Minireview Article

A Brief Review: Occurrence of Aflatoxins in raw and parboiled rice in Sri Lankan market

ABSTRACT

Contamination of both raw and parboiled rice in Sri Lankan market with Aflatoxins is a crucial health hazard as Aflatoxins are carcinogenic and immune suppressive. Parboiled rice is found to be more vulnerable for the occurrence of Aflatoxins due to the quality changes happens within the kernel during the process of parboiling. Starch inside the parboiled rice kernel appears to be a better substrate for mould growth and high moisture levels are often available within parboiled rice kernels due to improper drying. Out of the two types of parboiling practiced within Sri Lanka cottage parboiling remains safer with compared to commercial level parboiling. However, Sri Lankans has a potential risk of being exposed to Aflatoxins as a result of consuming both raw and parboiled rice contaminated with Aflatoxins.

Key words: Aflatoxins; Rice; Parboiling; Sri Lanka.

1. INTRODUCTION

Aflatoxins are basically identified as the secondary metabolites of fungi in genus Aspergillus such as A. *flavus*, A. *parasiticus*, A. *nomius* and A. *astellatus.* Aflatoxin B1, Aflatoxin B2, Aflatoxin G1, Aflatoxin G2, Aflatoxin M1 and Aflatoxin M2 are the types of Aflatoxins produced by these filamentous fungi while aflatoxin B1 appears as the most hazardous and classified under group 1 carcinogens by the International Agency for Research on Cancer (IARC). Aflatoxins are widely available in variety of food commodities including cereals such as rice, corn, wheat and barley [1, 2, 3, 4, 5]. Further, tropical and sub-tropical climatic conditions like high temperatures, precipitations and humidity exacerbates the mould infestations subsequently leading to the Aflatoxin occurrence. Thus, researches have reported that Aflatoxins are frequently detected from foods in tropical countries as a result of hot humid climate, poor irrigation practices, poor pest management and inappropriate storage facilities [6, 7, 8, 9].

25% of agricultural food commodities in the world are contaminated with mycotoxins including Aflatoxins. These foods are subjected to contamination at different stages from “farm to fork” [10, 4, 11, 12, 13, 14]. Presence of Aflatoxins in foods is identified as a critical health issue due to the associated carcinogenicity of Aflatoxins. Moreover, Aflatoxins cause in immune dysfunctions, mutagenicity and genotoxicity. Due to the possible health risks many countries have imposed strict legislations to control the level of Aflatoxins in food commodities [9, 15]. Inadequacy of quality control standards in Sri Lanka is a major reason for human exposure to Aflatoxins and it is essential to impose proper standards to ensure food safety. However, Sri Lanka generally adhere to the quality standards imposed by the European Union based on its import and export markets. Hence a maximum permissible level (MPL) of 2 µg/kg and 4 µg/kg are often maintained respectively for Aflatoxin B1 (AFB1) and total Aflatoxins [16, 17, 18, 19].

Rice, *Oryzae sativa* L. is the staple food in Sri Lanka which is widely produced and consumed throughout the country. Sri Lanka is nearly self-sufficient with rice approximately fulfilling 95% of domestic rice requirement with its national production. In year 2019 annual production of paddy was 4,592,000 metric tons as per the records of Central Bank of Sri Lanka [20, 21, 22, 23]. Tropical climate in Sri Lanka facilitates the optimum conditions for paddy growth as well for fungal colonization. Furthermore, storage of paddy for months in poor storage conditions aggravates the mould growth. As a result Aflatoxin contaminated rice has been reported from Sri Lanka in several instances and few other South-East Asian countries also have records of aflatoxin in rice. This causes human exposure to Aflatoxins through consumption of rice [6, 7, 8, 24]. As a person consumes a substantial amount of rice per day in Sri Lanka, even a small dose of Aflatoxin available in rice can cause a huge harm on health of Sri Lankans [21, 25, 26]. Although this is a crucial health hazard as a developing country Sri Lanka has very scarce data sources on this regard. Insufficiency of data also responsible for the inadequacy of proper regulatory measure. Therefore this brief review aims on presenting the gravity of this issue by employing the limited data available in a comprehensive manner.

2. PARBOILING

Rice is milled either without parboiling as raw rice or after parboiling as parboiled rice. Parboiling is a process where rice is soaked in water over night followed by precooking of rice within the husk itself. Subsequently, the precooked rice is sun dried and then passed through a rubber roll sheller and a polisher in order to remove the husk and outer bran layer respectively. Parboiled rice is very popular within Asian continent and almost 20% of global rice production is turned into parboiled rice before consumption [20, 27, 28]. Parboiling of rice causes numerous changes in the color, texture, nutritional composition and shelf life of rice. Parboiled rice is preferred by some consumers due to these changes; particularly due to the changes of nutritional aspects. Parboiling causes the gelatinization of starch forming amylose-lipid complexes and inducing disulfide bonds between the protein molecules [28, 29]. Basically two types of parboiling practices are available in Sri Lanka,

2.1 COMMERCIAL PARBOILING

Commercial parboiling involves large scale production of parboiled rice in large concrete tanks. In this commercial scale parboiling water is often reused due to the associated practical issues and this causes high contamination [27].

2.2 COTTAGE PARBOILING

Household level process where rice is washed and precooked in clay or copper pots of 15L capacity up to the point of grain split. This step is followed by sun drying in open areas while frequent turning [27].

3. EFFECTS OF PARBOILING ON MOULD GROWTH

Soaking of rough rice in water causes to reduce the cooking time to save the amount of fuel required for precooking step. As well this step provides the moisture requirement of endosperm starch for gelatinization. The gelatinization of rice starch facilitates nutrition retention within the kernel; specially, vitamins like vitamin B and minerals. Gelatinized starch within the parboiled rice kernel is more susceptible to fungal growth than the endosperm starch in raw rice kernels. Hence this parboiled rice kernel is an ideal substrate for fungal growth and Aflatoxin production. Improper sun drying of precooked rice may result in high moisture contents favorable for mould growth [27, 29, 30].

During the storage, rice packed in jute or polythene bags are stacked in warehouses with poor ventilation for a prolonged time duration which results in the mouldiness of rice. Hence parboiled rice is highly prone to Aflatoxins in comparison to raw rice [21, 27].

A study conducted by Breckenridge et al. in 1986 reported Aflatoxins in both raw and parboiled rice samples collected from wet, intermediate and dry zones of the country. The minimum detectable level of Aflatoxin in the study was 12 µg/kg and the level of Aflatoxin in different rice samples was compared with UNICEF/WHO/FAO maximum permissible level of 30 µg/kg.

Table 1. Aflatoxin B1 contents in raw and parboiled rice samples collected from the three different climatic zones (wet, Intermediate and Dry Zones) in Sri Lanka

Year	Number of Samples tested	Aflatoxin B1 not detected	< 30µg/kg*	30µg/kg

Comment [EJ1]: It is better to add data on the level of starch gelatinization in parboiled rice

Comment [EJ2]: Add the information about temperature and humidity of warehouse commonly used to store the raw rice and parboiled rice

Comment [EJ3]: The data used is very old, the latest data should be used at least to obtain data on aflatoxin content in raw rice and parboiled rice for several storage periods

1986	Raw rice	35	32	3	0
	Parboiled Rice	562	493	57	12

Comment [EJ4]: There is no information about the variety of rice used. Is the same variety of rice used for raw and parboiled rice in this data?

[21] * *As the mnimum detectable level of Aflatoxins is 12 µg/kg. The value <30µg/kg falls within the range of 12-30µg/kg*

Out of the total Aflatoxin positive 72 rice samples 69 samples were parboiled rice and 12 parboiled samples were containing Aflatoxin B1 levels of 30 µg/kg. With these results it was showed that parboiled rice is more susceptible to Aflatoxins than raw rice. Nevertheless, number of raw rice samples employed was not sufficient to conclude it.

In a later study conducted by Bandara et al., in 1991 concluded that parboiled rice is highly preferred by fungi of genus Aspergillus over raw rice and incidence of Aflatoxin presence is higher in parboiled rice than raw rice. During the study AFB1 and AFG1 was tested while both AFB1 and AFG1 levels in parboiled rice remained higher than that of raw rice. The highest AFBI level was 185 µg/kg and AFG1 content 963 µg/kg, was detected from parboiled rice samples [20].

In 1991, commercial parboiling and cottage parboiling was compared with respect to susceptibility to Aflatoxins. Aflatoxin contents in rice produced by commercial parboiling (AFB1 60-92 µg/kg) were significantly higher than that in rice produced by cottage level parboiling (AFB1 12-29 µg /kg). Further this study presented that longer soaking duration causes to enhance the susceptibility of grains to A. flavus resulting in Aflatoxins and this could be reduced by adding a bleaching agent to the soaking water. Furthermore, reusing of soaking water, steeping for long durations, inproper sun drying are possible reasons for commercial level parboiling to be more prone for Aflatoxins [27].

4. CONCLUSION

The major focus of this short review was to highlight the risk associated with occurrence of Aflatoxins in rice; inadequacy of data and regulatory standards; effects of parboiling on contamination of rice with Aflatoxins. As per the data found Aflatoxins were detected from raw and parboiled rice within Sri Lanka. Parboiling of rice promotes growth of fungi on rice ultimately causing Aflatoxin occurrence. Moreover, commercial parboiling was concluded as much harmful in comparison to cottage parboiling as the chance of being contaminated is high.

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