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Effectiveness of Jengkol (Pithecollobium Lobatum) Fruit Peel as A Botanical Repellent for Munia Birds (Lonchura Spp.) in Bogor, West Java, Indonesia

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ABSTRACT

Three munia birds, javan munia (Lonchura leucogastroides), white-headed munia (Lonchura maja), and scaly-breasted munia (Lonchura punctulata), are important pests at rice fields in Indonesia. These seed-eating birds can consume up to 10% of their body weight in seeds, causing significant damage. Botanical repellents, which use active ingredients derived from plants, are an eco-friendly method to deter pests. This study examined the potential of jengkol (Pithecollobium lobatum) fruit peel as a natural repellent to control munia birds in the rice fields. The research was conducted in Cicadas Village, Ciampea District and Situ Gede Village, West Bogor District. Repellent concentrations of 0, 400, 600, and 800 g jengkol fruit peel per liter water, then it diluted within water with 10 ml of jengkol fruit peel concentrate per liter water. Each concentration were applied to 75 m² plots within spray volume of 3.75 liter. Bird populations were observed over seven consecutive days. The results showed that no concentration approached the 70% repellent standard, with the effect lasting only one day after spraying due to various factors including rain, heat, and the surrounding environment. These findings suggest that the jengkol fruit peel for bird repellent is ineffective in its current form, therefore it need a sticker. Keywords : Efficacy, important pest, seed-eating birds

INTRODUCTION

The bondol bird is a seed-eating pest that often attacks rice plants. The presence of the bondol bird is often worrying and a threat to farmers, because it attacks rice grains both ready for harvest and those that have not been harvested. In Indonesia, some types of bondol birds that often attack rice plants include scaly-breasted munia (Lonchura punctulata), Javan munia (Lonchura leucogastroides), and white-headed munia (Lonchura maja). The distribution of the bondol bird population is spread across the islands of Sumatera, Java, Sulawesi, Bali, and Nusa Tenggara (Kusumanegara et al. 2015).

The bondol group consists of seed-eating birds that can consume up to 10% of their body weight in the form of seeds (Soemadi and Mutholib 2003). The presence of the bondol bird and its feeding activities can cause rice panicles to break, rice grains to break and fall, which has a negative impact on rice plants (Ejiogu and Okoli 2012). This bird can cause serious damage to rice plants due to its group attack pattern. Protecting rice plants in the field is a problem in maintaining the quantity and quality of rice to reduce the risk of crop failure, especially as the population increases. The agricultural industry is an important component in a country's economy, especially because rice is the main food crop in Asia, including Indonesia (Alamadani 2024). Problems faced by farmers can be caused by failure to respond quickly to rice pest attacks. It is crucial for farmers to understand the value of early pest prevention. Without this knowledge, agricultural yields may decline, which may result in significant financial losses (Ucik and Abidin 2024).

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Controlling the munia bird is generally done by using scarecrows, metallic colored ropes, and other things that can generally threaten the existence of the munia bird (Ardjansyah *et al.* 2017). Other control methods, such as guarding the rice fields from morning to evening, require a lot of energy and time to get rid of these bird pests (Abipraya 2018). Some control measures that have been widely implemented, such as the use of nets, are often limited in effectiveness and less sustainable (Tuti et al. 2024). Wise control is needed to maintain the sustainability of the munia bird and not disrupt the food chain system as well as new and sustainable approaches.

Botanical pesticides can be a good choice because they use plant components that are easily available and do not harm the environment, unlike chemical pesticides. Toxic residues that accumulate in water, soil and plants require special treatment. More than 400,000 plant species have been chemically identified, with 10,000 of them containing secondary metabolites that can be used to make botanical insecticides (Saenong 2016). Around 1,800 plant species are claimed to have botanical pesticides that can be used for pest control. In Indonesia itself, plant species that produce botanical pesticides are grouped into 235 families with 2,400 plant varieties (Kardinan 2011).

Jengkol (*Pithecollobium lobatum*) is a tropical plant that is widely found in Indonesia. Jengkol plants are woody shrubs that grow up to 20 m tall and can be found in both highlands and lowlands. This plant produces brown fruit that is round and flat. Jengkol fruit is a plant that is rich in vitamin C, carbohydrates, protein, vitamins A and B, phosphorus, calcium, alkaloids, essential oils, steroids, glycosides, tannins, and saponins (Thressia and Mulyadi 2022). The tannin and flavonoid content in jengkol skin is as strong as the tannin and flavonoid content in woody and herbaceous plants, which helps protect these plants from pest attacks. The high tannin content makes jengkol skin a promising candidate for use as a botanical insecticide (Sakinah 2010). Jengkol skin can influence the consumption level of rice field rats (Rattus argentiventer) due to its aroma, the concentration levels tested include 200 g/L, 400 g/L, 600 g/L, and the best results were obtained at a concentration of 800 g/L (Simbolon *et al.* 2017). This is expected to be in line with the objective of this research, namely to determine the effectiveness of jengkol skin fruit solution against the munia bird pest in rice crops.

MATERIAL AND METHOD

Place and Time of Research

This research was conducted in Cicadas Village, Ciampea District, Bogor Regency and Situ Gede Village, West Bogor District, Bogor City. Time of repellent apllication from August to November 2024.

Materials and Tools

The materials used in this study were jengkol fruit skin and water. The tools used in this study were scales, buckets, trays, knives, scissors, measuring tape, blenders, raffia rope, sieves, jerry cans, measuring cups, 8 liter knapsack sprayers, Canon EOS Kiss X8i cameras, Tamron 70-300 mm telephoto lenses, smartphones, and counter applications.

METHOD

Jengkol Skin Preparation

Jengkol skin/peel is obtained from waste from the Citayam Raya Traditional Market, Depok City, West Java (Figure 1a), which is intentionally discarded as it is considered to have no economic value. Selected mature jengkol peel (Figure 1b) is washed with water and drained for approximately 15 minutes.

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Figure 1 (a) Citayam Traditional Market, Depok City; (b) Washed jengkol fruit peel waste Repellent Production[a]

The jengkol fruit peel was first sliced into small pieces and then ground using a blender. The test treatments (concentration) were 400 g, 600 g, and 800 g of jengkol fruit peel per liter of water. Spray volume applicated 500 liter/Ha, equal with 3.75 liter/75 m^2 resulting 15 g, 22.5 g, and 30 g dose of jengkol fruit peel per 75 m^2. The ground jengkol fruit peel solution was left for 24 hours to produce a strong aroma due to its sulfur concentration (Sakinah 2010).

Observation Plots

One plot in each observation location covered an area of 300 m^2 and was divided into four (4) plots of 75 m^2 each. Within each treatment plot, there were five sub-plots, each measuring 1 m^2. The sampling points were positioned 1 m from the edge of the field and 2 m from the center sub-plot (Figure 2).

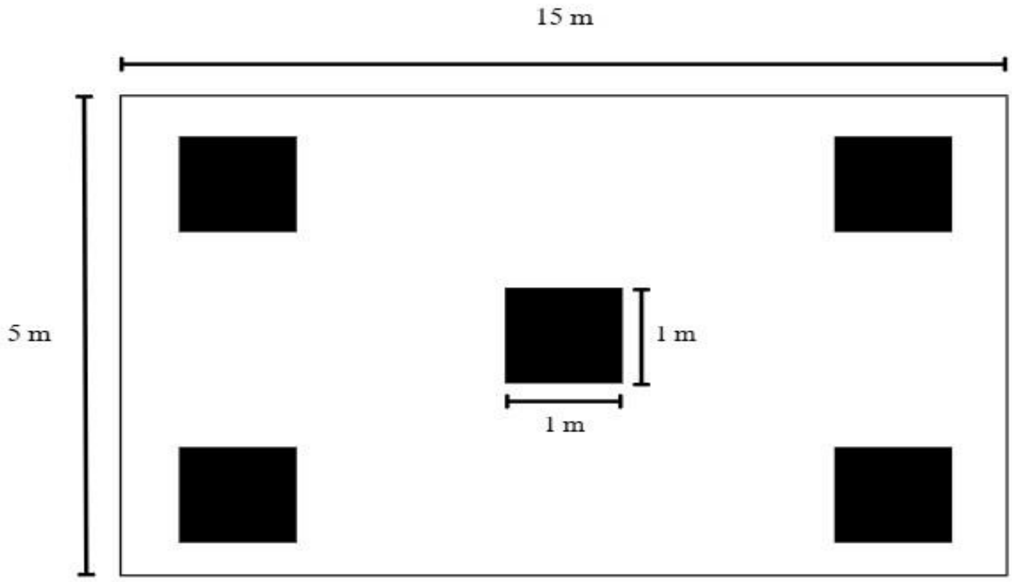

Figure 2. Sub-plots within the treatment plot Jengkol Fruit Peel Repellent Spraying Volume

The spraying volume of 7.5 liters was used with an 8-liter sprayer for two plots. The concentration of the jengkol fruit peel solution used was 10 ml/liter. The observation area was divided into five sub-plots of 75 m^2. The volume of jengkol fruit peel solution used was as follows: 3.75 liter/75 m^2, with each treatment consisting of six (6) plots sprayed once per replication. Plots one and two were located in Cicadas, and plots three to six were located in Situ Gede. **Observation Time**

There were six observation plots. The observation duration was 7 days, or one week per plot. Observations were conducted before spraying and followed by the first observation. Initial population observations on the first day were conducted from 5:30 to 6:00 a.m. WIB (Western Indonesian Time). Spraying was conducted from 6:00 to

7:00 a.m. WIB. The first observation was conducted from 7:00 to 8:00 a.m. WIB, followed by observations on subsequent days for six days.

Population Count and Identification of the White-rumped Shama (Wolf-billed Shama)

Wolf-billed Shama (Wolf-billed Shama) attacking rice plants were photographed using a Canon EOS Kiss X8i camera with a Tamron 77-300 mm telephoto lens. Counts were conducted using a counter app on a smartphone.

Data Analysis

The identification data was tabulated in Microsoft Office Excel 2019 to create a database. The average value and efficacy percentage were then calculated. Data analysis was performed using R software version 4.4.2 and R Studio version 2024.09.1. If the results were significantly different, the test was continued with the Tukey test at a 5% confidence level. The repellency criterion can be declared effective if the pesticide efficacy level reaches 70% (Priyambodo 2024).

RESULT AND DISCUSSION

Observations of Bondol Bird Species

The bondol bird species observed at both research sites were Javan munia (Lonchura leucogastroides), white-headed munia (L. maja), and the scaly-breasted munia (Lonchura punctulata). This finding aligns with the literature from Harahap and Tjahjono (1994) that various bird species, including the Javan munia, the scalybreasted munia, and the White-hraded munia, can be important pests of rice crops. Munia birds are a genus of small birds in the Lonchura Family, Ploceidae, that feed on seeds and live in tropical regions (Roslinawati et al. 2017).

Based on observations, the Javan munia (Lonchura leucogastroides) was the munia most frequently visited the observation fields in both areas. The Javan munia is distinguished by its dark upper body, from head to tail, and white belly (Figure 3a, MacKinnon 1990). The Javan long-tailed shrike is often observed during the rice harvest season, when many of this species form small groups and live in pairs. The scaly-breasted munia has a long-tailed shrike can also damage rice harvests. The scaly-breasted has long-tailed shrike, also known as the scaly-breasted shrike (Lonchura punctulata), is characterized by a brown upper body from head to tail, with a slightly reddish neck. The lower body, chest, and abdomen are white with brown markings (Figure 3b) (Wicaksana et al. 2020).

Another long-tailed shrike seen in the observation area is the white-headed long-tailed shrike. The whiteheaded long-tailed shrike (Lonchura maja) has distinctive white pigmentation from the head to the neck, and light to dark brown along the neck toward the chest and abdomen (Figure 3c, Widodo et al. 2024). During the rice harvest season, the white-headed munia long-tailed shrike behaves like other long-tailed shrike, appearing in large groups and pairing up when the breeding season begins. The white-headed munia bird is spread across Sumatra, Java, Sulawesi, and Bali (Kusumanegara et al. 2015).

Figure 1 (a) Javan munia (Lonchura leucogastroides); (b) scaly-breasted munia (Lonchura punctulata); and (c) white-headed munia (Lonchura maja)

External Influences on the Activity of Javan Munia

Bird as a pests in the rice fields can be influenced by various external variables, including the environment, human disturbance, food supply, weather, and resting places. Weather factors can be a factor in Java sparrow activity. Java sparrows are more active in foraging during calmer weather (Ziyadah 2011). Birds often forage between 6 and 10 a.m. and 2 and 6 p.m. (Hardiansyah 2020).

Plants are essential for bird survival, serving as nesting sites, monitoring, producing sounds, and providing shelter (Welty 1982). Javan munia's instincts can differentiate when selecting trees that are safe for their survival. Previous research indicates that Javan munia prefer trees between 3.5 m to 8 m tall, which are recommended for nesting, egg-laying, and monitoring food sources (Hidayatullah 2015). Based on information provided by Mr. Acep (personal consultation), a private rice field worker in Situ Gede, he stated that the incidence of munia bird attacks tends to be higher when rice planting is not carried out simultaneously with other rice fields in Situ Gede. This is in line with Tuti *et al.* (2024) which states that asynchronous rice planting can cause birds to choose rice plants that are already ripe or in the milk phase to eat (Kartikasari *et al.* 2024).

Durability of the Repellent Effect of Jengkol Fruit Peel

The average daily results of the effect of jengkol fruit peel on munia birds in each observation area. In the Cicadas observation area, munia birds population decreased on the first day after spraying. On the second day, it increased, followed by a decrease on days three and four. Munia birds population began to return to its before spray level on day five and then on the following days. In the Situ Gede observation area, the population decline occurred only on the first day, and then increased again to the initial before spray level on day two and thereafter. This suggests that the repellent effect of jengkol fruit peel only persists for 1-3 days, based on the average population results across all replications in six plots. Jumlah rata-rata burung munia di Cicadas lebih rendah daripada di Situ Gede (Table 1 and Figure 4).

Table 1 Mean number of munia birds (heads) in daily observation within six plots observation

Day of Observation	Plot								Mean
	1	2	Mean 1-2	3	4	5	6	Mean 5-6	
0	26	20	23	23	23	25	24	23.75	23.5
1	17	13	15	15	14	23	23	18.75	17.5
2	17	17	17	21	24	24	25	23.5	21.33
3	15	21	18	23	23	25	26	24.25	22.17
4	21	23	22	27	31	24	25	26.75	25.17
5	23	25	24	31	31	25	23	27.5	26.33
6	24	26	25	28	32	23	23	26.5	26
7	24	24	24	31	32	22	24	27.25	26.17
Mean	21	21	**21**	25	26	24	24	**24.75**	**23.52**

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Note: The first and second plots were observed in Cicadas and the third to sixth plots were observed in Situ Gede.

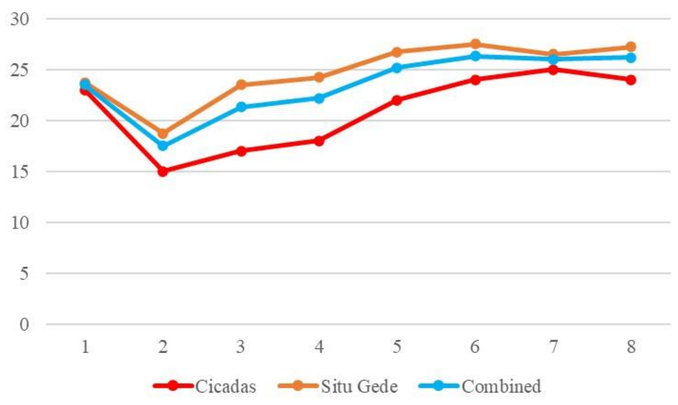

Figure 4 Number of munia birds (heads) in daily observation within six plots observation in Cicadas, Situ Gede, dan Combined

Based on field conditions, the weather during the observation period, from October to November, was quite variable. Rainfall in October 2024 occurred three times during the two weeks of observation. Observations continued at the Situ Gede sub-district site, where it rained almost every day for two weeks in November 2024. According to Suhardjadinata *et al.* (2019), the effectiveness of active ingredients in botanical pesticides is not maximized because they are easily washed away by rainwater, making them easily washed away or lost.

The Effect of Jengkol Fruit Peel Repellent

Bird population observations were conducted daily using a counter application on a smartphone, as shown in Table 1. The frequency of individuals munia birds indicates that the dominant species as a pest in rice crops is the Javan (Lonchura leucogastroides), followed by the scaly-breasted (L. punctulata), and the whiteheaded (L. maja) (Table 2). According to Ziyadah (2011), the Javan munia (L. leucogastroides) has greater potential as a pest in rice crops due to its higher feed consumption capacity than other birds.

Based on the test results, the average number of munia birds in each observation area and six observation plots was significantly different (Table 3). However, the control treatment with 400 g/liter showed no significant difference, and a comparison of the areas showed a significant difference between Cicadas and Situ Gede. However, the highest concentration (800 g/liter) showed a significant difference in the presence of munia birds compared to the control treatment at both locations and their combination. Pesticide efficacy can be declared effective if it reaches 70% (Priyambodo 2024) (Table 4). The highest efficacy results for each treatment were in Cicadas at 800 g/liter treatment.

Table 2 The number of frequencies of individual munia birds in two observation locations

Location	Number of individual munia bird (head)			Mean (head)	Total (head)
	Javan	Scaly-breast	White-headed		
Cicadas	645	283	209	446.67	1137
Situ Gede	1524	881	744	1049.67	3149
Total	2169	1164	953	1496.34	4286

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%	50.6	27.2	22.2		

Note: Number of birds from the first until the end of observation

Table 3 The effect of treatment jengkol fruit peel repellent on the presence of munia birds in the rice field

	Cicadas	Situ Gede	Combined	Pr > F		
Concentration (g/liter)				Cicadas	Situ Gede	Combined
Control	23 a	26.75 a	25.83 a	0.0093	0.0217	0.0186
400	21 ab	25.25 a	23.83 ab			
600	20 bc	24.75 ab	23.16 ab			
800	18 c	22 b	20.67 b			

Note: Numbers followed by the same letter in the same column indicate no significant difference from the results of the Tukey test at a 5% level. Data are daily individual data from the total individual bird data. Table 4 The efficacy test of jengkol fruit peel solution (%)

Concentration (g/liter)	Cicadas	Situ Gede	Combined	Reference
400	8,69	5,60	7.74	70%*
600	13,04	7,47	10.33	
800	21,74	17,75	19.97	

* Source: Priyambodo 2024

Based on the efficacy test results, no concentrations reached 70% in any replication. This indicates that jengkol fruit peel solution at any concentration is not effective enough to repel munia birds in rice fields. This is due to several factors, including rainfall and intense sunlight at the observation site, which can dissolve the jengkol fruit peel concentrate in the rice crops. Furthermore, the uneven harvest times cause munia birds from neighboring fields to migrate to the observation area. Therefore, an adhesive or sticker is needed to ensure the jengkol fruit peel solution adheres longer than before. The spray volume of 3.75 liters used in each plot is based on the use of common repellent plants (500 liter/Ha), such as jengkol leaf extract in research (Nugraha *et al.* 2016) and citronella extract in research (Rustam and Tarigan 2021).

CONCLUSIONs AND SUGGESTIONS

Conclusion The study of jengkol fruit peel solution showed a significant difference at a concentration of 800 g/liter compared to the control treatment (0 g/liter), as tested using the Tukey test at the 5% level. However, the efficacy test showed that the solution was less effective in repelling munia birds, as no treatment reached the standard efficacy value of 70%. Therefore, an adhesive or sticker is needed to make the jengkol fruit peel concentrate stick longer to the rice plants. External factors that contributed to the ineffectiveness of the jengkol fruit peel repellent for rice rats included rainy weather during the observation period, harvest times that did not coincide with harvest times in other fields, and the presence of trees around the rice fields that could provide shelter for rice rats during the day.

Suggestions

Further research on jengkol fruit peel repellent is expected to explore variations in solution concentration

to determine its effectiveness.

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