# Evaluation of Quality Parameter Variations and Aflatoxin Contamination of Corn Seeds (*Zea mays*) Stored in Purdue Improved Crop Storage (PICS) Bags in North Central Province, Sri Lanka

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***Abstract***

*Post-harvest grain storage is crucial for maintaining the grain quality and ensuring food security. This study assesses the variation in quality parameters and aflatoxin contamination of corn seeds under two storage conditions. Treatments included Poly Propylene (PP) Woven bags ($T_0$), and Purdue Improved Crop Storage (PICS) bags ($T_1$), evaluated as a safer and cost-effective alternative. Dried corn seeds (Jet 999 variety, <13% moisture) were stored under warehouse conditions (Temperature: 31-37 $^0$C and Relative Humidity (RH): 55-70%) in Ihalagama, Kekirawa, North Central Province, Sri Lanka. A total number of 54 corn seed samples (27 per treatment) were evaluated to measure changes in moisture content, seed color, and aflatoxin contamination during an eight-week storage period in PICS and PP woven bags. A significant ($p < 0.05$) increase in aflatoxin content was observed in PP woven bag by the eighth week (2.87±0.25), whereas it aflatoxin levels remained lowest in PICS bag (0.90±0.10). Moisture content in $T_0$ (PP woven bags) significantly increased from 12.37% to 13.01%, compared to a smaller increase in $T_1$ (PICS bags) from 12.34% to 12.50%. No significant differences were observed in L, a, or b color values between treatments over time ($p > 0.05$). These findings confirm that PICS bags provide a chemical-free, cost-effective, and sustainable alternative for safer corn storage in Sri Lanka, with important implications for food safety, postharvest policy, and industry adoption.*

***Keywords- Aflatoxin, Corn, PICS bags, Moisture, Storage***

## I. INTRODUCTION

Corn (*Zea mays* L.) is the second most cultivated cereal crop in Sri Lanka and is widely used for poultry feed, food processing, and direct consumption. Postharvest losses of corn in Sri Lanka are estimated between 5%–13%. These losses are aggravated by the country's hot and humid climate, which promotes fungal infestation and aflatoxin contamination (Jayaratne & Abeyratne, 2020). Conventional storage practices, such as using polypropylene (PP) woven bags are insufficient, because they allow moisture and oxygen penetration, thereby accelerating microbial growth (Baributsa et al., 2010). Aflatoxin B1, produced by *Aspergillus spp*., is a carcinogen that threatens food safety and market acceptance (Williams et al., 2004). Therefore, sustainable storage alternatives are needed to mitigate aflatoxin contamination and ensure grain quality. The objectives of this study were to evaluate the quality parameter variation and aflatoxin contamination of corn stored in PICS bags in Sri Lanka, with a specific focus on assessing changes in aflatoxin levels in corn seeds stored in PICS bags compared to polypropylene woven (PP) bags over an eight-week storage period, and to monitor and compare the variation in moisture content of corn seeds under both storage methods.

## II. LITERATURE REVIEW

Globally, postharvest grain losses account for 10–30% of production, with tropical regions being most affected due to high humidity and poor storage infrastructure (FAO, 2011). In Sri Lanka, smallholder farmers primarily use PP woven bags. These bags are permeable to air and moisture, which increases the risk of fungal contamination and aflatoxin buildup (Baoua et al., 2012). Hermetic storage technologies such as

PICS bags have emerged as an effective, chemical-free solution. PICS bags, consisting of a triple-layer barrier, restrict oxygen flow and moisture ingress, thereby reducing fungal and insect proliferation (Murdock et al., 2012). Studies in West Africa and Asia demonstrated that PICS bags significantly reduce aflatoxin levels and extend storage life of maize, groundnut, cowpea and sorghum (Baoua et al., 2014; Sudini et al., 2015). However, limited research exists in the Sri Lankan context, where local climatic and storage conditions differ from other regions. This study addresses this gap by experimentally comparing PICS bags with conventional PP bags in preserving corn quality.

## III. PROBLEM SPECIFICATION

Sri Lanka faces persistent postharvest storage challenges. Significant quality and safety losses in maize are caused by moisture re-absorption and aflatoxin contamination. Chemical fumigants such as aluminum phosphide are commonly used but raise health and environmental concerns (Yadav et al., 2021). Despite international success, the effectiveness of PICS bags under Sri Lankan conditions has not been scientifically validated. Therefore, a knowledge gap exists regarding whether hermetic storage can reduce aflatoxin levels, stabilize moisture content, and maintain the physical quality of corn under local warehouse conditions.

## IV. METHODOLOGY

### *A. Experimental Design*

A completely randomized design (CRD) was used with two storage treatments and three replicates, to evaluate the effect of hermetic storage on corn seed quality over eight weeks. The two treatments were defined as follows:

Treatment 0 ($T_0$ – Control): Conventional storage using polypropylene woven (PP) bags

Treatment 1 ($T_1$ – Treatment): Hermetic storage using Purdue Improved Crop Storage (PICS) bags.

### *B. Sample Collection*

Dried corn seeds (Jet 999 variety) with initial moisture content below 13% were collected from Mahiyangana. They were stored under ambient warehouse conditions in Ihalagama, Kekirawa (31–37 °C; 55–70% RH). A total of 54 corn seed samples (27 per treatment) were evaluated. Three replicate bags per treatment were sampled weekly from Week 0 to Week 8. Subsamples were obtained using the coning and quartering method.

### *C. Analytical Procedures*

Analyses included moisture content determination by the oven-dry method (AOAC, 2016), aflatoxin detection using ELISA (Enzyme-Linked Immuno-sorbent Assay) based quantification, and seed color (L*, a*, b*) assessment with a portable chromameter. Data were analyzed using one-way ANOVA and Tukey's HSD test at a 5% significance level.

### *D. Aflatoxin Detection Using ELISA*

The quantification of total aflatoxins in corn samples was performed using Enzyme-Linked Immuno-sorbent Assay (ELISA) following the method described by the manufacturer's instructions and previous studies (R-Biopharm, 2018; Stroka et al., 2000). A representative sample was obtained using the cone-and-quarter method to ensure homogeneity. For powdered samples, sieving through a 20-mesh sieve was performed, while non-powdered samples were blended and sieved similarly. An aliquot of 4 g of ground sample was weighed into a clean blender cup, to which 20 mL of 80% methanol extraction solution was added, maintaining an extraction ratio of 1:5. The mixture was blended for 3 minutes, allowed to settle, and the supernatant was filtered through Whatman No. 1 filter paper to obtain the clear extract. For ELISA analysis, 100 µL of conjugate solution was pipetted into dilution wells, followed by the addition of 50 µL of each standard and sample extract. After thorough mixing, 100 µL was transferred into antibody-coated wells and incubated at room temperature for 15 minutes. The wells were washed five times with distilled water and tapped dry. Subsequently, 100 µL of substrate solution was added and incubated for 5 minutes at room temperature, after which 100 µL of stop solution was introduced. Absorbance was read within 7 minutes using an ELISA microplate reader (AFL 1–20 ppb setting). The total aflatoxin concentration was determined based on calibration curves generated from the standards, and results were expressed in µg/kg.

## V. RESULTS AND DISCUSSION

### A. *Aflatoxin Content*

Figure 01 shows the aflatoxin content of corn seeds stored in polypropylene woven bags ($T_0$) and PICS bags ($T_1$) over eight week storage period. The significant increase in aflatoxin levels observed in polypropylene woven bags ($T_0$) from 0.23 ± 0.06 µg/kg to 2.87 ± 0.25 µg/kg over 8 weeks can be attributed to their high permeability, which allows both moisture and oxygen to enter, creating favorable conditions for fungal growth and subsequent aflatoxin production. By contrast, PICS bags ($T_1$) showed only a slight increase (0.20 ± 0.10 µg/kg to 0.90 ± 0.10 µg/kg), as their hermetic triple-layer structure restricts oxygen diffusion and maintains stable internal conditions, thereby inhibiting mold proliferation and toxin accumulation. These results are consistent with Baoua et al. (2014), who demonstrated that maize and cowpea stored in PICS bags exhibited minimal aflatoxin development compared to conventional storage, and with Sudini et al. (2015), who reported that PICS bags significantly reduced aflatoxin contamination in groundnut by maintaining a low-oxygen environment. Together, these findings highlight that hermetic storage not only preserves grain quality but also serves as an effective strategy to mitigate aflatoxin contamination relative to conventional polypropylene bags.

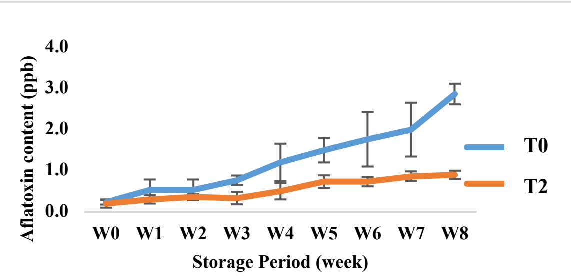


Figure 01: Aflatoxin content of corn seeds stored in polypropylene woven bags (T0) and PICS Bags (T1) over an 8-week storage period

### B. *Moisture Content*

Figure 02 shows that the moisture content with eight week storage period of treatments. In $T_0$ (polypropylene bags), the increase in moisture content from 12.37% at week 0 to 13.01% at week 8 can be explained by the porous nature of the packaging, which allows ambient humidity to penetrate and rehydrate the grains, creating conditions conducive to fungal growth and quality deterioration. In contrast, $T_1$ (PICS bags) maintained nearly constant moisture levels (12.34%–12.50%) due to its hermetic triple-layer design that prevents oxygen and moisture ingress, thereby stabilizing the internal environment. These findings are in line with Baoua et al. (2014), who reported stable moisture in maize and cowpea stored in PICS bags compared to significant increases in woven bags, and with Sudini et al. (2015), who found similar results for groundnut, demonstrating that hermetic storage effectively prevents rehydration, reduces aflatoxin risk, and extends storage life.

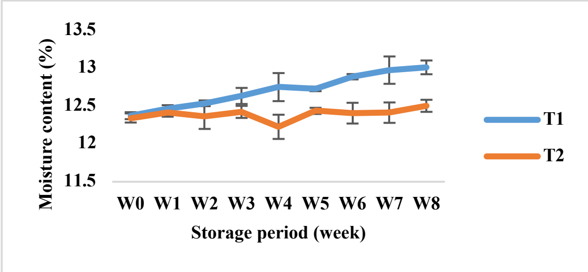


Figure 06: Moisture content with storage period

### C. *Color Parameters*

Only L values (lightness) differed significantly between treatments ($p < 0.05$), with PICS bags generally maintaining higher lightness. However, a and b values showed no significant differences ($p > 0.05$) across treatments or storage duration, suggesting minimal effect on kernel appearance during the 8-week period.

The results indicate that storage method and duration significantly influenced aflatoxin and moisture content, while color changes were minimal. PICS bags provided superior protection compared to PP woven bags, further supporting their use for safer corn storage under Sri Lankan conditions.

## VI. CONCLUSION

This study confirms that storage method and duration strongly affect the quality of corn (*Zea mays* L.), particularly moisture content and aflatoxin contamination. PICS bags maintained lower moisture content and aflatoxin contamination. The PICS bags maintained lower moisture levels and significantly reduced aflatoxin accumulation compared to polypropylene woven bags, while color parameters showed minimal change during the


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eight week storage. These results highlight PICS bags as a safer and more effective storage option under Sri Lankan conditions, provided corn is dried below 13% moisture before storage. Further research on longer durations, other grain types, and economic feasibility is recommended to support wider adoption of hermetic storage technologies.

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