Aspergillus flavus and *Penicillium islandicum* on milled rice collected from different parts of the postharvest handling chain

O. S. Dharmaputra* and I. Retnowati†

Abstract

In 1992–1993, 89 milled rice samples were collected from farmers (FM), rice mills (RM), civil servant warehouses (CSW) and retailers (RT) in Bogor, Cipanas and Sukabumi (West Java, Indonesia).

The percentages of grains infected by *Aspergillus flavus* (A.f.) and *Penicillium islandicum* (P.i.), and the moisture contents (m.c.) of the grains were analysed.

The m.c. of samples collected from Bogor were as follows: 2 samples from FM 12.5 and 14.5%, one sample from RM 14.9%, 14 samples from CSW between 12.3–15.0%, and 35 samples from RT between 11.0–15.9%. The m.c. of samples collected from Cipanas were as follows: 1 sample from FM 15.8%, 1 sample from RM 15.8%, and 3 samples from RT between 13.3–14.3%. The m.c. of 32 samples collected from RT in Sukabumi were between 11.9–15.8%. The percentages of grains infected by A.f. in samples collected from Bogor were as follows: 2 samples from FM 27 and 43%, 1 sample from RM 25%, 14 samples from CSW between 1–24%, and 35 samples from RT between 5–100%. The percentages of grains infected by A.f. in samples collected from Cipanas were as follows: 1 sample from FM 100%, 1 sample from RM 65%, and 3 samples from RT between 81–100%. The percentages of grains infected by A.f. in 32 samples collected from RT in Sukabumi were between 0–100%.

The percentages of grains infected by P.i. in samples collected from Bogor were as follows: 14 samples from CSW between 0–12%, 32 samples from RT between 0–98%. According to some reports, in certain conditions some strains of A.f. and P.i. could produce aflatoxin and islanditoxin, respectively.

Introduction

Rice (*Oryza sativa* L.) is the primary foodcrop in Indonesia. The government of Indonesia buys and stores a large amount of milled rice as national stock and to maintain price stability. Consequently, postharvest handling, including processing and storage, needs greater attention to preserve milled rice quality.

Since Indonesia has a humid tropical climate, rice could easily be infected by fungi during storage, or at or before harvest.

There are various of postharvest processing and storage practices that could affect the moisture content and intactness of the kernels and thus their susceptibility to fungal infection.

Aspergillus and *Penicillium* are the two common genera of fungi found on stored products. They can cause weight loss, seed discolouration, heating and mustiness, and production of mycotoxins including aflatoxins and islanditoxins.

In Indonesia, very little research has been done on storage fungi of milled rice.

This study provides information on the percentage of grains infected by *Aspergillus flavus* and *Penicillium islandicum*, and moisture content of freshly harvested, stored and marketed materials.

Materials and Methods

Sample collection

A total of 89 milled rice samples was collected from farmers (FM), rice mills (RM), civil servant warehouses (CSW) and retailers (RT) in Bogor, Cipanas and Sukabumi, West Java, Indonesia, in 1992–1993.

About 1 kg of each sample was collected, then divided into 3 subsamples for moisture content analysis, fungal analysis and reserve sample.

Moisture content analysis

Percent moisture content of kernels (on the basis of water loss) was determined by the oven method (BSI 1980). Three replicated were used for each sample. The grains were ground and dried in the oven at 130°C for 2 hours.

The moisture content was determined using the formula:

$$\text{Moisture content} = (M_0 - M_1) \times {}^{100}/_{Mo}$$

where:

M_0 is the initial mass, in grams, of the test portion

M_1 is the mass, in grams, of the dry test portion.

Fungal analysis

A. flavus was isolated using a direct plating method on *Aspergillus flavus* and *Parasiticus Agar* (AFPA), while *P. islandicum* was grown on Dichloran 18% *Glycerol Agar* (DG18) (Pitt and Hocking 1985).

Before plating, samples were individually disinfected using 0.5% sodium hypochlorite for 1 minute. One hundred grains were then plated (10 grains/plate) on the medium and incubated at 30°C for 3 days (for AFPA) and at 28°C for 7 days (for DG18).

The percentages of grains infected by *A. flavus* and *P. islandicum* on each medium were determined.

Results and Discussion

Moisture content

Moisture content (m.c.) is the most important factor determining the development of storage fungi in stored products (Christensen and Kaufmann 1974).

The moisture contents of samples collected from different localities are presented in Table 1. The moisture contents of

* SEAMEO BIOTROP, P.O. Box 116, Bogor, Indonesia; and Department of Biology, Faculty of Mathematics and Natural Sciences, Bogor Agricultural University, Bogor, Indonesia.

† SEAMEO BIOTROP, P.O. Box 116, Bogor, Indonesia.

Table 1. Moisture content and percentages of the grains infected by *Aspergillus flavus* and *Penicillium islandicum* of milled rice collected from different levels of post-harvest handling in some locations.

Date and place of collection	Level	Number of samples	Moisture content (%)	Grains infected by *A. flavus* (%)	Grains infected by P. islandicum (%)
Bogor. 16 March, 21 & 24 June, 8 July, 3, 5, 6 & 20 October 1992 & 6 April 1993.	FM[a]	2	12.5–14.5	27–43	0
	RM	1	14.9	25	0
	CSW	14	12.3–15.0	1–24	0–12
	RT	35	11.0–15.9	5–100	0–16
Cipanas. 3 March & 23 June 1992.	FM	1	15.8	100	0
	RM	1	15.8	65	0
	RT	3	13.3–14.3	81–100	0
Sukabumi. 17 October 1992 & 13 April 1993.	RT	32	11.9–15.8	0–100	0–98

[a]FM = farmers; RM = rice mills; CSW = civil servant warehouses; RT = retailers

samples collected from farmers (FM), rice mills (RM), civil servant warehouses (CSW) and retailers (RT) in Bogor were between 12.5–14.5%, 14.9%, 12.3–15.0% and 11.0–15.9%, respectively.

The moisture contents of samples collected from FM, RM and RT in Cipanas were 15.8%, 15.8% and 13.3–14.3%, respectively; while those from in Sukabumi were between 11.9–15.8%.

The mean moisture contents of samples collected from FM, RM, CSW and RT in Bogor were 13.5, 14.9, 13.6 and 13.9%, respectively; while those from FM, RM and RT in Cipanas were 15.8, 15.8 and 13.9%, respectively; and from RT in Sukabumi was 13.7%.

The moisture contents of samples collected from the same location was not affected by each postharvest handling, because they were not derived from the same source.

The moisture contents of some samples collected during this study exceeded the maximum recommended moisture content of 14% for stored milled rice.

Fungal analysis

The percentages of grains infected by *Aspergillus flavus* (A.f.) in samples collected from FM, RM, CSW and RT in Bogor were 27–43%, 25%, 1–24% and 5–100%, respectively; those from FM, RM and RT in Cipanas were 100%, 65% and 81–100%, respectively; and those from RT in Sukabumi were between 0–100% (Table 1).

The mean percentage of grains infected by A.f. in samples collected from RT (44%) was higher than that from FM (35%), RM (25%) and CSW (13%) in Bogor. It is assumed that the length of storage of samples collected from RT had been longer than those from FM, RM and CSW.

The mean percentage of grains infected by A.f. in samples collected from FM (100%) and RM (65%) in Cipanas was higher than that (35 and 25%, respectively) in Bogor . Also, the mean percentage of grains infected by A.f. in samples collected from RT (93%) in Cipanas was higher than that in Bogor (44%) and Sukabumi (37%).

The presence of storage fungi may cause yellowing in stored milled rice. Phillips (1984) reported that the high moisture content of paddy and inability to dry it rapidly resulted in high incidence of yellowing of the rice during storage. One of the toxin-producing moulds isolated from batches of yellow rice was *Penicillium islandicum* (P.i.).

According to Pitt (1991) P.i. produced some of the toxins found in yellow rice, including *luteoskyrin, erythroskyrin, cyclochlorotine* and *islanditoxin*. Each compound is quite toxic, but their significance in human and animal health remains unclear.

In this study, P.i. was not isolated from samples collected from FM and RM in Bogor or from any of the samples from Cipanas.

The percentages of grains infected by P.i. in samples collected from CSW and RT in Bogor varied between 0–12% and 0–16%, respectively; while those from RT in Sukabumi were between 0–98% (Table 1).

That A.f. can infect grain before harvest was indicated bu its isolation from milled rice collected from farmers (FM), whereas P.i. was isolated only from milled rice that had been stored for a long period (from CSW and RT).

Conclusion

The moisture contents of rice samples collected from different levels (sources) in Bogor, Cipanas and Sukabumi was varied. The moisture contents of samples collected from the same location were not affected by their source (FM, RM, CSW and RT from Bogor; FM, RM and RT from Cipanas).

The percentages of grains infected by A.f. from samples collected from markets (RT) were higher than those from freshly harvested (FM and RM) and stored samples (CSW).

P.i. was isolated only from stored samples and marketed samples.

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