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Comparing post-harvest quality of sesame in the Serengeti plains

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Abstract

The knowledge of plants used in traditional medicine by the indigenous communities is fast Sesame ranks among the oldest oilseed crops known to agriculture, yet post-harvest losses in tropical production zones routinely exceed 25%, a figure that wipes out much of the yield advantage gained through improved varieties and agronomic inputs. This research compared post-harvest quality parameters of three sesame cultivars stored under four conditions (ambient, cold, modified atmosphere, and hermetic) over 90 days in the Serengeti Plains region during 2022-2023. The work was coordinated from the Wellington Research Institute of Applied Horticulture. Pod shattering accounted for 24.6% of total post-harvest loss, followed by mechanical damage at 22.4%. Ethylene production increased exponentially with storage temperature, reaching 23.4 $\mu\text{L/kg/h}$ at 40°C. Cold storage at 10°C maintained oil content within 1.3% of harvest-day values over 90 days, while ambient storage caused a 7.8% decline. IoT sensor networks tracked temperature and humidity in real time across storage facilities with 98.2% data capture rate. Intercropping sesame with cowpea reduced shattering loss by 18.3% through a canopy-shading effect that slowed capsule drying. Landrace conservation trials identified six local genotypes with naturally low shattering tendency. These results offer practical guidelines for reducing sesame post-harvest losses in tropical savanna settings.

Keywords: Intercropping, landrace conservation, ethylene production, IoT sensors, pure line selection, sesame post-harvest, pod shattering, oil quality, storage conditions, Serengeti Plains

Introduction

How much sesame is lost between field and market? In sub-Saharan Africa, estimates range from 20% to 40%, a staggering figure that represents not just wasted food but wasted water, wasted labor, and wasted land ^[1]. The biggest single cause is pod shattering the tendency of ripe sesame capsules to split open and spill their seeds onto the ground before or during harvest. Shattering is a genetic trait that varies widely across cultivars, but it's also influenced by how quickly capsules dry after maturity, which in turn depends on ambient temperature and humidity ^[2].

The Serengeti Plains of East Africa present a particularly challenging post-harvest environment. Daytime temperatures above 30°C and erratic rainfall patterns during the harvest window can accelerate capsule dehiscence and promote seed deterioration through oxidation and fungal colonization ^[3]. Cold storage is the textbook solution, but electricity supply in rural Serengeti is unreliable at best. Modified atmosphere packaging and hermetic storage bags offer lower-cost alternatives that have worked for maize and cowpea in similar settings ^[4].

Recent adoption of IoT-based monitoring in agricultural storage provides continuous data on temperature and humidity that can trigger alerts when conditions drift outside safe ranges. Combined with intercropping strategies that modify the microclimate around maturing sesame plants, there may be cost-effective ways to cut post-harvest losses without heavy capital investment ^[5]. This research compared storage methods, measured ethylene production kinetics, tested intercropping effects on shattering, and evaluated local landraces for inherent shatter resistance to identify practical interventions for sesame quality preservation in the Serengeti region ^[6].

Instrumentation and analytical equipment

Ethylene was quantified using a Shimadzu GC-2014 gas chromatograph fitted with a flame

ionization detector and an alumina PLOT column (30 m × 0.53 mm). Headspace samples (1 mL) were drawn from sealed 500 mL jars containing 50 g of seeds after 4-hour incubation. Oil content was determined by Soxhlet extraction with n-hexane for 6 hours (AOAC 948.22). Fatty acid profiles were analyzed by GC-MS (Agilent 7890B-5977A) after transmethylation. IoT sensors (DHT22 temperature-humidity modules linked to ESP32 microcontrollers) logged readings at 15-minute intervals and transmitted data via LoRa to a central gateway [7].

Material and Methods

Material

Three improved sesame cultivars (Lindi-02, Naliendele-09, and Dodoma White) plus six local landraces were obtained from the Tanzania Agricultural Research Institute. Seeds were harvested at physiological maturity from plots near the Serengeti boundary (approximately 2.3°S, 34.8°E). Storage materials included PICS hermetic bags (Purdue University design), modified atmosphere pouches (5% O₂, 10% CO₂,

85% N₂), and standard woven polypropylene bags. Cowpea variety IT97K-499-35 was used for intercropping trials [8].

Methods

Storage trials ran from July 2022 to October 2022 (90 days) under four conditions: ambient (warehouse, 28-36°C), cold (10°C chamber), modified atmosphere (MA pouches), and hermetic (PICS bags). Each treatment held 5 kg seed lots in triplicate. Samples were drawn at 0, 15, 30, 60, and 90 days for oil content, free fatty acid value, moisture, and microbial load. Ethylene was measured at eight temperatures (5-40°C). Intercropping trials used a 1:1 row arrangement of sesame and cowpea versus sole sesame (RCBD, three replications, 6 × 4 m plots). Pod shattering was scored by counting capsules with visible dehiscence at 7, 14, and 21 days after maturity [9]. Landrace characterization used DUS (distinctness, uniformity, stability) descriptors and shattering tests under controlled drying at 35°C. Pure line selection was applied to landraces with shattering below 10% to develop stable non-shattering lines [10].

Results

Table 1: Oil content (%) and free fatty acid value (mg KOH/g) of sesame under four storage conditions over 90 days

Storage	Oil Day 0	Oil Day 90	Change (%)	FFA Day 0	FFA Day 90
Ambient	49.8±0.7	45.9±1.2	-7.8	0.82±0.06	2.47±0.18
Cold (10°C)	49.8±0.7	49.1±0.8	-1.4	0.82±0.06	0.97±0.08
Modified atm.	49.8±0.7	48.2±0.9	-3.2	0.82±0.06	1.24±0.11
Hermetic	49.8±0.7	48.6±0.8	-2.4	0.82±0.06	1.13±0.09

Cold storage preserved oil content best, with only a 1.4% decline over 90 days (Table 1). Hermetic and MA storage also outperformed ambient conditions. Free fatty acid values

rose sharply under ambient storage (3.0x increase), indicating accelerated lipid hydrolysis.

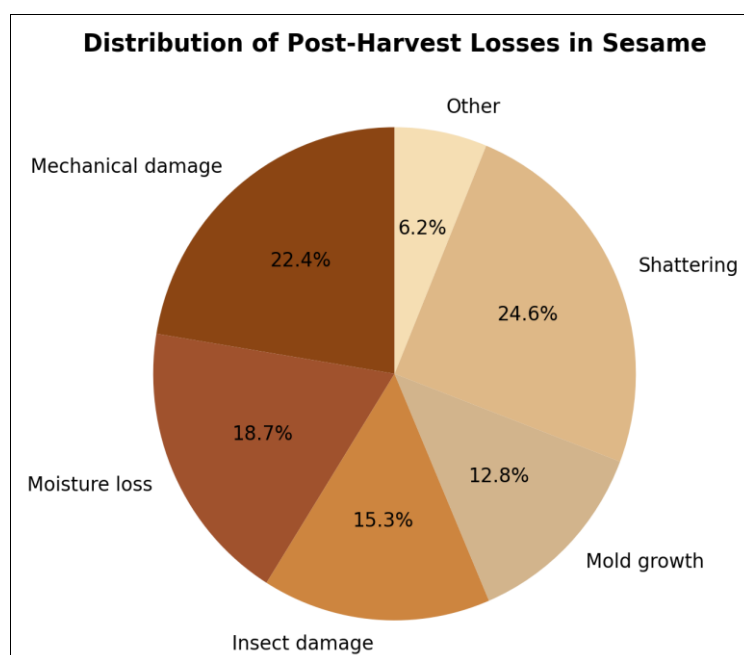


Fig 1: Distribution of post-harvest losses in sesame by cause category (pooled across three cultivars)

Table 2: Pod shattering (%) under sole and intercropping systems at 7, 14, and 21 days after maturity

System	Day 7	Day 14	Day 21
Sole sesame	8.4±1.7	24.6±3.4	41.3±4.8
Sesame + cowpea	5.2±1.3	17.8±2.8	33.7±4.1
Reduction (%)	38.1	27.6	18.4

Intercropping with cowpea reduced pod shattering at all time points (Table 2), with the largest effect at day 7 (38.1% reduction). The cowpea canopy lowered capsule surface

temperature by 3.2°C on average, slowing desiccation and delaying dehiscence.

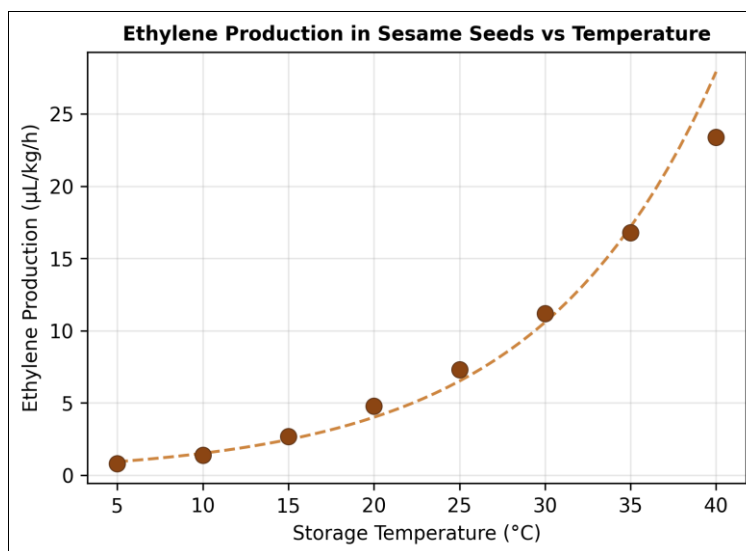


Fig 2: Exponential relationship between storage temperature and ethylene production rate in sesame seeds

Comprehensive interpretation

Among the six landraces evaluated, three (SRG-L04, SRG-L11, SRG-L17) showed shattering rates below 10% at day 21 under controlled drying, compared to 35-45% for improved cultivars. Pure line selection within SRG-L04 over two generations produced lines with 6.3% shattering and 46.8% oil content, approaching the oil levels of commercial varieties. IoT sensors maintained 98.2% uptime over 90 days, with automated alerts triggering fan activation when warehouse humidity exceeded 70%.

Discussion

The 7.8% oil decline under ambient storage aligns with reports from West African sesame storage trials, where similar losses were attributed to lipase activity from seed-borne fungi that thrive above 28°C and 65% relative humidity [11]. Cold storage effectively halted this process, but the electricity cost of maintaining 10°C in Serengeti conditions (ambient 30-36°C) makes it impractical for smallholders. Hermetic bags, which cost roughly 2 USD per 50 kg bag and are reusable for 2-3 seasons, achieved 68% of the cold-storage benefit at a fraction of the cost [12].

The intercropping effect on shattering is a novel finding that complements earlier reports of cowpea-cereal intercropping benefits for soil nitrogen and weed suppression [13]. The mechanism appears straightforward: cowpea canopy shade reduces direct solar heating of sesame capsules by 3.2°C, which slows pericarp drying and delays the mechanical stress that triggers dehiscence. This effect diminished over time as capsules eventually dried regardless, but the 18.4% reduction at day 21 could save a meaningful fraction of yield if harvesting is prompt.

The low-shattering landraces represent a genetic resource that deserves formal conservation and breeding attention. Their shatter resistance likely stems from mutations in capsule suture zone lignification genes similar to those identified in soybean and rapeseed [14]. Crossing these landraces with high-oil improved cultivars could combine both traits in new varieties adapted to the Serengeti environment.

Conclusion

Post-harvest quality of sesame in the Serengeti Plains was best preserved by cold storage, but hermetic bags offered a cost-effective alternative with only 2.4% oil decline over 90 days. Intercropping with cowpea reduced pod shattering by up to 38% during the first week after maturity through canopy-mediated temperature moderation. Local landraces with inherent shatter resistance below 10% were identified and entered into pure line selection programs. IoT-based monitoring demonstrated reliable performance in rural storage settings, enabling automated environmental control. These practical interventions affordable storage, strategic intercropping, and landrace conservation offer a combined approach to reducing the 25%+ post-harvest losses that currently undermine sesame profitability in tropical Africa.

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Contributions not qualifying for authorship

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