



E-ISSN: 2320-7078

P-ISSN: 2349-6800

[www.entomoljournal.com](http://www.entomoljournal.com)

JEZS 2021; 9(3): 32-36

© 2021 JEZS

Received: 16-03-2021

Accepted: 18-04-2021

**Maisarah Mohamad Saad**

Rice Research Center, Malaysian  
Agricultural Research and  
Development Institute  
(MARDI), Seberang Perai, 13200  
Kepala Batas, Seberang Perai  
Utara, Penang, Malaysia

**Wahid Said**

Rice Research Center, Malaysian  
Agricultural Research and  
Development Institute  
(MARDI), Alor Star, Kedah,  
Malaysia

**Dan Hanisa Hosni**

Rice Research Center, Malaysian  
Agricultural Research and  
Development Institute  
(MARDI), Headquarters,  
Serdang, Selangor, Malaysia

## Evaluation on air-dried of fluidized bed dryer for rice pre-treatment to control stored insect pests

Maisarah Mohamad Saad, Wahid Said and Dan Hanisa Hosni

DOI: <https://doi.org/10.22271/j.ento.2021.v9.i3a.8683>

### Abstract

An integrated pest management of stored insect pests play an important role in helping the growth of the rice industry. Among the methods that can be exploited is to use air-dried treatment. A study was conducted to evaluate the effectiveness of air-dried treatment on MRQ76 fragrant milled rice at MARDI Pendang, Kedah Malaysia. The sources of air-dried treatment method that has been used in this study from the batch type fluidized bed dryer. A total of five different temperatures namely 30 °C, 40 °C, 50 °C, 60 °C and 70 °C were tested with a treatment time of 300 seconds for each temperature. MRQ76 rice samples were then packed using low-density polyethylene (LDPE) plastic and seven packs of rice samples for each treatment were stored for evaluation of treatment effects on insect pests. It was found that 55.2% of mortality was recorded on treatment with a temperature of 30 °C and 64.9% mortality of total insect at 40 °C. While 100% mortality were recorded at temperatures of 50 °C, 60 °C and 70 °C. The experiment, however found that the air-dried treatment given direct to the milled rice would implicate rice physiochemical quality. Thus, further study is recommended, perhaps by combining the air-dried treatment with other parameters.

**Keywords:** rice pre-treatment, *Sitophilus oryzae*, *Rhizopertha dominica*, fragrant rice

### Introduction

Rice (*Oryza sativa*) production in Malaysia can only meet 60-70% of the people's needs (Che Omar *et al.*, 2019) <sup>[1]</sup>. Freshly harvested paddy usually has no problem with stored insect pests. National rice supply from local paddy production will be distributed directly to the market for the daily consumption after been processed at the rice mills. Notwithstanding the needs and demands of the people, at least 30% of the rice is imported from rice exporting countries such as Vietnam, Thailand, Pakistan and Bangladesh. Especially nowadays, Malaysian dishes are to some extent influenced by the food from the Middle East countries, Japan and Korea. Most of the imported rice is premium rice; including fragrant rice, basmathi type, coloured and japonica rice. There is no denying that the presence of foreigners living in Malaysia on the basis of work also contributes to the need for premium rice as well as consuming local rice. Usually, chemicals treatment as stipulated in the import permit has been made on the supply of milled rice brought in to this country by the exporting country, but the rice operators in Malaysia still facing problems with stored insect pests' infestation. This is due to the period taken for the milled rice from exporting country to reach the country and also the infestation that occurs at the temporary rice storage warehouses.

There are many factors that contribute to the damage to milled rice stored in warehouses, especially in a warm climate country. Infestation of insect pests and other pests such as rats and birds in Malaysia is estimated to be between 5-10% (Yunus and Singh, 1968) <sup>[2]</sup>. There are more pests that attack milled rice than in paddy form given the rice conditions that are exposed and broken. Among the major rice storage pests that can be found in Malaysia including *Sitophilus oryzae*, *Tribolium sp.*, *Oryzaephilus surinamensis* and *Rhizopertha dominica* (Nurul Huda and Noor Amni, 2019; Syarifah Zulaikha *et al.*, 2018) <sup>[3-4]</sup>. Insect pest infestations that occur in temporary storage warehouses (in bulk form) before the packaging process is made are serious, due to active rice supply in and out activities occur (personal communication). Most of middle-scale rice mill facilities in Malaysia do not usually clean the mills after the operation, so the unhygienic conditions tend to increase the number of insect pests. These insect pests can also hide on the edges of storage areas and on the storage building's structure. Through personal observation, it was found that adult insect pests will move towards new food

### Corresponding Author:

**Maisarah Mohamad Saad**

Rice Research Center, Malaysian  
Agricultural Research and  
Development Institute  
(MARDI), Seberang Perai, 13200  
Kepala Batas, Seberang Perai  
Utara, Penang, Malaysia

sources when new supply of milled rice stocks arrives, while looking for breeding grounds for survival. Generally, the rice operators will carry out the cleaning process of the rice and separating the impurities from the imported milled rice before packaging is made. During this process, most adult insect pests are also removed from processed rice and this activity helps rice operators to manage insect pests. Still, only the adult stage can be controlled, not for the eggs, larvae and pupae stage because at these immature stages, pests are in the rice grains. Numerous approaches are used to manage these insect pests of harvested paddy and milled rice. The most undeniable method is by using a chemical fumigation. In spite of that, there is globally awareness in reducing the use of pesticides and chemical fumigants in agricultural commodities as some chemical agent such as methyl bromide was claimed hazardous to human health (Miyanoshita *et al.*, 2006) [5]. Thus, there is undoubtedly an essential to develop non-chemical treatment approaches.

Air-dried/hot air treatment or heat treatment is certainly not new to post-harvest technologies. The used of air-dried/heat treatment in controlling stored-product insect pests has also been studied by various researchers worldwide. Previously, Ahmed *et al.* (2011) [6] were using dielectric spectroscopy to analyze lesser grain borer, *R. dominica* for microwave heat treatment to paddy of MR219. They found that 100% mortality of *R. dominica* was observed at 60 second when infested paddy MR219 was subjected to 2.45 GHz frequency with 1kW MW power microwave environment. Pande and Mishra (2013) [7] reported that modern technology can be utilized to control storage insect pests by using heat treatment. The use air dried of fluidized bed dryer (FBD) in particular has the potential to kill storage insect pests for the legume family (green beans) without affecting grain quality.

This paper will look at the potential perspective of the use of fluidized bed dryer in managing the rice storage pests in line with the environmentally friendly technology being developed at the Malaysian Agricultural Research and Development Institute. The objective of this study is to evaluate the effectiveness of air-dried treatment i.e. fluidized bed dryer and also to determine the appropriate parameters before the storage of specialty milled rice is done to reduce the rate of infestation of stored pests.

### Materials and Methods

Study were carried out between August 2019 and March 2020 at grains and herbs laboratory at the Malaysian Agricultural Research and Development Institute (MARDI) Pendang Station, Kedah Malaysia (6°01'06.1"N 100°26'42.8"E). The rice sample used in this experiment was local fragrant milled

rice MRQ76 (launched by MARDI in 2012) which was purchased from the local rice mill and did not undergo any chemical treatment. The rice has been stored at the MARDI Seberang Perai, Penang Malaysia (5°58'36"N, 102°25'36"E) rice mill for over a month to experience insect infestation naturally. Infested milled rice was transported to MARDI Pendang Station prior to the experiment procedure.

A small-scale batch type fluidized bed dryer (FBD) used in this experiment is shown in Plate 1 and 2. With a capacity of 100 kg per batch, the drying temperature can reach up to about 80 °C. The condition of the moving sample (up and down) makes the drying more uniform and the moisture loss rate (MLR) is higher between 9.5-17.6% per hour depending on the temperature used. A total of five (5) different temperatures of 30 °C, 40 °C, 50 °C, 60 °C and 70 °C were tested with a treatment time of 300 seconds for each temperature.

Before the experiment started, the FBD was warmed up until the temperature within the system reached the desire operating level and 50 kg infested milled rice with an initial moisture content of 11.75% (wet basis) was then loaded into drying chamber. The infested milled rice that have been treated using FBD at MARDI Pendang Station were packed 1kg in individual low-density polyethylene plastic (LDPE), seven packed for each temperature and were brought back to Entomology Laboratory, MARDI Seberang Perai for evaluation of the effects on insect pests. Another set of rice sample were used for quality assessments. Milled rice samples without access to air dried treatment also were stored together in the laboratory with other treatment samples in an ambient condition at 28°C and 70%RH for further analysis. The first data, insect mortality assessment was taken 24 hours after each treatment. Subsequent data are taken 30 days from the first data and for another two (2) consecutive months. At each sampling time for the insect count, all rice samples were sifted using a laboratory test brass sieve (Aperture size: 1.40mm, Endecotts LTD.). Both dead and alive insects found from rice samples were determined and they were transferred to 1.5cm x 7.0cm (Diam/H) glass screw-cap vials containing 70% ethyl alcohol. The sorting and identification of all species was conducted under stereo-microscope according to the key of Rees (2004) [8] until genus and species level.

### Data analysis

All data were analyzed statistically using one-way variance analysis or ANOVA (PROC GLM), while comparison of treatment means was performed using Duncan's Multiple Range Test (DMRT). All data analysis was produced using SAS statistical package version 9.4.

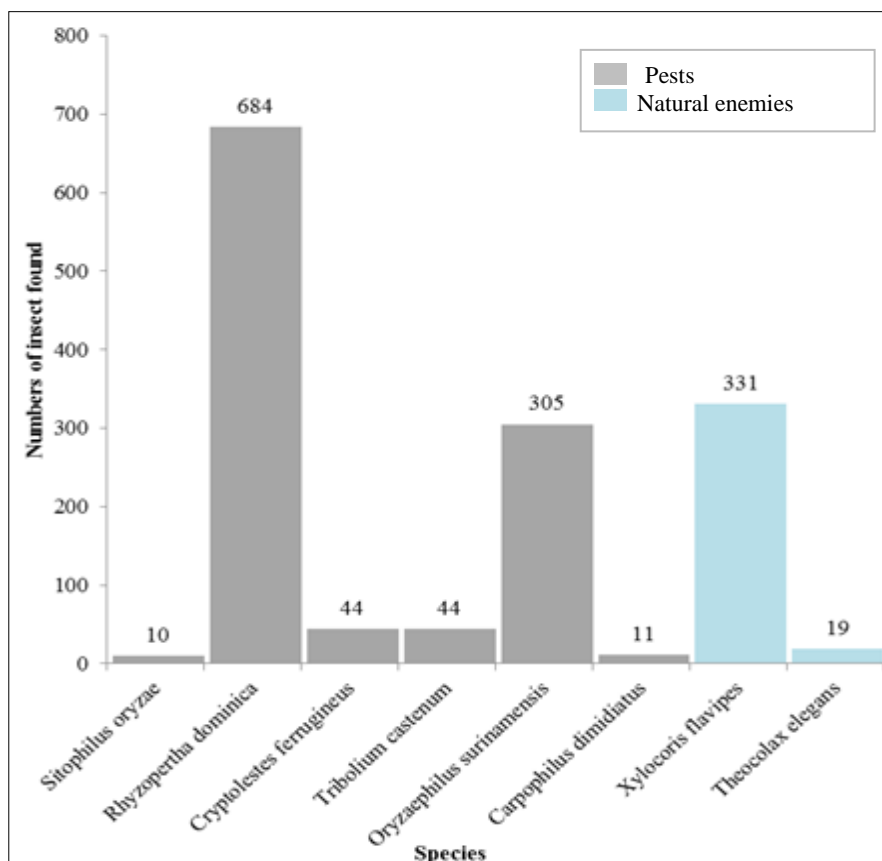


**Plate 1 and 2:** fluidized bed dryer (fbd) used in the experiment (left: external view; right: internal view)

**Results and Discussion**

The presences of insect species in rice that have been left naturally infected at the rice mill are shown in Figure 1. It was found that 1448 individual insects comprising six species of pests and two species of natural enemies have been identified in the rice samples used in the experiment. *Sitophilus oryzae* (rice weevil), *Rhizopertha dominica* (lesser grain borer), *Cryptolestes ferrugineus* (rust-red grain beetle/flat grain beetle), *Tribolium castenum* (flour beetle/rust-red flour beetle), *Oryzaephilus surinamensis* (saw-toothed grain beetle) and *Carpophilus dimidiatus* (sap beetle) are pests found.

Meanwhile, about one quarter of insect found in the rice samples were natural enemies, viz. *Xylocoris flavipes* (warehouse pirate bug) and *Theocolax elegans* Westwood (pteromalid wasp). A lesser grain borer, *Rhizopertha dominica* (family: Bostrichidae) is the highest number of individuals identified with a total of 684 individuals. This number followed by a cosmopolitan predator from the family Anthocoridae namely *Xylocoris flavipes* (331 individuals) and a total of 305 *Oryzaephilus surinamensis* (family: Sylvanidae). Other insects were found with less than 50 individuals each.



**Fig 1:** Frequency of insect species found in rice samples used for experiments

Table 1 shows the number of alive, dead as well as mortality (%) of insects in the 24 hours after air dried treatment using batch type fluidized bed dryer at different temperatures. The increasing percentage of insect mortality after 24-hour of all treatment given show consistent effect on the insect populations in rice samples used in this study. Out the total number of individual insects found in rice samples, 55.2% of deaths were recorded on treatment using FBD with a temperature of 30 °C and 64.9% of total insect deaths at a

temperature of 40 °C. While 100% of deaths were recorded at 50 °C, 60 °C and 70 °C. At temperature of 40 °C and above, only ≤5 insect were found alive. It was found that numbers of insects identified (*R. dominica* and *O. surinamensis*) was still alive and survived after being subjected to temperatures of 30 °C and 40 °C. Based on the data obtained from this study, it clearly indicates that treating rice with air dried treatment as low as at 30°C for 300 seconds seem to have suppressing effect on insect population.

**Table 1:** Number of alive, dead and mortality (%) of insects in 24 hours after air-dried treatment using fluidized bed dryer at different temperatures

Temperature* (°C)	Number of alive, dead and mortality (%); Mean±SE			
	MC (%)	Alive	Dead	Mortality (%), after 24 hours
Untreated check	11.75	71.4±7.50a	3.1±0.51b	4.5±0.84c
30	12.14	30.0±7.51b	40.0±8.62a	55.2±5.39b
40	11.52	5.0±1.20c	11.0±3.40b	64.9±6.05b
50	11.36	0.0±0.00c	9.30±3.80b	100.0±0.00a
60	0.00	0.0±0.00c	35.4±12.54a	100.0±0.00a
70	0.00	0.0±0.00c	1.6±0.69b	100.0±0.00a

\*The treatment is applied for 300 seconds. Value across all different temperature tested in each figure followed by a same letter are not differ significantly at the 5% level based on Duncan’s Multiple Range Test (DMRT).

The effect of air-dried treatment using FBD at different temperatures on eggs, larvae or pupae is shown in Table 2. Based on the table, observations within a month after air-dried treatment were applied recorded the highest number of progenies emerged at 30 °C (9.1 individuals) and followed by a temperature of 40 °C which is 4.9 individuals. The appearance of progeny a month after treatment consisted of only two species of primary pests (*S. oryzae* and *R. dominica*) and two species of secondary pests (*T. castenum*, and *O. surinamensis*). The series of temperature chosen as treatment do not seem to have good effect on immature stages as we can see the appearance of more progenies three months after treatment. The appearance of progenies in rice sample bags with a temperature treatment of 30 °C was the highest after untreated samples with a number exceeding 11 times the number of progenies found in the first month of sampling.

The number of progenies decreases with increasing temperature. Similar results reported by Yoshihashi *et al.* (2006) [9], as high temperature showed complete disinfection of adult and egg *Sitophilus zeamais*. At 70 °C, no progeny was detected. Unfortunately, none of natural enemies (predators or parasitoids) found on rice samples after treatment. Apart from the small number of available hosts after the treatment given, the absence of natural enemies showed that temperature obviously influenced the development of predators or parasitoids. The results are in accordance with the findings of Uraichuen *et al.* (2006) [10], who recorded number of *T. elegans* progeny at temperature of 30 °C was lesser than number of progenies at 2 °C. In other study, Flinn and Hagstrum (2002) [11] indicated that all parasitoids were killed after been exposed to the temperature of 35 °C.

**Table 2:** Effect of air-dried treatment using batch type fluidized bed dryer at different temperatures on the appearance of insect progeny

Temperature* (°C)	Appearance of progeny; Mean±SE	
	After 1 month	After 3 months
Untreated check	94.9±5.01a	319.4±20.51a
30	9.1±1.68b	111.0±0.00b
40	4.9±2.30bc	53.4±25.73bc
50	0.1±0.14c	37.4±13.55c
60	0.4±0.30c	28.86±7.84c
70	1.3±1.13bc	0.0±0.00c

\*The treatment is applied for 300 seconds. Value across all different temperature tested in each figure followed by a same letter are not differ significantly at the 5% level based on Duncan's Multiple Range Test (DMRT).

Air-dried treatment using FBD at temperature above 60 °C for 300 seconds on milled rice resulted over dried sample, hence unreadable moisture contents (%). Although the results show maximum mortality on insects and very low progenies emergence, these may be implied some side effects on the physical and cooking quality of the rice. The head rice yield was used to estimate physical quality for treated rice, while the physicochemical properties of rice measured were gel consistency (GC), Alkaline Spreading Value (ASV)/Gelatinisation Temperature (GT) and elongation ratio (ER). Physical quality of rice showed no different after air-dried treatment. Head rice yield maintained in high percentage as the range between 84.47-89.46% among treatment temperature. Table 3 shows the effect of air-dried treatment using batch type fluidized bed dryer at different temperatures on physicochemical properties. Physicochemical analysis of treated rice samples recorded significant differences in GC reading and ER compared to untreated sample. With value of 29.33±0.67 (30°C), 28.67±0.67 (40°C), 29.33±0.67 (50°C), 30.67±0.67 (60°C) and 35.33±2.91 (70°C), all treated samples were classified as hard (26-40 mm) compared to the initial untreated samples which was classified as medium/intermediate (41-60 mm). Cooked rice texture

become hard after exposed to heat and unfavorable to consumers. At temperature above 40°C for 300 seconds resulted immeasurable elongation ratio. Treated rice looks good physically, nonetheless the cooked rice ruptured during elongation test. This might be because of crack grains occurred at higher temperature. The air-dried treated milled rice will then only suitable for rice flour as consumer preference is long-grain cooked rice. There was no significant difference in ASV or gelatinization temperature, however, lower value (high intermediate) was observed compared to initial untreated rice sample. Treated samples showed higher gelatinization temperature (>74°C) than untreated (70 - 74°C). It also showed treated samples needed longer time to cook than untreated. Despite the potential of using air-dried treatment in managing stored insect pests, maintaining the rice quality is also imperative for consumer acceptance. There is other parameter that could be focusing on in order to increase the efficiency of FBD. As those results observed by Pande and Mishra (2013) [7], Franco *et al.* (2013) [12] and several other studies, the effects of temperature on insect mortality rate is also influenced by the exposure time. At this moment, only one exposure time has been used in this study.

**Table 3:** Effect of air-dried treatment using batch type fluidized bed dryer at different temperatures on physicochemical properties

Temperature* (°C)	Physicochemical properties; Mean±SE		
	Gel consistency (mm)	ASV/GT	Elongation ratio
Untreated check	47.0±0.00a	5.45±0.00	1.83±20.51a
30	29.33±0.67bc	4.03±0.03	1.23±0.03b
40	28.67±0.67c	3.80±0.61	0.25±0.09c
50	29.33±0.67bc	4.23±0.03	0.00±0.00d
60	30.67±0.67bc	4.37±0.03	0.00±0.00d
70	35.33±1.91b	3.87±0.94	0.00±0.00d

\*The treatment is applied for 300 seconds. Value across all different temperature tested in each figure followed by a same letter are not differ significantly at the 5% level based on Duncan's Multiple Range Test (DMRT).

### Conclusion

Using air-dried of fluidized bed dryer treatment to control insect pests in pre-packaging milled rice resulted in significantly, but need some modification. The findings showed air-dried treatment on direct milled rice would implicate rice physicochemical quality though it might resolve rice stored pest infestation. We are looking for method that can be used to control the insect pests and maintain the quality of the cooked rice in the same time. And for that, physical and physiochemical qualities of rice after air-dried treatment must be given consideration. In spite of all findings, further study would investigate the potential constant temperatures (40 °C and 50 °C) with different exposure time without any adverse effect on the quality of the grain.

### Acknowledgment

This work was supported by Development Fund grant for specialty rice (21003004010001/P-RIC01). The author would like to thank to Mohd Fadli Mohd Fauzi, Abdul Razak Hashim, Wan Khairiah Mohd Noor, Mohd Fikruddin Abdul Wahab, Nur Hidayatul Alia Mohamad Sanusi, Siti Aishah Sulaiman, Syahidatul Nadiah Basri, Siti Farhah Najihah Ismail, Noor Amy Edayu Mat Jaafar, Tuan Mohd Fakhruddin Tuan Yunus and Kyairil Asrul Omar, for their technical assistance on setting up the experiment and insect/data collection.

### References

1. Che Omar S, Ahmad Shaharudin AA, Tumin SA. The Status of the Paddy and Rice Industry in Malaysia. Khazanah Research Institute 2019. [http://www.krinstitute.org/assets/contentMS/img/template/editor/20190409\\_RiceReport\\_Full%20Report\\_Final.pdf](http://www.krinstitute.org/assets/contentMS/img/template/editor/20190409_RiceReport_Full%20Report_Final.pdf)
2. Yunus A, Singh KI. Storage problems and investigations in control of pests of stored products in West Malaysia. Dept. of Agric 1968, 22. (mimeographed).
3. Nurul Huda A, Noor Amni M. Food preference of *Oryzaephilus surinamensis* (Coleoptera: Silvanidae) to different types of plant products. Malaysian Journal of Halal Research 2019;2(2):53-57. Doi:10.2478/mjhr-2019-0015
4. Syarifah Zulaikha SA, Halim M, Nor Atikah AR, Yaakop S. Diversity and abundance of storage pest in rice warehouses in Klang, Selangor, Malaysia. Serangga 2018;23(1):89-98.
5. Miyanoshita A, Imamura T, Kengkanpanich R, Visarathanonth P. Use of predatory natural enemies. JIRCAS Working Report No. 45 2006, 91-94.
6. Ahmed M, Malek F, Ahmad RB, Rahman M, Juni KM. Disinfestation of *Rhyzopertha dominica* (F.) using microwave heat treatment to the Malaysian paddy. World Acad Sci Eng Technol 2011;81:399-404.
7. Pande RA, Mishra HN. Effect of fluidized bed heat treatment on insect mortality, proximate composition and antinutritional content of stored green gram (*Vigna radiata*) seeds. Journal of Food Chemistry and Nutrition 2013;01(02):94-99.
8. Rees D. Insects of Stored Products. Collingwood: CSIRO 2004.
9. Yoshihashi T, Tirawanichakul Y, Tirawanichakul S, Surojanamathakul V, Visarathanonth P, Kengkanpanich R *et al.* Relationship between drying method and quality of rice. JIRCAS Working Report No. 45 2006, 137-140.
10. Uraichuen J, Imamura T, Miyanoshita A, Visarathanonth

P. Effect of temperature on development of *Theocolax elegans* (Hymenoptera: Pteromalidae) parasitizing maize weevil larvae (*Sitophilus zeamais*) in brown rice. JIRCAS Working Report No. 45 2006, 101-105.

11. Flinn PW, Hagstrum DW. Temperature-mediated functional response of *Theocolax elegans* (Hymenoptera: Pteromalidae) parasitizing *Rhyzopertha dominica* (Coleoptera: Bostrichidae) in stored wheat. J Stored Prod. Res. 38 2002, 185-190.
12. Franco Jose G, Franco Suely SH, Franco Caio H, Arthur Paula B, Arthur Valter. Microwave radiation effects on the different stages of *Sitophilus oryzae* (Linne 1763) (Coleoptera, Curculionidae) evolutive cycle in rice, focusing its control. INAC 2013: International Nuclear Atlantic Conference, Brazil.