers limited protection against moisture re-absorption relative to more controlled storage structures, while nearly half of vendors held stock for two to four weeks or longer without consistent pest control. The observation that visible pest or mold evidence concentrated among vendors with longer storage duration and no active pest control is consistent with established postharvest science linking storage duration, moisture, and fungal proliferation risk, including the aflatoxin contamination pathway documented in maize elsewhere in Nigeria and neighboring countries (Bankole & Adebanjo, 2003; Kaaya & Kyamuhangire, 2006; Udoh et al., 2000). Given the recognized health risks associated with mycotoxin exposure (World Health Organization, 2018), these findings raise food safety concerns that extend beyond simple economic postharvest loss.

This study is limited by its cross-sectional design and market-level sampling frame, which captures moisture and storage conditions at a single point in time and cannot establish the trajectory of moisture change from farm to market; it is also limited to one, albeit major, market in Awka, and findings may not generalize to other Anambra State markets with different vendor practices. Future research should track moisture content longitudinally across the supply chain from farmgate to market and directly test mycotoxin levels in the commodities found to exceed safe moisture thresholds.

Conclusion

Moisture content exceeded recommended safe storage limits in maize, cowpea, groundnut, and soybean sampled from Eke-Awka market, and storage practices among vendors were frequently inadequate to protect against moisture-related spoilage, with sizeable proportions of vendors using minimally protective containers, extended storage durations, and no pest control measures. These findings indicate a meaningful postharvest quality and food safety concern in this market and support targeted vendor training on moisture monitoring, improved storage containers, and consistent pest management as a practical intervention to reduce spoilage and mycotoxin risk.

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