A REVIEW: PREVALENCE OF MYCOTOXINS IN DRIED FISH AND FOOD SAFETY IN NIGERIA

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ABSTRACT

Mycotoxins are toxic secondary metabolites produced by molds. Which represent a growing concern in the field of food safety. This study delves into the prevalence of mycotoxins in dried fish and its far-reaching implications. The research explores the extent of mycotoxin contamination, its health and economic consequences, and recommended strategies for mitigation. Key findings indicated the presence of mycotoxins in dried fish, these pose significant health risks to consumers. The study also highlights their impact on the quality and marketability of dried fish and the challenges this presents to the food industry. Emerging trends, including the influence of climate change, the discovery of new mycotoxins, and the need for global surveillance and harmonization of regulations, further complicate the landscape of mycotoxin contamination. Small holder farming, biomarker development, and sustainable mitigation strategies stand out as ongoing challenges and research needs. Regulatory harmonization and enhanced public awareness are critical to addressing these challenges. The implications for food safety are profound, affecting trade, consumer confidence, and the cost of control measures. Compliance with mycotoxin regulations and standards is essential, while a multifaceted approach is required to tackle this complex issue. The study recommends enhanced monitoring and surveillance, public awareness and education campaigns, regulatory harmonization, support for small holder farmers, biomarker development, and sustainable mitigation strategies. Collaborative efforts among governments, the food industry, research institutions, and consumers are crucial to ensuring the safety and security of the global food supply chain. These recommendations provide a roadmap for mitigating mycotoxin contamination and enhancing food safety for consumers worldwide.

Keywords: Fish, Food safety, Fungi, Mycotoxin and Mitigation.

INTRODUCTION

Dried fish has been a staple food in diets across various cultures for centuries, valued for its long shelf life and convenience (Naylor *et al.*, 2021). However, recent concerns have arisen regarding the presence of mycotoxins in dried fish and its potential impact on food safety. Mycotoxins are toxic secondary metabolites produced by certain fungi, and their contamination in food is a global issue (Imran *et al.*, 2020). Mycotoxins are secondary metabolites (substances manufactured by plants that make them competitive in their own environment) of molds that can contaminate a wide range of agricultural products, including grains, nuts, and dried fish. These toxic compounds, including aflatoxins, ochratoxins, and fumonisins, have been linked to adverse health effects, such as liver damage, kidney problems, and even carcinogenicity (Oliveira & Vasconcelos, 2020). Consequently, understanding the extent of mycotoxin contamination in dried fish and implementing strategies to mitigate this risk is essential for ensuring food safety.

Dried fish, a staple in many traditional diets, plays a crucial role in providing a source of protein and essential nutrients in regions where fresh seafood is not readily available (Kari *et al.*, 2022). Its history traces back centuries, and it remains an integral part of the culinary heritage of numerous cultures worldwide. However, concerns have arisen regarding the safety of dried fish products due to the potential presence of mycotoxins, toxic compounds produced by molds (Fitri *et al.*, 2022). Historically, drying fish was a means of preserving this highly perishable food source, relying on sun drying or smoking methods. These traditional practices, while effective at extending the shelf life of fish, did not always address the risks of mold growth and mycotoxin contamination. Dried fish is particularly susceptible to mycotoxin contamination due to its moisture content and the conditions in which it is traditionally prepared and stored (Fitri *et al.*, 2022). In regions with high humidity and inadequate drying facilities, dried fish could become a breeding ground for molds, increasing the likelihood of mycotoxin production (Abdelmotilib *et al.*, 2021). Additionally, the lack of standardized monitoring and testing practices can contribute to mycotoxin contamination going undetected.

As global trade continues to expand, dried fish products are increasingly crossing borders, necessitating rigorous food safety measures to protect consumers (Barrett, 2021). Understanding the prevalence of mycotoxins in dried fish, along with the factors contributing to their presence, is crucial for addressing this emerging food safety challenge. The prevalence of mycotoxins in dried fish presents a multifaceted challenge to both food safety and the preservation of cultural dietary traditions. Despite the significant role dried fish plays in the diets of communities around the world, there exists a lack of comprehensive research and data on the extent and nature of mycotoxin contamination in dried fish products. The consumption of dried fish is deeply ingrained in the culinary traditions of many cultures, serving as a valuable source of protein and essential nutrients. However, this cherished tradition is increasingly marred by the potential presence of mycotoxins, toxic compounds produced by molds, in dried fish products.

Mycotoxins pose a significant threat to public health when present in food products. They are known to cause various health problems, including liver and kidney damage, immune system suppression, and cancer. Investigating the prevalence of mycotoxins in dried fish is crucial, as this widely consumed food item can potentially expose a large number of people to these health risks. Dried fish production is a vital economic activity in many regions, supporting livelihoods and contributing to local economies (Berenji *et al.*, 2021). Ensuring the safety of dried fish products is essential to maintain consumer confidence and protect the economic interests of those involved in the industry.

The significance of this study lies in its potential to shed light on the prevalence and levels of mycotoxin contamination in dried fish products. Understanding the extent of this issue is crucial due to the harmful health effects associated with mycotoxin ingestion, ranging from acute toxicity to chronic health problems (Frisvad *et al.*, 2019). Furthermore, the presence of mycotoxins in dried fish can have economic implications, affecting trade and consumer confidence in these products (FAO, 2018).

Mycotoxins are toxic secondary metabolites produced by various species of molds (fungi) that can contaminate a wide range of agricultural products, including grains, nuts, and dried fish (Cinar & Onbaşı, 2019). These compounds pose a significant threat to human and animal health due to their potential to cause a variety of adverse effects, including acute and chronic illnesses. Several types of mycotoxins have been identified, each produced by different fungal species. Some of the most common mycotoxins include: Aflatoxins, Ochratoxins, Fumonisins, Zearalenone, Deoxynivalenol (DON), and Patulin, T-2 Toxin. Mycotoxins are often associated with mold growth in agricultural commodities, especially when conditions favor fungal proliferation. Several factors contribute to mycotoxin contamination in food: Environmental Factors, Storage and Handling, Crop Conditions, Fungal Species.

Overview of Dried Fish

Dried fish is a traditional method of preserving fish that has been practiced for centuries in various cultures around the world (Akintola & Fakoya, 2017). This preservation technique involves removing moisture from fresh fish through natural processes like sun drying or smoking. The resulting dried fish products are known for their extended shelf life, concentrated flavors, and nutritional benefits.

Production Process

Preparation, Salting, Drying, Packaging.

Types of Dried Fish

Sun-dried fish, smoked dried fish, and salted dried fish.

Nutritional Benefits

Dried fish retains much of its nutritional value, including protein, vitamins, and minerals, making it a nutritious food source. It is often rich in omega-3 fatty acids, which have numerous health benefits (Byrd *et al.*, 2021).

Challenges and Food Safety

Despite its advantages, the drying process can sometimes be susceptible to contamination by molds and mycotoxins, which pose food safety risks. Proper drying techniques, storage conditions, and quality control measures are essential to minimize these risks.

Global Consumption Trends of Dried Fish

Dried fish is consumed globally, and its popularity varies across regions due to cultural preferences, availability of seafood resources, and dietary traditions. Understanding global consumption trends can provide insights into the importance of dried fish in different parts of the world; Asia-Pacific Region, Africa, Europe and North America and South America.

Importance of Dried Fish in Diets

Dried fish holds significant importance in diets worldwide, offering a range of nutritional and practical benefits. Dried fish is a rich source of protein, making it a valuable dietary component, especially in regions where access to fresh meat or seafood is limited (Rasul et al., 2021). The protein content in dried fish helps meet daily protein requirements contributing to overall health and growth. Drying preserves essential nutrients, including vitamins and minerals, making dried fish a nutritious option. Retaining these nutrients ensures that consumers receive a valuable source of vitamins and minerals, such as vitamin B12 and selenium (Kipper & Sulg, 2016).

Dried fish has an extended shelf life due to its low moisture content, making it an excellent choice for long-term storage (Kanatt, *et al.*, 2020). This long shelf life is especially advantageous in areas with unreliable refrigeration or limited access to fresh foods. Dried fish is lightweight and easy to transport, making it suitable for communities with nomadic lifestyles or limited access to markets (Kruijssen *et al.*, 2020). Its portability allows for consumption in various settings, including remote or outdoor locations. Dried fish often holds cultural significance in many culinary traditions. It is used to add unique flavors to dishes and preserve cultural heritage through traditional recipes (Gopakumar & Arunlal, 2016). Dried fish can be used in various culinary applications, from soups and stews to stir-fries and curries. Its versatility in cooking allows for the creation of a wide range of flavorful and satisfying dishes (Morgan, *et al.*, 2006).

In some regions, dried fish production supports sustainable fishing practices and the livelihoods of coastal communities. It can contribute to the conservation of fishery resources when managed responsibly (Su *et al.*, 2020).

Factors Contributing to Contamination of Dried Fish

Contamination of dried fish can occur at various stages of production, processing, and storage. Understanding the factors contributing to this contamination is essential for ensuring food safety. Poor hygiene and sanitation practices during fish handling, drying, and storage can introduce contaminants. Inadequate cleaning of drying racks, equipment, and processing areas can lead to microbial contamination (Mwasulama *et al.*, 2021). Environmental factors such as high humidity and warm temperatures can promote mold growth on drying fish. Unprotected drying under direct sunlight without proper shelter can also lead to microbial contamination (FAO, 2013). Incomplete drying of fish can leave moisture content higher than desired, creating conditions for microbial growth and spoilage. Properly drying fish to the required moisture level is crucial for preventing contamination (Wagacha & Muthomi, 2008). Improper storage conditions, such as exposure to moisture, heat, or pests, can compromise the quality and safety of dried fish. Adequate packaging and storage facilities are essential to prevent contamination during storage (Marriott *et al.*, 2018).

Insects, including flies and beetles, can lay eggs on drying fish, leading to larval infestation. Infested fish can harbor harmful microorganisms introduced by insects (Barkai-Golan, 2008). Cross-contamination can occur when dried fish comes into contact with contaminated surfaces or equipment (Carrasco *et al.*, 2012). Separation of processing and drying areas from areas with potential contaminants is essential. The presence of molds (mycoflora) on drying fish can lead to mycotoxin contamination (Adebayo-Tayo *et al.*, 2008). Mycotoxins, such as aflatoxins, can be produced by molds and pose health risks. The choice of drying methods, including sun drying and smoking, can impact the safety of dried fish (Belton *et al.*, 2022). Proper smoking practices, such as using non-contaminated smoke sources, are crucial.

Diseases in Dried Fish

Scombroid Poisoning, Botulism, Anisakiasis, Bacterial Infections, Histamine Poisoning.

Mitigation and Prevention Strategies

Good Manufacturing Practices (GMP) for Dried Fish, Good Manufacturing Practices (GMP) are a set of guidelines and principles that ensure the production of safe and high-quality food products (Mtewa *et al.*, 2020). These practices are essential in the dried fish industry to prevent contamination, maintain product integrity, and protect the health of consumers.

Proper hygiene and sanitation practices are fundamental in preventing contamination. Workers should follow strict hygiene rules, and facilities and equipment should be regularly cleaned and disinfected (FAO, 2013).

Employees involved in dried fish processing should receive training on GMP principles, including proper handling, storage, and hygiene practices. Well-trained personnel are more likely to follow safe practices (Okpala & Korzeniowska, 2023). Facilities for drying and processing fish should be designed to minimize environmental contamination. Adequate airflow and protection from pests are important considerations (Coronel *et al.*, 2022). Quality control measures should be in place to identify and reject contaminated or substandard fish. Regular inspections can help ensure that dried fish products meet quality and safety standards (Hoque & Myrland, 2022). Drying and storage facilities should maintain appropriate temperature, humidity, and airflow conditions to prevent mycotoxin growth and spoilage. Dried fish should be stored in moisture-proof packaging to maintain quality (FAO, 2013).

Effective pest control programs should be implemented to prevent infestations that can contaminate the product. This includes regular monitoring and the use of safe pest control methods (Hervet & Morrison III, 2021). Hazard Analysis and Critical Control Points (HACCP) Stages include; Hazard Identification, Critical Control Points (CCPs), Establishing Critical Limits, Corrective Actions, Documentation and Record Keeping, Verification and Validation

Storage and Handling Best Practices for Dried Fish

Proper storage and handling of dried fish are crucial to maintain its quality, prevent spoilage, and ensure food safety. Here are some key guidelines for the storage and handling of dried fish: Dried fish should be stored in a cool, dry, and well-ventilated area. Proper storage conditions help prevent moisture absorption, which can lead to mold growth and mycotoxin production (FAO, 2013).

Use airtight containers or vacuum-sealed bags to protect dried fish from air and moisture, which can cause rancidity and loss of quality (FAO, 2013). Protect dried fish from pests by storing it in pest-resistant containers and maintaining a clean storage environment (FAO, 2013). Dried fish should be protected from direct sunlight, as UV radiation can deteriorate the quality of the product (Chiozzi *et al.*, 2022). Label containers with the date of drying and storage to monitor freshness and safety (FAO, 2013). Maintain an optimal relative humidity level (usually below 65%) to prevent mold and mycotoxin formation (Viviane *et al.*, 2021).

Wash hands thoroughly with soap and water before handling dried fish to prevent contamination (Sobuj *et al.*, 2022). Ensure that utensils and containers used for dried fish are clean and sanitized to prevent bacterial growth (Viji *et al.*, 2022). Implement pest control measures in storage areas to avoid infestations and protect the product from contamination (FAO, 2013). Periodically inspect stored dried fish for signs of mold, moisture, or pests, and remove any affected products (Jeyakumari, 2022). Store dried fish away from strong odors and contaminants that can affect its flavor (Zhang *et al.*, 2021).

Implications for Food Safety

Mycotoxin contamination has significant implications for food safety: Mycotoxins are toxic compounds that can cause acute and chronic health issues when ingested. These health risks range from gastrointestinal problems to more severe conditions, including liver and kidney damage, immunosuppression, and even cancer (Chadban *et al.*, 2020).

Mycotoxin contamination can result in significant economic losses. It affects the market value of crops, leads to food waste, and necessitates costly control and mitigation measures (Kagwathi *et al.*, 2023). Mycotoxin-contaminated food products can erode consumer confidence in the safety and quality of the food supply. This can have long-lasting effects on food industries and the reputation of brands (Gbashi *et al.*, 2021).

Stringent mycotoxin regulations in international trade can create trade barriers. Compliance with maximum permissible mycotoxin levels is necessary to access global markets (Mukhtar *et al.*, 2023). Mycotoxin contamination can undermine food security by reducing the availability and safety of staple foods, particularly in regions heavily reliant on crops vulnerable to mycotoxin production (Godde *et al.*, 2021).

Preventive Measures

Food safety systems must incorporate preventive measures to control mycotoxin contamination. This includes effective agricultural practices, post-harvest handling, storage, and processing techniques (Nada *et al.*, 2022). Consumer and industry education is crucial to raise awareness about mycotoxin risks. Proper food handling, storage, and preparation are essential to reduce exposure (Jeebhay *et al.*, 2019).

CONCLUSION

The study on the prevalence of mycotoxins in dried fish and its implications for food safety has yielded several important findings and insights. This research has shed light on the following key points: The study has confirmed that dried fish products are susceptible to mycotoxin contamination, a concern that is of increasing significance in the context of global food safety. The presence of mycotoxins in dried fish underscores the potential health risks associated with the consumption of contaminated products. These risks include both acute and chronic health issues, making the need for mycotoxin control paramount.

The research has identified various factors contributing to mycotoxin contamination in dried fish, including storage conditions, climate, and handling practices. Understanding these factors is crucial in developing effective mitigation strategies. The maximum levels for mycotoxins in food are very low due to their severe toxicity. For example, the maximum levels for aflatoxins set by the Codex in various nuts, grains, dried figs and milk are in the range of 0.5 to 15 µg/kg (a µg is one billionth of a kilogram).

RECOMMENDATIONS

Based on the findings and conclusions of a study on the prevalence of mycotoxins in dried fish and their implications for food safety, the following recommendations can be made: Establish comprehensive monitoring and surveillance systems to regularly assess mycotoxin levels in dried fish. This includes both routine testing of products in the market and field surveys to identify contamination hotspots. Invest in further research to better understand the factors influencing mycotoxin contamination in dried fish. This research should also focus on the development of innovative detection methods, mitigation strategies, and sustainable approaches.

Promote education and awareness among producers, processors, and consumers regarding the risks of mycotoxin contamination and the best practices for prevention and control. Work towards harmonizing mycotoxin regulations and standards across countries and regions to facilitate international trade while ensuring food safety. This can involve the alignment of acceptable mycotoxin levels and maximum residue limits.

Promote the adoption of Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) in the production, processing, and storage of dried fish. These practices can significantly reduce the risk of mycotoxin contamination. Continue research on biomarkers for mycotoxin exposure in humans and animals. Developing reliable biomarkers can aid in early risk assessment and intervention. Investigate and implement sustainable methods for mycotoxin control in dried fish production, including the use of biocontrol agents, mycotoxin binders, and genetic resistance.

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