Sahel Journal of Life Sciences FUDMA (SAJOLS)
June 2024 Vol. 2(2):24-29
ISSN: 3027-0456 (Print)
ISSN: 1595-5915(Online)
DOI: *https://doi.org/10.33003/sajols-2024-0202-04*

Review Article

Threat of *Fusarium pallidoroseum* on Post-Harvest Kola Nut (*Cola* spp.) in Nigeria: A Review

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ABSTRACT

Fusarium pallidoroseum poses a significant risk to Kola nut production, impacting both quality and quantity. This review explores the pressing threat of *Fusarium pallidoroseum* on post-harvest Kola nut (*Cola* spp.) in Nigeria. By identifying knowledge gaps and challenges in current management approaches, this review underscores the necessity for further research and collaboration among stakeholders to develop sustainable and effective control measures. Addressing the menace of *Fusarium pallidoroseum* on post-harvest Kola nut is crucial for safeguarding agricultural sustainability, promoting food security, and protecting the livelihoods of farmers in Nigeria.

Keywords: Agricultural sustainability, Economic implications, *Fusarium pallidoroseum*, Kola nut production, Management Strategy

Citation: Sulaimon, S.O., Ajadi, I., Mubarak, Y., Bello, H. B. and Ibrahim, K. (2024). Threat of *Fusarium pallidoroseum* on Post-Harvest Kola Nut (*Cola* spp.) in Nigeria: A Review. *Sahel Journal of Life Sciences FUDMA*, 2(2): 24-29. DOI: *https://doi.org/10.33003/sajols-2024-0202-04*

INTRODUCTION

Kola, a vital nut crop native to Africa, is part of the Malvaceae family and the Sterculioideae subfamily. It encompasses more than 140 species that grow in the tropical rainforests across the continent (Nyadanu *et al.,* 2020). According to Idris *et al*. (2017), approximately 40 Cola species are identified in West Africa, yet in Nigeria, the significant ones are *Cola acuminata and C. nitida*. In Nigeria's predominant languages, the Cola nut is referred to as Goro in Hausa, Oji in Igbo, and Obi in Yoruba (Olahan *et al.,* 2024). This evergreen plant can reach heights of up to 20 meters, with leaves measuring around 30 centimeters in length, and its star-shaped fruits typically contain between 2 to 6 lobes (Al Muqarrabun and Ahmat, 2015).

The term Cola is widely recognized throughout Africa due to the traditional utility of its seed, the kola nut. Across the continent, various parts of plants within this family, including the stem, seeds, nuts, roots, and leaves, are employed for diverse healthcare purposes, particularly in Nigeria (Ekalu and Habila, 2020). In African cultures, the kola nut is commonly chewed for its alkaloid properties, which alleviate sleepiness, quench thirst and hunger, rejuvenate energy levels, and serve as a mood booster (Agbor *et al.,* 2019; Dah-Nouvlessounon *et al.,* 2015). It is renowned as a performance enhancer, aids in weight loss, alleviates headaches, coughs, tuberculosis, diarrhea, bacterial infections, and contributes to cardiovascular wellness. Moreover, its stimulant properties make it a frequent ingredient in energy drinks (Adelusi *et al.,* 2020). The caffeine content in the nuts also functions as a bronchodilator, widening the bronchial air passages, thus making kola nuts a common remedy for conditions like whooping cough and asthma (Oduwaye *et al.,* 2018). Additionally, kola nut seeds have been historically used to alleviate vomiting in pregnant women (Saliu *et al.,* 2017; Atiba *et al.,* 2023).

In addition to its medicinal significance, kola holds cultural importance. Among the Igbos of Nigeria, kola nuts are employed to greet guests during meetings or communal events, as well as in marriage ceremonies, title ceremonies, oath-taking rituals, sacrifices, and various other occasions (Unya, 2021). Historically, they served as a form of currency in Mali and Senegal, and even today, in certain communities, kola nuts continue to play a role in negotiating bride prices or sealing business agreements (Onaolapo and Onaolapo, 2019).

The occurrence of diseases during storage poses a significant post-harvest challenge for Kola nut traders and farmers, a problem they strive to address (Oladigbolu *et al.,* 2023). Predominantly, molds from genera such as *Aspergillus*, *Penicillium*, and *Fusarium* are commonly associated with contamination of kola nuts during post-harvest processing (Aduama-Larbi *et al.,* 2022). In West Africa, notable post-harvest pathogens affecting the nuts include *Lasiodiplodia theobromae* and *Fusarium pallidoroseum* (Agbeniyi, 2004; Idris *et al.,* 2017; Oladigbolu *et al.,* 2023). Beyond the economic losses incurred due to these fungi, they also produce mycotoxins, under certain condition, harmful to both humans and animals. Certain *Fusarium* species generate mycotoxins like fumonisin B1 and B2, trichothecenes, and zearalenone, which can induce diseases in both humans and animals (Senna and Lathrop, 2017).

Pests and diseases affecting stored kola nuts in Nigeria

The prevalence of diseases affecting kola nuts during storage poses a significant challenge for farmers and traders in West Africa. Among the notable post-harvest pathogens in the region are *Lasiodiplodia theobromae* and *Fusarium pallidoroseum* (Agbeniyi, 2004). These fungi can also trigger latent infections on nuts in the field when harvesting is delayed, subsequently leading to rot during storage (Adeniyi *et al.,* 2023). *Fusarium pallidoroseum* is identified as the primary pathogen responsible for causing brown rot disease in kola nuts.

The primary insect pests encountered during post-harvest storage include *Balanogastris kolae, Sophrorhinus spp, Characomasticti grapta*, and *Phosphorous virescens*. In Nigeria, the most severe ones are the kola weevils *Balanogastris kolae* and *Sophrorhinus* spp. (Ndubuaku *et al.,* 2015).

***Fusarium pallidoroseum* as a significant economic pathogen affecting kola nut storage**

Fusarium pallidoroseum is widely distributed across the globe, thriving in diverse climates and geographical regions. Its prevalence poses a considerable concern for agricultural and storage management practices worldwide. *Fusarium pallidoroseum,* a polyphagous pathogen, does not target specific hosts or plant families, making its control more complex. It infects a wide range of plant species, including fruits, vegetables, grains, and ornamental plants. This adaptability enables it to cause storage rot in numerous agricultural products such as corn, cotton, soybeans, and kola nuts.

In the case of kola nuts, *Fusarium pallidoroseum* can invade them during storage, particularly in environments with high humidity and poor ventilation. The fungus penetrates through wounds or natural openings in the nut's shell, spreading throughout the internal tissues and causing decay. Kola nut storage rot caused by *Fusarium pallidoroseum* manifests as discoloration, softening, mold formation, and the release of unpleasant odors. Infected nuts quickly decay with limited further spread, but nearby nuts often become contaminated by fungal spores. This spore transfer from decayed nuts to healthy ones, referred to as "soilage," poses a major economic issue, particularly in areas where fresh market produce is grown (Oladigbolu *et al.,* 2023). Contaminated nuts cannot be sold or consumed, leading to financial losses for everyone involved in the supply chain.

Agbeniyi *et al*. (2013) emphasized a significant post-harvest challenge concerning kola nuts, specifically storage rot caused by *F. pallidoroseum*. Instances of severe outbreaks of storage rot, reaching levels as high as 50% per tonne, have been documented. Such outbreaks can result in a shortened storage lifespan and reduced market sales (Ihejirika *et al.,* 2015). Given the absence of recommended fungicides for post-harvest use on kola nuts in Africa, it is crucial to explore alternative options that are safe for human consumption and effective in managing the disease. Evaluating the ability of these alternatives to prevent or reduce *L*. *theobromae* on kola nuts during storage is paramount.

Controlling the development of kola storage rot caused by *F. pallidoroseum*

According to surveys by Uwagboe (2010), Azeez (2015), and Ndubuaku *et al*. (2015), many farmers frequently use DDT and other prohibited pesticides like organochlorine and chlordane on their farms and for storing kola nuts. The surveys revealed several reasons for this practice. Farmers cited a lack of sufficient awareness about the ban on these insecticides, their low cost, ease of access in the market, and a lack of knowledge about the harmful effects of these banned substances (Uwagboe, 2010; Azeez, 2015).

The challenges posed by kola nut diseases during storage significantly impact the already modest yields achieved by kola nut farmers. Sosan and Oyekunle (2017) detected organochlorine residues in kola nuts collected from various states in Nigeria, including Osun. Similarly, Aikpokpodion *et al*. (2013) found traces of two organochlorine pesticides, heptachlor and endosulfan, in kola nut samples from states such as Oyo, Osun, and Ogun. However, they did not assess the potential health risks associated with consuming these contaminated kola nuts. Chlordane is another commonly used pesticide in this context. Its prohibition stemmed from concerns about potential exposure to its hazards through consuming food contaminated with it. Aldrich and Holmes (1969) documented an incident involving the ingestion of chlordane by a 4-year-old girl, resulting in clonic convulsions, impaired coordination, and heightened excitability. Similarly, Lehman (1952) conducted research involving the administration of chlordane to rats in their diet at concentrations of 2.5, 25, or 75 ppm for 104 weeks. Significant effects were observed at 75 ppm, including reduced appetite, slowed growth, and unspecified signs of toxicity. Liver abnormalities were noted at concentrations of 25 and 2.5 ppm. Furthermore, exposure to chlordane compounds and their metabolites may be associated with an increased risk of developing seminoma.

While the pesticides employed are recommended, the significant reliance on chemical pest and disease control among traders is worrisome, especially considering that most nuts are consumed raw. Research indicates that all kola nut traders using chemicals to manage pests and diseases purchase them from vendors at the marketplace. This situation raises concerns about the risks associated with pesticides, as traders with limited education might unintentionally buy expired or counterfeit products, which could pose serious threats to human health (Oladigbolu *et al.,* 2023).

Prospects for safer management of *F. pallidoroseum*-induced storage disease in Nigerian kola nuts

Currently, farmers primarily rely on periodic removal of diseased nuts throughout the storage period to safeguard kola nuts, as the use of chemical fungicides is discouraged due to potential health risks to consumers. Natural plant fungicides, which are bioactive compounds derived from plants, are increasingly being explored for controlling fungal pathogens. This exploration of plant-derived bioactive compounds is crucial for effectively managing the storage of kola nuts. Integrating Integrated Disease Management into the control measures against *F. pallidoroseum* in kola nut storage is essential. Utilizing plant bio-extracts for controlling kola nut storage diseases provides a practical solution to the challenges faced by kola farmers and traders during nut storage. Furthermore, this approach is seen as a proactive measure addressing public concerns regarding the negative impacts of pesticide usage on human health and the environment. Research conducted by Senna and Lathrop (2017) revealed a safer alternative for managing *F. pallidoroseum* by demonstrating the effectiveness of bacterial isolates against this fungus. Similarly, Kumawat *et al*. (2013) evaluated the effectiveness of various plant extracts and biocontrol agents against *F. pallidoroseum* at different concentrations. Regardless of concentration, garlic clove extract exhibited the highest efficacy in suppressing mycelial growth (89.16%), followed closely by NSKE (83.16%) and bitter melon (62.75%) after 10 days of incubation. *Trichoderma harzianum* emerged as the most effective biocontrol agent in inhibiting the fungus's mycelial growth, displaying a significant inhibition zone of 7.87 mm in the dual culture plate method. Following closely were *T. viride* with 7.40 mm and *Aspergillus niger* with 6.0 mm.

Gulzar *et al*. (2009) evaluated aqueous extracts from locally sourced plants, including *Zingiber officinale Rose., Conium maculatum L., Salix alba L., Datura stramonium L., Coriandrum sativum L., Juglans regia L., Allium sativum L., Urtica dioica L., Morus alba L.,* and *Matricaria chamomile L.,* against *F. pallidoroseum*. They found that all extracts demonstrated inhibitory effects on both the mycelial growth and conidial germination of the pathogen. Among these, the *M. chamomile* extract exhibited the

highest inhibition of mycelial growth at 84.20 mm^2, followed by *A. sativum* and *D. stramonium* extracts with inhibition areas measuring 81.79 mm^2 and 70.33 mm^2, respectively. Additionally, the *A. sativum* extract inhibited conidial germination by 90.57%, followed by *M. chamomile* and *D. stramonium* with inhibition percentages of 89.26% and 78.90%, respectively.

Similarly, Gulzar *et al*. (2013) investigated the effectiveness of ethanolic extracts from the same locally sourced plants against both the mycelial growth and conidial germination of *F. pallidoroseum*. They observed inhibitory effects on both parameters with all the extracts. The *A. sativum* extract demonstrated the highest inhibition of mycelial growth, measuring 78.49 mm^2, followed by *M. chamomile* (75.87 mm^2), *C. maculatum* (74.09 mm^2), and *D. stramonium* (73.10 mm^2). Furthermore, the extracts of *D. stramonium* and *A. sativum* inhibited conidial germination by 93.07% and 90.76%, respectively, while *C. maculatum* and *D. stramonium* showed inhibition percentages of 85.86% and 81.72%, respectively.

Further research is warranted on various plant extracts and their combinations to ascertain their effectiveness, thereby providing farmers with a wider array of options to manage the adverse effects of *F. pallidoroseum* on kola nuts.

CONCLUSION

The challenge presented by *Fusarium pallidoroseum* on post-harvest kola nuts in Nigeria is a multifaceted and urgent problem that demands coordinated action from all involved parties. Through the adoption of proactive mitigation measures and fostering cooperation, Nigeria can reduce economic losses, safeguard consumer health, and ensure the enduring viability of kola nut production. Effectively tackling this challenge is crucial for preserving Nigeria's cultural heritage, sustaining rural livelihoods, and enhancing food security across the nation.

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