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INFLUENCE OF PROCESSING STAGES IN CULTIVATED RICE VARIETIES ON THE FEEDING PREFERENCE OF THE LESSER GRAIN BORER, *RHYZOPERTHA DOMINICA* F. (COLEOPTERA: BOSTRICHIDAE)

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ABSTRACT

Rhyzopertha dominica (Coleoptera: Bostrichidae), a prevalent post-harvest pest in rice storage, significantly impacts global financial losses, necessitating a comprehensive understanding of its feeding habitats and processing phases. This study aimed to compare feeding preferences of *R. dominica* among four rice cultivars (Basmati 515, Super Basmati, Super Gold, and Super Basmati 2019) and three processing stages (paddy, brown rice, and polished rice). *Rhyzopertha dominica* exhibits distinct feeding preferences for rice cultivars and processing stages, with paddy of Super Basmati 2019 having the highest mortality rate (50.89%) and Basmati 515 polished rice having the highest survival rate (84.89%). The maximum growth rate (67.00 nos.), grain damage (80.67%), and grain weight loss (1.5806%) were seen on polished rice of Basmati 515. The study reveals that the processing stages of rice cultivars significantly influence *R. dominica* infestation and feeding preferences, with polished rice being the preferred stage. The study emphasizes the need for site-specific integrated pest management strategies to control *R. dominica* infestation in rice, highlighting the need for further research on its feeding preferences. To mitigate insect losses, improved management strategies should be implemented, including improved storage conditions, post-harvest handling practices, and a combination of physical and chemical control techniques.

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INTRODUCTION

The lesser grain borer, *Rhyzopertha dominica*, is a devastating pest of stored grains, causing significant financial losses globally (Edde et al., 2012). Although it originated in the Mediterranean area, it has since expanded to many other regions of the world, including Africa, Asia, Europe, Australia, and North and South America. It has been identified as a serious pest of grain storage in Pakistan (Dowdy et al., 1993; Mayhew and Phillips, 1994). The pest has reportedly been found in wheat and rice stored in both conventional and sophisticated facilities across the nation (Chittenden, 1911). Reports of infestation rates in stored wheat as high as 100% have resulted in substantial financial losses for farmers and the food industry (Razaq et al., 2015).

Studies have indicated that *R. dominica* can cause losses

ranging from 10-100% in stored grains, depending on the intensity of the infection and the storage circumstances. For instance, a study carried out in India discovered that, depending on the length of storage and temperature conditions, *R. dominica* infestation in stored wheat led to a loss of between 8.1-33.4% (Kumar et al*.,* 2016). Another study conducted in Egypt found that *R. dominica* infestation in stored wheat led to losses of up to 100% in just 45 days (Abdullah et al*.,* 2015). Numerous studies have reported losses driven by *R. dominica* infestation in Pakistan. For instance, a study conducted in the Punjab province found that smaller grain borer infestation caused a loss of up to 29.5% in stored wheat. In a study conducted in the Sindh region, it was discovered that smaller grain borer infection in stored rice caused a loss of up to 20% (Mahroof and Phillips, 2012). It is significant to note that *R. dominica* infestation losses have been documented in countries other than Pakistan. For example, a study conducted in Ethiopia found a loss of up to 38% caused by *R. dominica* infection in stored corn (Subramanya and Resoli, 2016). The infestation of *R. dominica* in stored maize also resulted in a loss of up to 21% of the crop, according to a Mexican study (Castro-Rocha et al., 2017).

R. dominica can infest dried fruits like figs, dates, raisins, and prunes, damaging seeds and causing significant losses in spice production. It may also be present in spices like cumin, coriander, red pepper, and black pepper (Lale et al., 2017; Trematerra et al., 2000). *R. dominica* has two potential damage types: direct damage and indirect damage. The word "direct damage" refers to the beetle's own physical harm. Its larvae bore into the kernels of stored grains, such as wheat, corn, and rice, consuming the endosperm and leaving behind damaged kernels with a recognizable circular escape hole. Adult bugs eat grains as well, which causes more damage.

R. dominica feeds and reproduces, allowing fungi to grow and produce mycotoxins, indirectly harming grain quality. Stored grain's exuviae and excrement promote fungi growth, contaminating grain (Nayak et al*.,* 2020). It can harm storage grains, reducing their market value due to discoloration, shriveling, lower test weight, and potential rejection or downgrade if live beetles or damaged kernels are present (Opit et al*.,* 2012). It can cause significant economic damage, with an estimated $1 billion loss annually in the United States alone due to pest infestations in stored grains (Arthur et al*.,* 2009). Pest infestations in stored grains in developing countries, where storage facilities and insect management methods are less advanced, can lead to up to 25% of losses (Nayak et al*.,* 2020).

The current study was designed with the aforementioned information in mind to investigate the effects of various rice cultivars (Basmati 515, Super Basmati, Super Gold, and Super Basmati 2019) on *R. dominica* feeding preferences (survival rate, mortality rate, and growth rate), as well as associated post-harvest losses (grain damage and grain weight loss).

MATERIALS AND METHODS

Research site

The Rice Research Institute's Entomology Laboratory in Kala Shah Kaku, Punjab, Pakistan, which is situated at 31°43′ 17" N and 74° 16' 14" E, was chosen as the study location for the year 2023.

Mass rearing of *Rhyzopertha dominica*

Preparation of rice grains

Rice grains were cleaned, washed, and dried, then placed in plastic containers with a 1.5 L capacity, distributing 1 kg evenly. A mesh was placed on top to prevent insects' escape.

Introduction of adult *R. dominica*

Adult *R. dominica* adults were fed to containers from maintain rice grain culture, with 100-200 insects added. Containers incubated at 30°C and 60% relative humidity for adaptation and reproduction.

Maintenance and monitoring

Daily observations of insect activity in containers, checking for bacterial, fungal, or mold growth, and removing tainted grains were conducted. Containers were changed weekly to prevent heat and moisture accumulation. After 30 days, insects were removed and rice grains were dried. Adult of *R. dominica* that had undergone a 24-hour starvation phase before the research study started were 2-3 weeks old post-hatch.

Procurement of rice cultivars and preparation of their processing stages

The Breeding Section developed rice varieties viz. Basmati 515, Super Basmati, Super Gold, and Super Basmati 2019. Each cultivar had unique processing steps for paddy, brown rice, and polished rice, after cleaning and grinding samples (Atta et al., 2022).

Evaluation of feeding preference of *R. dominica* along with the associated post-harvest losses on various processing stages of rice cultivars

The rice cultivars were processed, weighed, and placed

in plastic jars. Thirty *R. dominica* adults were added, and the experiment was repeated three times, with the activity boosted in a dark room. Adults and insect-damaged rice cultivars were gently shaken over a white sheet of paper after 15, 30, and 45 days, and then placed in the sun for 30 minutes.

The study recorded *R. dominica* survival, mortality, and growth rates in each jar, visually examined for signs of damage, and weighed and measured to determined level of damage after processing phases were divided into grains with and without damage. The methods used to carry out these processes were those indicated above by Atta et al. (2020; 2022). After 45 days, the weight loss was determined by counting and weighing all of the rice cultivars under examination's insect-damaged processing stages with an analytical balance.

The parameters that were recorded were calculated using the formula below:

$$\text{Survival rate (\%)} = \frac{\text{TN}_\text{a}}{\text{TN}_\text{i}} \times 100$$

Where: TN_a = Total number of alive insects; TN_i = Initial number of insects released

$$\text{Mortality rate (\%)} = \frac{\text{TN}_d}{\text{TN}_i} \times 100$$

Where: TN_d = Total number of dead insects; TN_i = Initial number of insects released

$$\text{Grain damage (\%)} = \frac{\text{N}_\text{d}}{\text{N}_\text{t}} \times 100$$

Where: N_d = number of damaged grains; N_t = total number of grains in sample (Atta et al., 2022)

$$\text{Grain weight loss (\%)} = \frac{(\text{W}_\text{u} \times \text{N}_\text{d}) - (\text{W}_\text{d} \times \text{N}_\text{u})}{\text{W}_\text{u}(\text{N}_\text{d} + \text{N}_\text{u})} \times 100$$

Where: W_u = weight of undamaged paddy grains; N_u = number of undamaged paddy grains, W_d = weight of damaged paddy grains; N_d = number of damaged paddy grains (Atta et al., 2022)

Statistical analysis

The data were analyzed using Statisticx® version 8.1, calculating survival, mortality, and growth rates of *R. dominica* in factorial experiments in a Completely Randomized Design (CRD) using two-way analysis of variance (ANOVA). On the other hand, a one-way ANOVA was used to evaluate grain damage and weight losses within the same CRD. The study used a Bonferroni test with a significance level of P = 0.05 to compare means and assess differences between data sets to determine the relative effects of tested rice cultivars on *R. dominica* infestation.

RESULTS

Feeding preference of *R. dominica* and associated post-harvest losses in paddy rice cultivars

Survival rate

The study found that the primary effects of rice cultivars and time intervals on *R. dominica's* percent survival rate were highly significant (P < 0.05), with no significant interaction effects (P > 0.05) (Table 1). The study found significant differences in the percent survival rate of *R. dominica* on paddy among the rice cultivars investigated, with the highest rate on Basmati 515 (75.56%) (Table 2). The survival rate of *R. dominica* significantly varied over time, with the highest survival rate (68.50%) occurring at 45 days and the lowest of 52.00% at 15 days (Table 3).

Mortality rate

The study found significant main effects of *R. dominica* mortality rate (%) on rice cultivars and time intervals on paddy mortality (P < 0.05), but no significant interaction effects were observed (P > 0.05) (Table 1). The *R. dominica* rice cultivars, Basmati 515 and Super Basmati 2019, had varying mortality rates, with the former having the lowest (24.44%) and the latter of 50.89% (Table 2). The mortality rate of *R. dominica* exhibited significant fluctuations across different time periods, with the highest rate occurring at 15 days and the lowest at 45 days (Table 3).

Growth rate

The study revealed that the growth rate of *R. dominica* was significantly influenced by the paddies, times, and interactions of the test rice cultivars (Table 1). The study found that rice cultivars like Basmati 515 and Super Basmati 2019 showed varying growth rates on paddy, with the longest interval having the most beneficial effect. The maximum growth rate for Basmati 515 was recorded at a 45-day interval (62.33) and the minimum growth rate for Super Basmati 2019 was recorded at a 15-day interval (26.33) (Table 4).

Grain damage

The study revealed that the paddy rice cultivars tested had a significant impact (P < 0.05) on the percentage of damaged grains (Table 1). Rice cultivars examined showed significant grain damage from *R. dominica*, ranging from 71.33% on Basmati 515 to 31.33% on Super Basmati 2019, indicating substantial differences (Table 5).

Table 1. Analysis of Variance (ANOVA) for the survival rate (%), mortality rate (%), growth rate, grain damage (%) and grain weight loss (%) of *Rhyzopertha dominica* on processing stages of tested rice cultivars at different time intervals.

Source	*df*	Paddy		Brown rice		Polished rice	
		F-value	*P*-value	*F*-value	*P*-value	*F*-value	*P*-value
Survival rate (%)							
Cultivars	$3^a/35^b$	41.08	0.0000**	33.70	0.0000**	27.60	0.0000**
Time intervals	$2^a/35^b$	24.49	0.0000**	20.08	0.0000**	16.45	0.0000**
Cultivars × Time intervals	$6^a/35^b$	0.36	0.8969^{NS}	0.30	0.9332^{NS}	0.24	0.9580^{NS}
Mortality rate (%)							
Cultivars	$3^a/35^b$	41.08	0.0000**	33.70	0.0000**	27.60	0.0000**
Time intervals	$2^a/35^b$	24.49	0.0000**	20.08	0.0000**	16.45	0.0000**
Cultivars × Time intervals	$6^a/35^b$	0.36	0.8969^{NS}	0.30	0.9332^{NS}	0.24	0.9580^{NS}
Growth rate							
Cultivars	$3^a/35^b$	5.59	0.0047**	6.20	0.0028**	3.67	0.0263**
Time intervals	$2^a/35^b$	81.25	0.0000**	90.23	0.0000**	53.33	0.0000**
Cultivars × Time intervals	$6^a/35^b$	10.99	0.0000**	12.20	0.0000**	7.21	0.0002**
Grain damage (%)							
Cultivars	$3^a/11^b$	11.5	0.0029**	7.04	0.0124**	24.5	0.0002**
Grain weight loss (%)							
Cultivars	$3^a/11^b$	123	0.0000**	1832	0.0000**	5569	0.0000**

Means with the same lowercase letters are not significantly different at α = 0.05 (Bonferroni test). ***df*:** degree of freedom. [a] Degree of freedom of treatment. [b] Error degree of freedom. **Highly significant at probability level of 5%. [NS]Non significant at probability level of 5%.

Table 2. Survival rate (%) and mortality rate (%) of *Rhyzopertha dominica* on processing stages of tested rice cultivars.

Cultivars	Paddy		Brown rice		Polished rice	
	Survival rate (%)	Mortality rate (%)	Survival rate (%)	Mortality rate (%)	Survival rate (%)	Mortality rate (%)
Basmati 515	75.56a	24.44c	79.56a	20.44c	84.89a	15.11c
Super Basmati	65.56b	34.44b	69.56b	30.44b	74.89b	25.11b
Super Gold	51.78c	48.22a	55.78c	44.22a	61.11c	38.89a
Super Basmati 2019	49.11c	50.89a	53.11c	46.89a	58.44c	41.56a

Table 3. Survival rate (%) of *Rhyzopertha dominica* on processing stages at different time intervals.

Time interval	Paddy		Brown rice		Polished rice	
	Survival rate (%)	Mortality rate (%)	Survival rate (%)	Mortality rate (%)	Survival rate (%)	Mortality rate (%)
15 days	52.00c	48.00a	56.00c	44.00a	61.33c	38.67a
30 days	61.00b	39.00b	65.00b	35.00b	70.33b	29.67b
45 days	68.50a	31.50c	72.50a	27.50c	77.83a	22.17c

Table 4. Growth rate of *Rhyzopertha dominica* on processing stages of tested rice cultivars at different time intervals.

Cultivars	Time intervals (Days)	Growth rate		
		Paddy	Brown rice	Polished rice
Basmati 515	15	36.00 h	38.00 h	40.67 h
	30	49.00 d	51.00 d	53.67 d
	45	62.33 a	64.33 a	67.00 a
Super Basmati	15	35.67 h	37.67 h	40.33 h
	30	45.33 e	47.33 e	50.00 e
	45	56.00 b	58.00 b	60.67 b
Super Gold	15	29.67 i	31.67 i	34.33 i
	30	42.67 f	44.67 f	47.33 f
	45	53.00 c	55.00 c	57.67 c
Super Basmati 2019	15	26.33 j	28.33 j	31.00 j
	30	39.00 g	41.00 g	43.67 g
	45	50.00 d	52.00 d	54.67 d

Table 5. Grain damage (%) due to *Rhyzopertha dominica* on processing stages of tested rice cultivars.

Cultivars	Grain damage (%)		
	Paddy	Brown rice	Polished rice
Basmati 515	71.33 a	75.33 a	80.67 a
Super Basmati	59.33 ab	63.33 b	68.67 ab
Super Gold	42.67 bc	46.67 c	52.00 bc
Super Basmati 2019	31.33 c	35.33 c	40.67 c

Grain weight loss

The statistical analysis revealed that the paddy of the tested rice cultivars significantly impacted (P< 0.05) the grain weight loss caused by *R. dominica*. (Table 1). Rice varieties examined showed significant grain weight losses due to *R. dominica*, with Basmati 515 experiencing the highest loss (0.3335%) and Super Basmati 2019 showing the lowest (0.1746%) (Table 6).

Table 6. Grain weight loss (%) due to *Rhyzopertha dominica* on processing stages of tested rice cultivars.

Cultivars	Grain weight loss (%)		
	Paddy	Brown rice	Polished rice
Basmati 515	0.3335 a	0.9570 a	1.5806 a
Super Basmati	0.2757 b	0.7109 b	1.1461 b
Super Gold	0.1818 c	0.4174 c	0.6531 c
Super Basmati 2019	0.1746 c	0.2993 d	0.4239 d

Feeding preferences of *R. dominica* and associated post-harvest losses on brown rice in rice cultivars

Survival rate

The study found that the main effects of the examined brown rice cultivars and time periods on the percent survival rate of *R. dominica* were highly significant (P < 0.05). However, the interaction between cultivars and time intervals did not show a significant effect on the percent survival rate of *R. dominica* (P > 0.05) (Table 1). The survival rate of *R. dominica* on brown rice varied significantly among tested cultivars, with the highest rate recorded on Basmati 515 (79.56%) and the lowest on Super Basmati 2019 (53.11%) (Table 2). The survival rate of *R. dominica* on brown rice varied significantly at different intervals, with the highest rate (72.50%) at 45 days and the lowest (56.00%) at 15 days (Table 3).

Mortality rate

The statistical analysis revealed that the main effects of

brown rice cultivars and time intervals on the percent mortality rate of *R. dominica* were highly significant (P < 0.05). The study found that the percentage mortality rate of *R. dominica* did not significantly change due to the interaction of cultivars and time periods (P > 0.05) (Table 1). The mortality rates of *R. dominica* on brown rice cultivars varied significantly, with Super Basmati 2019 having the highest mortality rate (46.89%) and Basmati 515 having the lowest (20.44%) (Table 2). The mortality rates of *R. dominica* on brown rice varied significantly, with the 45-day interval having the lowest (27.5%) and the 15-day period having the highest (44%). The longest time period had a favorable effect on % mortality rate of *R. dominica* (Table 3).

Growth rate

The study revealed that the main effects of brown rice cultivars, time intervals, and their interaction significantly impacted the growth rate of *R. dominica* (P < 0.05) (Table 1). The growth rate of *R. dominica* on brown rice varied significantly at different time intervals, with the highest interval of 45 days, resulting in the highest growth rate on Basmati 515 (64.33) while the minimum growth rate of *R. dominica* was recorded on Super Basmati 2019 at a 15 days interval (28.33) (Table 4).

Grain damage

The statistical analysis showed that the main effects of brown rice of tested cultivars on percent grain damage due to *R. dominica* was highly significant (P < 0.05) (Table 1). The study found significant differences in grain damage caused by *R. dominica* on brown rice cultivars, with Basmati 515 exhibiting the highest damage (75.33%) and Super Basmati 2019 showing the least (35.33%) (Table 5).

Grain weight loss

The statistical analysis revealed that the main effects of brown rice cultivars on the percent grain weight loss caused by *R. dominica* were highly significant (P < 0.05) (Table 1). The study found significant differences in grain weight loss due to *R. dominica* on brown rice cultivars, with Basmati 515 experiencing the highest loss (0.9570%), while the lowest weight loss (0.2993%) was observed in Super Basmati 2019 (Table 6).

Feeding preference of *R. dominica* and associated post-harvest losses in polished rice cultivars

Survival rate

The statistical analysis revealed that the main effects of polished rice cultivars and time intervals on the percent survival rate of *R. dominica* were highly significant (P < 0.05). However, the interaction between cultivars and time intervals did not have a significant effect on percent survival rate (P > 0.05) (Table 1). The survival rate of *R. dominica* on polished rice varied significantly among tested cultivars, with Basmati 515 having the highest rate of 84.89% and Super Basmati 2019 having the lowest of 58.44% (Table 2). The survival rate of *R. dominica* on polished rice varied significantly at different intervals, with the highest rate (77.83%) at 45 days and the lowest (61.33%) at 15 days, with higher intervals positively affecting survival rates (Table 3).

Mortality rate

The study found significant effects (P < 0.05) of polished rice cultivars and time periods on *R. dominica* mortality rate, but no significant variation (P > 0.05) in percent mortality rate when interacted (Table 1). The mortality rate of *R. dominica* on polished rice varied significantly among examined cultivars, with Basmati 515 having the lowest mortality rate and Super Basmati 2019 having the highest (41.56%) (Table 2). The percent mortality rate of *R. dominica* on polished rice varied significantly among the cultivars examined, with Basmati 515 having the lowest percent mortality rate and Super Basmati 2019 having the greatest percent mortality rate (41.56%) (Table 3).

Growth rate

The mortality rate of *R. dominica* on polished rice varied significantly (P < 0.05) among examined cultivars, with Basmati 515 having the lowest mortality rate and Super Basmati 2019 having the highest (41.56%) (Table 1). The study found that the growth rates of *R. dominica* on polished rice varied significantly over time, with Basmati 515 showing the highest growth rate (67.00) over 45 days interval and Super Basmati 2019 having the lowest growth rate (31.0) at a 15-day interval (Table 4). The growth rate of *R. dominica* was significantly influenced by specific polished rice cultivars and experimental time periods, with the longest period having a positive effect.

Grain damage

The statistical analysis indicated that polished rice cultivars significantly influenced the percentage of grains that *R. dominica* damaged (*P* < 0.05) (Table 1). The effects of *R. dominica* on polished rice from examined cultivars varied significantly, with Basmati 515 showing the highest grain damage (80.67%) and Super Basmati 2019 showing the lowest (40.67%) (Table 5).

Grain weight loss

The statistical analysis revealed a significant impact of polished rice cultivars on the percent grain weight loss caused by *R. dominica* ($P < 0.05$) (Table 1). The study found that *R. dominica* significantly affected the percent grain weight loss on polished rice, with Basmati 515 experiencing the highest loss of 1.5806% and Super Basmati 2019 suffering the lowest percent grain weight loss (0.2993%) (Table 6).

DISCUSSION

The present study compared post-harvest losses and feeding preferences of *R. dominica* in different rice cultivars to develop effective management measures for economic loss and pest control.

Impact of processing stages of different cultivated rice cultivars on survival rate of *R. dominica*

The study revealed that rice cultivar processing stages significantly affected *R. dominica* survival rate, with polished rice being more susceptible and each cultivar having a different preferred feeding method. The polished Basmati 515 rice had the highest *R. dominica* survival rate, indicating its vulnerability to insect invasion due to the removal of the protective coating during the polishing process. *R. dominica*'s preference for specific rice cultivars was due to variations in chemical composition and nutritional contents, such as Basmati 515's higher starch and reduced protein content, which may promote insect growth and survival.

Impact of processing stages of different cultivated rice cultivars on mortality rate of *R. dominica*

The study found that Super Basmati 2019 rice had a higher *R. dominica* death rate compared to polished and brown rice, possibly due to its lower processing stage and higher moisture contents, which is better for *R. dominica* growth and development. (Tian et al., 2019). The study found that rice type significantly influenced *R. dominica* feeding preferences, with the Super Basmati 2019 variety having the highest death rates due to genetics or processing techniques (Chaudhry et al., 2020).

Impact of processing stages of different cultivated rice cultivars on growth rate of *R. dominica*

The study found that polished Basmati 515 rice had the highest growth rate of *R. dominica*, indicating that rice grain polishing affected feeding preferences. Basmati 515 rice was preferred for *R. dominica*, and experienced higher post-harvest losses. Research indicated that polishing rice grains can significantly alter *R. dominica* feeding preferences, potentially leading to increased post-harvest losses, confirming its vulnerability to *R. dominica* infestations (Sundaram and Krishnamoorthy, 2018; Sharma et al., 2020).

The results also demonstrated that when it came to feeding, *R. dominica* had distinct preferences for various rice cultivars, with Basmati 515 being the pest's top pick. This outcome is consistent with past studies, which demonstrated that Basmati rice types are extremely vulnerable to *R. dominica* infestations (Pandey and Singh, 2011; Iqbal et al., 2015).

Impact of processing stages of different cultivated rice cultivars on grain damage due to *R. dominica*

The study revealed that Basmati 515 polished rice was the most susceptible to *R. dominica* damage, with a maximum grain damage percentage of 75.33%, while Super Basmati 2019 was the least susceptible. Processing stage also affected *R. dominica* feeding preference. Polished rice, due to extensive processing, was more susceptible to *R. dominica* damage than brown rice and paddy due to the removal of outer layers, reducing rice's natural defense mechanisms (Astuti et al., 2013). The study revealed that rice cultivars' susceptibility to *R. dominica* infestation varied due to genetic factors, with Super Basmati 2019 being the least susceptible and Basmati 515 being the most susceptible (Ebadollahi and Borzoui, 2019; Hampton et al., 2019).

Impact of processing stages of different cultivated rice cultivars on grain weight loss due to *R. dominica*

In comparison to paddy and brown rice, polished Basmati 515 rice saw the greatest grain weight loss as a result of *R. dominica*. This outcome is consistent with studies conducted by Zou et al. (2016), who found that polished rice had a lower fiber content and a higher starch content, making it more vulnerable to insect damage. The high starch content of polished rice may appeal to *R. dominica* as a rich source of nutrition, resulting in increased feeding and a loss of weight.

Compared to polished rice, paddy and brown rice showed less grain weight loss due to *R. dominica*. According to a study by Cheng et al. (2018), paddy and brown rice had lower starch contents and higher fiber contents, which may make them less attractive to *R. dominica*. This finding is in line with their findings. Therefore, the processing stage of rice cultivars plays a critical role in determining the feeding preference and weight loss of *R. dominica*. Cheng et al. (2018)

experimented that paddy and brown rice showed less grain weight loss due to *R. dominica*, as they have lower starch and fiber content, making them less attractive, suggesting that processing stage plays a crucial role.

The feeding preferences of *R. dominica* were shown to be significantly influenced by the rice cultivars used in the study. The largest grain weight loss due by *R. dominica* was seen in Basmati 515, the most affected of the four rice cultivars analyzed. This result is in line with a study by Talukder et al. (2017) who found that basmati rice cultivars are particularly vulnerable to insect damage because of their fragrant nature and reduced fiber content. Super Basmati, Super Gold, and Super Basmati 2019 showed less grain weight loss as a result of *R. dominica* than Basmati 515. This result is consistent with a study by Zhu et al. (2019), who found that *R. dominica* was less attracted to rice cultivars with higher fiber content and lower starch content.

The study highlights the significant influence of rice variety and processing stage on R. *dominica*'s feeding preferences and weight loss, highlighting the need for careful consideration in rice processing and storage facilities.

CONCLUSION

The results of this study suggest that the choice of rice for feeding of *Rhyzopertha dominica* that is significantly influenced by the type of rice used and the stage of processing. While paddy, brown, and rice cultivars with higher fiber and lower starch contents were less appealing to *R. dominica*, polished rice of Basmati 515 demonstrated the highest survival rate, growth rate, grain damage, and grain weight loss due to *R. dominica*. The study reveals that rice type and processing stage significantly influenced *R. dominica* feeding, with polished Basmati 515 rice showing the highest survival rate, growth rate, grain damage, and weight loss. Super Basmati 2019 rice has high death rate due to *R. dominica*, requiring discouragement and replacement with higher fiber and lower starch cultivars. To reduce post-harvest losses caused by *R. dominica* polished rice, especially Basmati 515, should be discouraged and replaced with rice cultivars with higher fiber and lower starch concentrations.

AUTHORS' CONTRIBUTIONS

BA, AMS and TB designed and conducted the experiment, collected and analysed the data, and wrote manuscript; MDG, MAF and MAA helped in apprehending the idea of this research, designing the layout of experiment and improving the write-up, format and language of this manuscript; THA, SSA, and MUS reviewed the manuscript, added and improved declaration section, edited the format of the tables according to the format of the journal; BA, AMS, MDG, MAF and AN contributed in data setting for analysis, reviewed the final manuscript and made the format of this manuscript according to the format of the journal; This final manuscript was ultimately perused, scrutinized and approved for final submission by all the authors.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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