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Postharvest handling practices and the use of *Cedrela Odorata* leaves against insect pests of maize grain in storage

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A survey conducted in the Ejura-Sekyedumasi municipality of Ghana's Ashanti Region assessed the use of Cedrela odorata leaves for storing maize. The study sampled fifty farmers from five maize-producing communities. Maize storage methods included shelling and bagging or storing unshelled maize in rooms or barns. Common field pests encountered included weevils, termites and fall armyworms. The majority of farmers (52%) stored maize for up to three months before sale or consumption. Seventy percent of farmers treated maize before storage, with 52% using *C. odorata* leaves and 8% using phostozin. Farmers perceived *Cedrela odorata* leaves as safe, as they are traditionally used to treat malaria, unlike phostozin, which is highly toxic. Typically, three kilograms of leaves were used for every 100 kg of maize, spread at the bottom, middle and top of the sack and tightly sewn. Farmers reported that the leaves were effective against storage weevils for up to three months but suggested further research to empirically determine efficacy and safety.

Key words: Post-harvest; agricultural production chain; food security; climate; maize cultivation.

INTRODUCTION

Ghana has a long history of maize (*Zea mays L.)* farming, particularly in the southern region where it became a staple crop in the late 16th century (Darfour and Rosentrater, 2016). Maize is the most extensively grown and consumed cereal crop in Ghana, with output steadily increasing since 1965 (FAO, 2008). Smallholder farmers, often with limited resources, primarily cultivate maize under rain-fed conditions in Ghana (Darfour and Rosentrater, 2016).

Maize is a staple diet for many people worldwide, with no known toxins associated with the *genus Zea*, which includes maize (IFBC, 1990). In northern Ghana, maize has largely replaced sorghum and pearl millet as the traditional staple crops (SRID-MoFA, 2011). Maize serves as a key source of calories in Ghana, with an average annual production of 1.5 million MT claimed between MY 2007 and MY 2010, and an average yield of approximately 1.7 t/ha (Rondon and Ashitey, 2011; SRID-MoFA, 2011).

Maize production is widespread across Ghana, with the

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guinea savanna, forest savanna, and transition zone accounting for over 70% of the country's total production (Amanor-Boadu, 2012). The main maize-growing regions include the Northern, Brong-Ahafo, Ashanti, Central, and Eastern Regions (Amanor-Boadu, 2012). Per capita maize consumption in Ghana was estimated at 42.5 kg in 2000, with total consumption projected at 943,000 MT in 2006 (MoFA, 2000; SRID-MoFA, 2007). According to Gage et al. (2012), Ghana markets around a million metric tons of maize each year. Maize grain is consumed in various forms across traditions and countries, with a significant portion used as chicken feed. Only 20 to 25% of the maize sold undergoes industrial processing. Maize wholesale prices are influenced by factors such as the season and proximity to markets, with prices typically higher during the off-season (Amanor-Boadu, 2012).

In the agricultural production chain, maintaining quality is paramount, and the handling of produce after harvest plays a crucial role in setting standards and ensuring quality. Post-harvest treatment, including drying, storage, insect protection, and moisture control, is essential before processing. Quality control procedures are particularly important at this stage to ensure the marketing of competitive products. While conventional methods of produce preservation were once prevalent, most farmers in Ghana now recognize the advantages of contemporary post-harvest handling techniques (Darfour and Rosentrater, 2016).

According to Ragasa et al. (2014), maize accounts for 50% of Ghana's total grain production and experiences post-harvest losses ranging from 5 to 70%. Reducing post-harvest losses is crucial for increasing food security, as losses not only raise the price of produce but also decrease consumers' purchasing power, reduce farmers' income, and limit food availability (Opit, 2014). To enhance agricultural output, improve food quality, and reduce post-harvest losses, both private and public sector organizations have established Postharvest Service Centers in Ghana, where the volume of grain stored in warehouses is steadily increasing. However, the grains stored in these centers often lack protection against atmospheric air, insects, and other pests.

To mitigate post-harvest losses, stabilize prices, and create emergency grain reserves, the Ghanaian government intentionally established the National Food Buffer Stock Company (Rondon and Ashitey, 2011; World Bank, 2011). The maize weevil (*Sitophilus zeamais*) (*Mots*) (*Coleoptera: Curculionidae*) and the larger grain borer (LGB), (*Prostephanus truncatus*) (Horns) (*Coleoptera: Bostrichidae*) are among the 20 species of insect pests that can attack stored maize.

According to Vachanth et al. (2010), insect and mite infestation are responsible for 90% of post-harvest losses worldwide. *S. zeamais* alone consumes approximately 20% of the maize produced each year (Owusu-Akyaw, 1991).

Additionally, maize may become contaminated with insect remains, frass, and toxic compounds such as quinines (Kabir et al., 2011). Local farmers often store their maize grains under the bark of *Cedrela odorata* to protect against *S. zeamais* damage after harvest. In this context, a study is underway to investigate whether odorata leaves can aid in storage and contribute to food security by extending the shelf life of maize grains.

S. zeamais Motschulsky, commonly known as the maize weevil, is a significant international pest of stored cereal grains, capable of reducing the yield of stored maize by up to 30%, thereby posing a threat to food security (Akinbuluma, 2020).

This pest has the ability to penetrate intact grain kernels, infest them, and develop immature stages, depleting the grain of its nutritional and seed value, which may lead to its rejection in both local and global markets (Nwosu et al., 2015; Lale and Ofuya, 2001). Additionally, the presence of *S. zeamais* often leads to the appearance of secondary pests and fungi, further exacerbating the damage to grains (Torres et al., 2014; Trematerra et al., 2013).

The widespread use of artificial chemical insecticides and fumigants to control storage insects like *S. zeamais* has resulted in serious issues such as insecticide residue in food grains, pesticide resistance, and toxicity to non-target organisms (Yusof and Ho, 1992). In response to these challenges, there has been a shift towards more affordable and environmentally friendly methods of insect pest management, including the use of powdered plant components and extracts (Akinkurolere et al., 2006). Many of these plants are readily available in tropical regions, which is advantageous for resource-poor farmers who are primarily responsible for maize production in rural areas of Nigeria.

Cedrela odorata Linnaeus (Meliaceae) is native to South America and the West Indies, and its red, rot-resistant wood is valued for various applications including furniture and musical instrument construction (Zuchowski, 2005). Research has shown that *C. odorata* exhibits insect-repelling and toxicity properties. For instance, Omer et al. (2003) found that a concentration of 1.0% of *C. odorata* extract significantly stunted the growth of *Ostrinia nubilalis*, the European corn borer. Akinbuluma and Adeyemi (2017) reported that the ethanol extract of *C. odorata* caused approximately 95% mortality in *Callosobruchus maculatus* and reduced oviposition and adult emergence. Asogwa and Osisanya (2000) observed mortality rates of adult *S. zeamais* ranging from 12 to 20% and 6 to 16% upon topical application and residual action tests of leaf and wood extracts of *C. odorata*.

Despite the known effects of *C.odorata* volatile oils on various insects, including antifeedant, repellent, and toxic effects, further research is needed to identify and evaluate individual components for their efficacy against stored produce insects such as *S. zeamais*. This study aimed to examine the volatile oil components from the stem bark of *C. odorata L*. and their potential as a

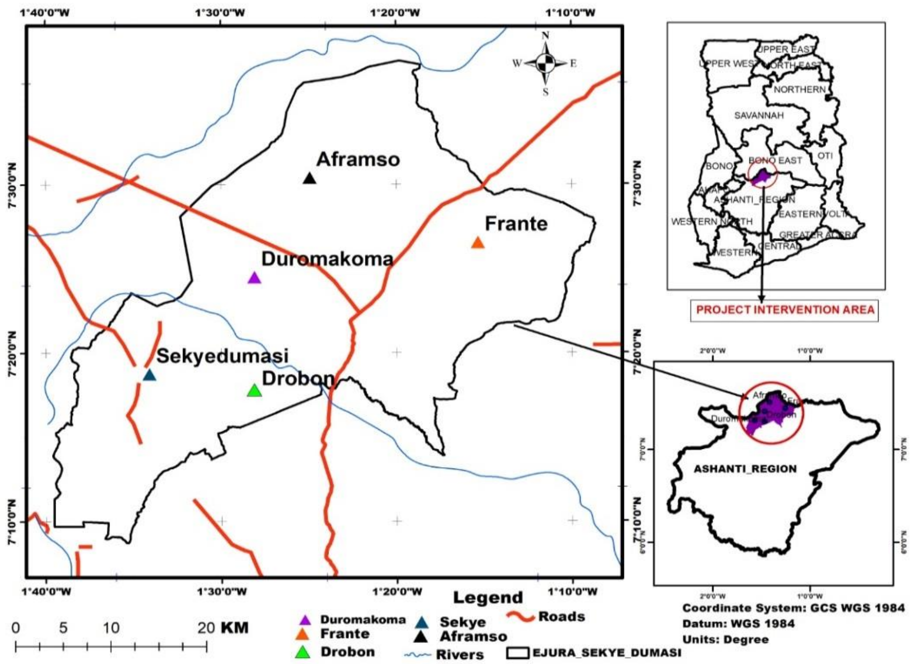

Figure 1. A map showing the study area.
Source: Author's construct (2021).

defense against *S. zeamais* in stored maize.

Research objective

The main objective of this research was to assess the potential of *C. odorata* leaves for enhancing the storability of maize to ensure food security.

MATERIALS AND METHODS

Scope of the study

The study was conducted in Sekyedumasi, located in the Ejura-Sekyedumasi Municipality of the Ashanti Region of Ghana. The Ejura-Skyedumase Municipality is a leading maize production area within the Ashanti Region and ranks among the top producers in Ghana. Figure 1 shows the map of the study area.

The Ejura-Sekyedumase Municipality was established following the decentralization program in 1988, carved out of the former Sekyere and Offinso districts. It was formally created by Legislative Instrument 1400, PNDC L.I 1400, on 29th November, 1988, and upgraded to municipal status by L.I 2098 on 6th February, 2012. The municipality is situated within Longitudes 1°5'W and 1°39'W and Latitudes 7°9'N and 7°36'N, covering an area of approximately 1,782.2 sq. km (690.781 sq. miles), making it the fifth largest district in the Ashanti Region, comprising about 7.3% of the region's total land area, with around one-third of its land area located in the Afram Plains. The capital, Ejura, is located 106 km from Kumasi, the regional capital.

The Ejura-Sekyedumasi Municipality lies in the transitional zones between the semi-deciduous forest and Guinea Savanna zones, experiencing a bimodal type of rainfall. The district has two distinct rainy seasons: the major season from April to August and the minor season from August to November. The dry season typically occurs between November and April, characterized by dry and dusty winds known as Harmattan, blown by the North-East trade winds across the district. The annual rainfall in the district ranges from 1,200 to 1,500 mm, with a highly erratic and unreliable pattern. Monthly average rainfall in the district is shown in Table 1. During the rainy periods, the district experiences very high humidity, with relative humidity reaching as high as 90% in June and as low as 55% in February. The Ejura-Sekyedumase Municipality is known to be the driest district in the Ashanti Region.

High temperatures ranging from a mean monthly of 21 to 30°C are generally experienced in the Ejura-Sekyedumase Municipality. The warmest months typically occur between January and April, while the coolest months are July and August. In April, the region experiences the "Easter wind," characterized by windstorms exceeding 4 knots (MSD, 1985), which can cause lodging to crops and trees and damage to buildings.

The soils in the district fall under the forest and savanna ochrosols groups. Forest ochrosols are primarily found in areas where cocoyam and plantain are grown. Other classifications include the soil under the Ejura-Amantin Association or Sene Soil Association. These soils are deep, light in color, well-aerated, and drained, with a moderate supply of organic matter and plant nutrients. Most soils have good water-holding capacity, are easy to work with, and are well adapted to mechanized cultivation. The soil ranges from sandy loam to clay and is suitable for growing a variety of crops such as maize, millet, groundnuts, cowpeas, guinea corn, yams, cassava, garden eggs, and tomatoes. The climate in the Ejura-Sekyedumase Municipality is highly suitable for cereal production, as well as for cashew, teak, vegetable, yam, cassava, livestock, and poultry production. The savanna vegetation in the area makes it particularly ideal for livestock production, with high potential for grasscutter and beekeeping activities. Additionally, the production cost for poultry is lower in the district compared to other areas due to the abundance of maize production.

Table 1. Background and socio-demographics of respondents.

Variable	Frequency	Percentage
Region		
Ashanti	50	100
District/municipality		
Ejura Sekyeredumasi	50	100
Community		
Aframso	14	28
Duromakoma	10	20
Sekyeredumasi	10	20
Drobon	6	12
Frante	10	20
Gender		
Male	37	74
Female	13	26
Age (years)		
20-29	1	2
30-39	4	8
40-49	25	50
>50	20	40
Marital status		
Married	33	66
Divorced	3	6
Single	7	14
Widowed	7	14
Educational background		
No Formal Education	9	18
MSLC/JHS	27	54
Secondary	9	18
Tertiary	5	10
Number of years in the maize cultivation (years)		
1-10	15	30
11-20	17	34
21-30	11	22
31- 40	6	12
>50	1	2
Size of maize farm (Acres)		
2	22	44
>2	28	56

Source: Field Survey (2023).

Data collection and analysis

Fifty farmers from five maize-producing communities were selected for the survey. A structured questionnaire was used to gather information on the use of *C. odorata*. Prior to the main survey, a pilot survey was conducted to pretest the questionnaires. The questionnaires were pretested with five maize farmers in the district. Farmers were individually visited in their farms based on

Table 2. Source of maize cultivation knowledge.

Source of knowledge	Frequency	Percentage
Ancestral/ family	32	64
Neighbor	3	6
Agriculture extension agent	15	30
Total	50	100

Source: Field Survey (2023).

Table 3. Source of chemical to spray your maize farm.

Source of chemical	Frequency	Percentage
No chemical	44	88
Purchased from any agro chemical shop	6	12
Total	50	100

Source: Field Survey (2023).

Table 4. Variety of maize cultivated.

Variety of maize	Frequency	Percentage
Abrohoma	16	32
Obaatanpa	28	56
Hybrid	6	12
Total	50	100

Source: Field Survey (2023).

recommendations from trusted sources, and data were collected by the research team.

To ensure the reliability and validity of the collected data, the questionnaires were edited into an appropriate format and subjected to analysis. Descriptive statistics were employed using the Statistical Package for Social Sciences (SPSS v20). This involved the use of frequencies, percentages, and means to describe both the data obtained and the socioeconomic characteristics of the maize farmers.

RESULTS

The field survey focused on maize predominant areas, randomly selecting fifty maize farmers from five communities in Ejura-Sekyedumasi, Ashanti region. Results from the survey showed that 28% of maize farmers were from Aframso community, followed by Duromakoma (20%), Sekyedumasi (20%), Frante (20%), and Drobon (12%) (Table 1).

Regarding gender, the survey revealed that 74% of respondents were male, while 26% were female (Table 1). The age distribution of farmers showed that 50% fell within the 40-49 age bracket, followed by above 50 years (40%), 30 to 39 years (8%), and 20 to 29 years (2%) (Table 1). In terms of educational background, the majority (54%) of maize farmers had completed Middle School/Junior High School (MSLC/JHS), followed by those with Senior Secondary education (18%), no formal education (18%), and tertiary education (10%) (Table 1). The survey also revealed that 34% of farmers had 11-20 years' experience in maize cultivation, 30% had 1 to 10 years, 22% had 21 to 30 years, 12% had 31 to 40 years, and 2% had more than 50 years (Table 1).

Sources of knowledge on maize cultivation included ancestral or family (64%), neighbors (6%), and Agricultural extension agents (30%) (Table 2). Additionally, 88% of farmers used chemicals sourced from agrochemical shops to control insect-pests, while 12% did not use any chemicals (Table 3). The study identified three main varieties of maize cultivated in the municipality: Obaatanpa (56%), Abrohoma (32%), and Hybrid (1%), which were further categorized into yellow and white maize (Table 4). Farmers in the municipality engage in maize production across two production seasons: major and minor.

Furthermore, the study found that 84% of maize farmers produce in both the major and minor seasons, while 16% cultivate maize only in the major season (Table 5). Maize farmers primarily depend on the sun to dry their maize after harvest before storage or sales, with

Table 5. Production cycles for maize.

Variable	Frequency	Percentage
Number of times of producing maize in a year		
One	8	16
Two	42	84
Seasonal production of maize in a year		
Major only	8	16
Both	42	84
Total	50	100

Source: Field Survey (2023).

Table 6. Drying of maize after Harvest.

Variable	Frequency	Percentage
Spread on mat	13	26
Spread on bare floor	9	18
Spread on tarpaulin	28	56
Total	50	100

Source: Field Survey (2023).

Table 7. Ascertaining the maturity index on the field.

Maturity index	Frequency	Percentage
When the cobs turn brown	49	98
When the cobs drop	1	2
Total	50	100

Source: Field Survey (2023).

Table 8. Number of days maize stay on the field after harvest before transportation.

Days	Frequency	Percentage
1-2	3	6
3-4	44	88
5-7	3	6
> 7	0	0
Total	50	100

Source: Field Survey (2023).

the majority (56%) spreading their maize grains on tarpaulin, followed by mat (26%), and bare floor (18%) (Table 6). Two maturity indices of maize were identified before harvest: cobs turning brown with yellow color and when cobs drop. The majority (98%) of maize farmers ascertain maturity when the cobs turn brown, while minorities (2%) wait for cobs to drop (Table 7).

Further findings revealed that some farmers keep their maize on the field for some time before transporting them. The majority (88%) of farmers keep their maize for 3-4 days, while smaller percentages keep them for 1 to 2 days (6%) and 5 to 6 days (6%) (Table 8). The major

Table 9. Major field pests that attack maize.

Field pests	Frequency	Percentage
Weevils	17	34
Termites	15	30
Fall Army worm	11	22
Termites and Fall Army worm	7	14
Total	50	100

Source: Field Survey (2023).

Table 10. Storage of maize before sales.

Variable	Frequency	Percentage
Storing with husk	5	10
Shelled and bagged	45	90
Total	50	100

Source: Field Survey (2023).

Table 11. Ascertaining the dryness of maize.

Ascertaining dryness	Frequency	Percentage
Visual assessment/ Color	3	6
By sound	47	94
Total	50	100

Source: Field Survey (2023).

Table 12. Duration of storage before sales of maize.

Variable	Frequency	Percentage
Longevity of storage before sales of maize		
Less than 1 month	4	8
Between 1-3 months	26	52
Between 3-6 months	20	40
Reason for storing dried maize		
For good market price	50	100

Source: Field Survey (2023).

pests on maize reported by farms are Fall Armyworms, weevils, and termites. The majority of farms (33%) reported attacks by weevils, followed by termites (30%), Fall Armyworms (22%), and a combination of Fall Armyworms and termites (14%) (Table 9).

Regarding maize storage, 90% of maize farmers shelled and bagged their harvested maize before storage, while 10% stored their maize unhusked (Table 10). Maize farmers typically stored their produce for 1 to 3 months (52%), 3 to 6 months (40%), and less than one month (8%) (Table 11). All farmers reported that maize had a good market price (Table 12).

Moreover, storage materials identified during the studies included Jute sacks, Hermetic bags, Fertilizer bags, and Nylon sacks. The majority (68%) of farmers stored their produce in Nylon sacks, followed by Jute sacks (16%), and Hermetic bags (10%). Unshelled maize was mainly stored in cribs or barns (6%). However,

Table 13. Storage material and for maize.

Materials	Frequency	Percentage
Nylon sacks	34	68
Jute sacks	8	16
Hermetic bag	5	10
Barn	3	6
Total	50	100

Source: Field Survey (2023).

Table 14. Parking of dried maize during storage.

Variable	Frequency	Percentage
Parking of dried maize during storage		
Concrete floor	27	54
Pallets	20	40
Barn	3	6
Storage facilities of keeping dried maize		
Store room	44	88
Living room	3	6
Barn	3	6

Source: Field Survey (2023).

shelled maize were kept in jute sacks, Nylon sacks, and Hermetic sacks, and stored in either a store room (88%) or a living room (6%) (Table 13).

According to the survey, maize farmers parked their harvested produce on concrete floors, pallets, and barns. The majority (54%) of farmers kept their produce on concrete pallets (40%), while a minority (6%) stored them in barns. These were further stored in living rooms, store rooms, and barns (Table 14).

Regarding treatment before storage, the survey found that the majority (70%) of farmers treated their maize before storage, while a minority (30%) did not. Out of the 70%, most farmers (62%) used botanical treatments, while a small percentage (8%) used chemicals. Among those who used treatments, the majority (52%) found botanical treatment (Cedrala Odorata) to be very effective, while a minority (10%) found it to be good. Additionally, 8% of farmers using chemicals (phostozin) responded that it was good (Table 15).

According to the survey, maize farmers used Phostozin and *C. Odorata* leaves as chemical and botanical treatments, respectively. The majority (62%) of maize farmers treated their maize with *C. Odorata* leaves, while a minority (8%) used Phostozin (Table 16). Regarding the duration of treatment, farmers reported treating their maize continuously for periods of 1 to 2 years, 3 to 4 years, and 5 to 6 years. Among those using Phostozin, the majority (6%) had continuously used it for 5 to 6 years, while a minority (2%) used it for 3 to 4 years. In contrast, among maize farmers using botanical treatments, 38% had continuously used it for 3 to 4 years, while 24% used it for 1 to 2 years (Table 17).

In terms of storage duration after treatment, maize farmers stored their treated produce for one month, two months, or three months before use. Among those using Phostozin, the majority (6%) stored their maize for two months, while a minority (2%) stored it for one month. Conversely, among those using botanicals, 26% stored their produce for three months, 22% for two months, and 16% for one month (Table 18).

Regarding the observed effects of treatments during storage, 8% of maize farmers using Phostozin reported side effects on maize, while 62% of those using botanicals reported no side effects. Additionally, 8% of maize farmers noted a change in taste when treated with Phostozin (Table 19).

In terms of application methods, maize farmers demonstrated how they applied the treatments. Phostozin was carefully wrapped in cotton wool or gauze and inserted into maize tied on a rope, while *C. Odorata* leaves were spread at the bottom, middle, and top of the maize in the sack (Table 20).

It was observed that the quantity of *C. Odorata* leaves used was estimated to be around 3 kg of fresh leaves for

Table 15. Treatment of maize during storage.

Variable	Frequency	Percentage
Treatment of maize before storage		
Yes	35	70
No	15	30
Kind of treatment		
Botanical	31	62
Chemical	4	8
No treatment	15	30
Its effectiveness		
Phostozin		
Good	4	8
C. Odorata		
Very good	26	52
Good	5	10

Source: Field Survey (2023).

Table 16. Name of chemical and botanical.

Type of treatment	Frequency	Percentage
Name of chemical and Botanical		
Phostozin	4	11.4
C. odorata leaves	31	88.6
Total	35	100

Source: Field Survey (2023).

Table 17. Duration of using the treatment to store maize.

Year	Frequency	Percentage
Phodtozin		
3-4	1	2
5-6	3	6
C. odorata		
1-2	12	24
3-4	19	38

Source: Field Survey (2023).

100 kg of maize.

DISCUSSION

From the gender perspective, out of the randomly selected fifty farmers, the survey revealed that approximately 74% were male, while 26% were female. This distribution underscores the male dominance in maize production, reflecting the labor-intensive nature of agriculture, which typically requires significant physical strength and manpower not readily available to women. Additionally, cultural and societal norms may contribute to the preference for male engagement in farming activities

Table 18. Duration treatments are kept in the maize before use.

Months	Frequency	Percentage
Phodtozin		
1	1	2
2	3	6
C. odorata		
1	8	16
2	10	22
3	13	26

Source: Field Survey (2023).

Table 19. Side effect of using the treatment.

Variable	Frequency	Percentage
Phodtozin		
Yes	4	8
C. odorata		
No	31	62
Observation using (Phostozin)		
Reduce the quality of maize	1	2
Change in taste	3	6

Source: Field Survey (2023).

Table 20. Application of the treatment.

How to apply	Frequency	Percentage
Chemical wrapped in cotton wool and inserted in maize pile	4	8
Spread the leaves at the bottom, middle and top of the maize in the sack.	31	62
Total	35	70

Source: Field Survey (2023).

over females. This trend aligns with broader patterns observed in agriculture, where men tend to dominate, as evidenced by previous studies (Owolade and Kayode, 2012). The prevalence of male participation in maize production in the study district reinforces the broader narrative of agriculture being a male-dominated occupation nationwide (Kongor et al., 2017). Males are often endowed with resources such as land and other assets by virtue of the inheritance system (Baffoe-Asare et al. 2013).

Moreover, regarding age distribution, 50% of the farmers fell within the age bracket of 40 to 49 years, followed by 40% above 50 years, 8% aged 30 to 39 years, and a minority (2%) aged 20 to 29 years. This suggests a lack of youth engagement in farming activities within the maize production communities, indicating that farming may not be perceived as attractive or appealing to the younger generation. This finding is consistent with the average age of farmers nationwide, which is reported to be 55 years according to MOFA (2022).

Furthermore, the majority of farmers had some level of formal education, indicating a basic level of literacy and numeracy skills that could aid in their farming activities. The average number of years the maize farmers had been engaged in maize production was 20 years, suggesting a considerable level of experience within the farming community.

Storage before sales

According to the survey conducted, the majority (52%) of maize farmers reported storing their produce for a period of 1 to 3 months before sales, while a minority (8%) stored it for less than one month before sales. Farmers attributed this variation in storage duration to the availability of a favorable market price for their produce.

Drying of maize after Harvest

According to the field data collected, the majority (56%) of maize farmers were observed spreading their maize grains on tarpaulin for drying in the sun, followed by the use of mats (20%) and drying directly on the bare floor (18%).

Additionally, a small percentage (6%) opted to store unshelled maize in cribs and barns. It was noted that drying maize on tarpaulin and mats appeared to be a more hygienic practice compared to drying directly on the bare floor, especially observed in roadside locations where dust and debris could contaminate the maize grains during the drying process.

Maize treatment in storage

According to the survey conducted, a portion of maize farmers treat their produce before storage while others do not. The majority (70%) of maize farmers reported treating their maize before storage, while the minority (30%) did not apply any treatment. Among those who treated their produce, the majority (62%) used botanical treatments, whereas a minority (8%) utilized chemical treatments. Farmers found botanical treatments to be easily applicable and highly effective. The preference for botanical treatments over chemical ones could be attributed to several factors, including the potential health risks associated with chemical usage, the environmental friendliness of botanical treatments, and the desire to reduce pest resistance over time (Ogendo et al., 2003). This finding is consistent with prior research on the use of *C. Odorata* leaves as a treatment in Africa, as reported by Effraim (1996). *C. Odorata* leaves were preferred due to their ready availability in the study area, eco-friendliness, and lower risk to human and livestock health compared to chemical alternatives. Additionally, farmers noted that *C. Odorata* leaves helped prevent pests from developing resistance to the treatment and offered additional benefits such as antifungal and antimicrobial effects. Moreover, most farmers agreed that there were no side effects associated with the use of *C. Odorata* leaves, as they resulted in fewer chemical residues on the maize, reducing the health risks for consumers.

Conclusion

From the study, it was found that the majority (70%) of maize farmers treat their maize before storage. This treatment is conducted to safeguard the maize from pests like weevils during storage, as well as to mitigate the risk of fungal growth and mycotoxin contamination. Among the farmers who apply treatment, the majority prefer using botanical treatments, while small percentages opt for chemical treatments. Specifically, the botanical treatment involves the use of *C. Odorata* leaves, while the chemical treatment involves the application of Phostozin. Most farmers utilize *C. Odorata* leaves for treatment, while minorities use Phostozin. Additionally, farmers generally agreed that there were no side effects associated with the use of Cedrela Odorata leaves for maize treatment.

Practical policy recommendations to guide investors and policymakers

Below are some key practical steps guide investors and policy makers to enhance the use of *C. Odorata* in the maize industry of Ghana?

1) Promotion of safe storage practices: Encourage farmers to adopt safer maize drying and storage practices, such as using tarpaulins or mats instead of bare floors. This can help reduce contamination and maintain maize quality.
2) Training on proper maize treatment: Provide training to farmers on the proper use of botanical treatments, such as *C. odorata* leaves, for maize storage. Emphasize the importance of following recommended dosage and application methods to ensure effectiveness and safety.
3) Promotion of eco-friendly pest control: Encourage farmers to use eco-friendly pest control methods, like botanical treatments, to reduce reliance on chemical pesticides. This can help protect the environment and human health.
4) Research on treatment efficacy: Support research to empirically determine the efficacy and safety of botanical treatments, such as *C. odorata* leaves, for maize storage. This can provide scientific evidence to support their use and address any concerns about their effectiveness.
5) Education on market price variations: Educate farmers on market price variations and the importance of proper storage duration for maximizing profits. This can help farmers make informed decisions about when to sell their maize.

Limitations of the study

Despite its insightful findings, the study on the use of *C. odorata* leaves for maize storage in the Ejura-Sekyedumasi municipality of Ghana has several limitations. These constraints, ranging from methodological issues to sample size and scope, need to be acknowledged to ensure a nuanced understanding of the research outcomes.

1) Seasonal variations: The study may not have captured seasonal variations in maize storage practices and pest infestations, which could affect the effectiveness of treatments.
2) Sample size and selection: The study sampled 50 farmers from five communities, which may not fully represent the diversity of practices and perspectives across all maize-producing areas. The sampling method (snowballing) might introduce bias.
3) Limited scope: The study focused primarily on the use of *C. odorata* leaves for maize storage, omitting other potential factors that could influence storage practices and outcomes.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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