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Mycoflora of stored “Ofada” and “Abakaliki” rice in Lagos and Ogun States, Southwestern Nigeria

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The presence of fungal contaminants in Ofada and Abakaliki rice varieties under storage in Lagos and Ogun States, Nigeria were examined. The fungal species isolated from the Ofada rice were *Actinomyces* spp., *Aspergillus flavus*, *Aspergillus niger*, *Aspergillus tamarii*, *Cladosporium sphaerospermum*, *Fusarium compactum*, *Fusarium oxysporum*, *Fusarium proliferatum*, *Penicillium oxalicum*, *Rhizopus nigricans*, *Rhizopus oryzae* and *Saccharomyces cerevisiae*. The Abakaliki rice was contaminated with *A. flavus*, *A. niger*, *A. tamarii*, *F. compactum*, *F. oxysporum*, *F. proliferatum*, *Penicillium citrinu*, *P. oxalicum*, *R. nigricans*, *R. oryzae* and *S. cerevisiae*. *A. niger* (80%) was the predominant fungal species while *Actinomyces* spp. (6.7%) was the least isolated. Some of these fungi are known to produce mycotoxins which have several health and economic implications. The presence of such species as seen in this study may show a potential risk of mycotoxin contamination in Ofada and Abakaliki rice varieties.

Key words: Fungi, contaminants, Ofada, Abakaliki, rice, mycotoxin, mycoflora.

INTRODUCTION

Rice (*Oryza sativa* Linn.) is a wholesome cereal grain that is ideal for diverse nutritional needs. It contains predominantly carbohydrates besides vitamins and fibre and has higher proportion of protein than in wheat, corn, and sorghum (USA Rice Federation, 2002). Rice is a major source of income and nutrition in many food-insecure regions of the world. About 85% of the total production of rice is meant for human consumption (Janick, 2002). Rice accounts for about 60 - 70% of total food intake in the world and currently, it has become the predominant staple food in about 33 countries of the world including Nigeria (FAO, 2004). About 90 - 95% of Nigerians consume rice and this cut across all economic class where it is eaten in different recipes (Wudiri, 1992).

In Nigeria, rice is cultivated by local farmers at subsistence levels, enough only to feed their families and a little remain for sale at local markets. Despite being West Africa's largest producer of rice, rice yield in Nigeria is low compared to other parts of the world and this limited rice produced is further reduced during post

harvest storage (WARDA, 2002). Storage of rice is done in bamboo-laid ceilings and barns, baskets and sacks. The prevailing high temperature and relative humidity are such that encourage colonization by moulds. Moulds have been found to contaminate maize (Orsi et al., 2000), wheat (Berghofer et al., 2003) and rice (Desjardins et al., 2000; Park et al., 2005; Sales and Yoshizawa, 2005). The presence of moulds in stored grains may lead to various forms of deterioration, visible mouldiness, seed discolouration, musty odours reduction in acceptability or outright rejection of the maize for consumption (Aboaba and Amasike, 1991) and decreased nutritive value (Maxiya-Dixon, 2004). However, the most debilitating effect of mould deterioration of stored grain and seeds is mycotoxin production (Bankole et al., 1999). Mycotoxins are important in food safety in that they not only lead to deleterious health effects in humans and in animals, they also pose adverse economic implications (Bhat and Vashanti, 2003; Wu, 2008).

The loss of grains in storage, loss of revenue from mouldiness and mycotoxin production and the potential health hazards posed to consumers formed the basis of this study. The present study examines the fungal species contaminating Ofada and Abakaliki rice in Lagos and Ogun states, Nigeria which may serve as an

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Table 1. Fungi isolated from Ofada and Abakaliki rice.

State	Rice variety	Fungi isolated
Lagos	Ofada	<i>Rhizopus oryzae</i> , <i>R. nigricans</i> , <i>Penicillium oxalicum</i> , <i>Aspergillus niger</i> , <i>A. flavus</i> , <i>Fusarium oxysporum</i> , <i>Cladosporium sphaerospermum</i> , <i>Actinomyces</i> spp., <i>Saccharomyces cerevisiae</i> , <i>F. proliferatum</i>
Ogun	Ofada	<i>S. cerevisiae</i> , <i>R. nigricans</i> , <i>A. niger</i> , <i>P. oxalicum</i> , <i>A. tamarii</i> , <i>F. compacticum</i>
Ogun	Abakaliki	<i>R. oryzae</i> , <i>A. niger</i> , <i>F. oxysporum</i> , <i>P. oxalicum</i> , <i>A. flavus</i> , <i>R. nigricans</i> , <i>P. citrinum</i> , <i>F. proliferatum</i> , <i>A. tamarii</i> , <i>F. compacticum</i> , <i>S. cerevisiae</i> ,

indicator of the potential risk of mycotoxin in Ofada and Abakaliki rice consumed by the populace.

MATERIALS AND METHODS

Ofada and Abakaliki rice samples were collected from different stores in Lagos and Ogun States, southwestern Nigeria. The samples comprised of nine samples of Ofada rice and six samples of Abakaliki rice. Samples were collected from rice stored in jute sacks. 500 g of sample was randomly drawn and from each batch of samples, representative sample weighing about 50 g was obtained and used for the study.

The samples were surface sterilized by dipping in 1% NaOCl solution for one minute, followed by three successive rinses in sterile distilled water. Isolation of fungi was done using the direct plating method described by Pardo et al. (2004). About 5 g (10 grains) of the surface-sterilized grains from each sample were plated on Potato Dextrose Agar complemented with 0.5% chloramphenicol (PDAC) and incubated at 25°C for about seven days. Axenic culture of each isolate was obtained by subculturing on fresh PDAC plates. Identification of the isolated fungi was done based on colony morphology and microscopic examination. Observations were recorded on colony colour, structure, shape, size and pigment and structure of mycelium, its branching, presence of conidiophores, sclerotia and shape which were compared with literature (Pitt and Hocking, 1997; Samson et al., 2004). The experiments were repeated in triplicates.

RESULTS AND DISCUSSION

Thirteen different fungal species were isolated from the rice samples viz., *Actinomyces* spp., *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus tamarii*, *Cladosporium sphaerospermum*, *Fusarium compacticum*, *Fusarium oxysporum*, *Fusarium proliferatum*, *Penicillium citrinum*, *Penicillium oxalicum*, *Rhizopus nigricans*, *Rhizopus oryzae* and *Saccharomyces cerevisiae*.

The fungal species isolated from the Ofada rice were *Actinomyces* spp., *A. flavus*, *A. niger*, *A. tamarii*, *C. sphaerospermum*, *F. compacticum*, *F. oxysporum*, *F. proliferatum*, *P. oxalicum*, *R. nigricans*, *R. oryzae* and *S. cerevisiae*. The Abakaliki rice was contaminated with *A. flavus*, *A. niger*, *A. tamarii*, *F. compacticum*, *F. oxysporum*, *F. proliferatum*, *Penicillium citrinum*, *P. oxalicum*, *R. nigricans*, *R. oryzae* and *S. cerevisiae*.

Table 2. Frequency of occurrence of the fungal isolates.

Isolates	Frequency (n=15)	Incidence (%)
<i>Actinomyces</i> spp.	1	6.7
<i>Aspergillus niger</i>	12	80
<i>A. flavus</i>	6	40
<i>A. tamarii</i>	3	20
<i>Cladosporium sphaerospermum</i>	3	20
<i>Fusarium compacticum</i>	2	13.3
<i>F. oxysporum</i>	2	13.3
<i>F. proliferatum</i>	2	13.3
<i>Penicillium citrinum</i>	2	13.3
<i>P. oxalicum</i>	5	33.3
<i>Rhizopus nigricans</i>	11	73.3
<i>R. oryzae</i>	4	26.7
<i>Saccharomyces cerevisiae</i>	3	20

Table 1 shows the fungal species isolated from Ofada and Abakaliki rice.

Aspergillus (93.3%) was the predominant genera, followed by *Rhizopus* (86.7%), *Penicillium* (46.7%), *Fusarium* (40%), *Cladosporium* (20%), *Saccharomyces* (20%) and *Actinomyces* (6.7%). The frequency of the isolated species is shown in Table 2.

Seven of the isolated fungi were classified as storage fungi and four as field fungi according to Christensen and Kauffmann (1965a). The field fungi isolated were *C. sphaerospermum*, *F. compacticum*, *F. oxysporum* and *F. proliferatum*. Field fungi infect grains on the field before harvest and they grow at moisture levels prevailing at relative humidity > 90% (Mills et al., 1978). The result of this study is similar to that of Desjardins et al. (2000) who reported prevalence of *Fusarium* in Nepalese rice. Among the species of *Fusarium* isolated from the Nepalese rice were *Fusarium verticillioides*, *Fusarium fujikuroi* and *F. proliferatum*. However, the incidence of field fungi reduces considerably during storage due to their location on the outer tissues of the grains when they infect grains in the field (Mondal et al., 1981). Also, as the

environmental requirements for the growth of the field fungi are different, the field fungi are eliminated during storage and the population of storage fungi increases (Bankole et al., 1999). The storage fungi isolated in the present study were *R. oryzae*, *R. nigricans*, *P. citrinum*, *P. oxalicum*, *A. niger*, *A. flavus* and *A. tamarii*. The storage fungi might have contaminated grains during harvest, or any other phase of processing such as drying, milling or winnowing.

Aspergillus (93.3%) was the most abundant genera with three species namely *A. niger*, *A. flavus*, *A. tamarii*. The other predominating storage fungi were *Rhizopus* (86.7%) and *Penicillium* (46.7%). This is similar to a report of Bankole (1993) who isolated *Aspergillus*, *Rhizopus*, *Penicillium* and *Rhizomucor* from two species of melon seeds stored for up to one year. Berghofer et al. (2003) had reported *Aspergillus* and *Penicillium* in wheat meant for flour production. In polished Korean rice meant for human consumption, Park et al. (2005) reported *P. citrinum* and *Aspergillus candidus* as the most prevalent. The abundance of storage fungi may be due to low relative humidity and reduced moisture levels that prevail during storage (Christensen and Kaufmann, 1965b).

Conclusion

The study indicated that fungi are common contaminants found in Ofada and Abakaliki rice during storage and species of *Aspergillus* are the predominant. Since some of the isolated fungi have been reported to be mycotoxin-producers, further study should be done to assess the occurrence of mycotoxins in Ofada and Abakaliki rice. Considering the huge economic importance of mycotoxins, the growth of mycotoxigenic fungi must therefore be prevented or at least reduced, so as to minimize the exposure of consumers to the dangerous health effects of mycotoxins in foods.

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