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First Report of Rodent Damage during Oyster Mushroom (*Pleurotus* sp.) Cultivation in Gujarat

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ABSTRACT: The incidence of rodent in oyster mushroom was evaluated at mushroom entrepreneur located in Dist. Tapi (Gujarat) during 2022. The house rat, *Rattus rattus* Gray was found major pests by consuming both the substrate in mushroom bags and the spawn layers in low cost mushroom house in tribal villages. The rat damage was ranged between 7.49 to 12.30 per cent with an average of 8.95±1.64 per cent during incubation phase and 3.21 to 5.74 per cent with average of 4.77±0.94 per cent during fruiting phase. Incubation period was the most susceptible than fruiting phase. Significantly highest mushroom yield was observed in healthy bag (1.69 kg to 2.43 kg per bag with an average of 2.00 kg/bag) as compared to bags infested with *R. rattus* (1.01 to 1.43 kg with an average of 1.27 kg/bag). Significantly lowest days for total mycelium colonization (20.6 days), first harvest (27.2 days), harvesting period (25.2 days) and total crop cycle (47.4 days) was observed in healthy bags as against infested bags (24.2, 30.8, 29.2 and 52.4 days, respectively). Whereas, significantly lowest cap diameter (84.72 mm), stipe length (32.08), stipe thickness (7.0), number of effective fruiting bodies (6.8) and fruiting body bunch weight (54.4 g) was observed in rat infested bags as against healthy bags (96.56 mm, 38.66 mm, 9.8 mm, 9.6, and 66.0 g, respectively).

Keywords: House rat, *Rattus rattus* Gray, oyster mushroom, incubation, fruiting, yield, morphology.

INTRODUCTION

The *Pleurotus* species, belongs of the basidiomycetes class, are typically grown on non-composted lignocellulosic substrates and have a shorter growth cycle compared to other types of mushrooms (Bellettini *et al*., 2018). These are shell-like fruiting bodies commonly known as "oyster mushroom", and also referred as "*Dhingri* mushroom" in India. The fanor spatula-shaped fruit body can be found in various colours depending on the species, including white, pink, yellow, grey, and blue (Verma *et al*., 2023). Their cultivation is popular due to the simple and low-cost methods. These mushrooms are highly favored not only for their taste, flavor, and pleasing texture but also for their nutritional and medicinal benefits (Sharma and Khanna 2019, Sarita *et al.,* 2023). *Pleurotus* sp. are found naturally in both temperate and tropical regions across the globe (Anderson *et al*., 2021) which are cultivated more widely around the world due to their adaptable nature (Badshah *et al*., 2021). Despite their potential, India's mushroom production has declined significantly, from 487 million MT in 2017 to 314.84 million MT in 2023 (Anonymous, 2023).

Mushroom farming in Gujarat presents several opportunities due to various factors such as favorable climatic conditions, easy availability of raw material increasing market demand, and supportive government initiatives. In India, rice straw is mainly used as substrate for large scale mushroom production (Kundu *et al*., 2022). But, cultivation and consumption of mushroom were limited due to lack of awareness about the health benefits of this high valued food. However, by the efforts of KVKs under Agricultural Universities through the trainings and awareness programmes, mushroom cultivation becomes popular among the people of Gujarat particularly in rural areas. Entrepreneurs and farmers can tap into this growing sector for profitable ventures, provided they are equipped with the necessary knowledge and resources.

Mushrooms are vulnerable to many pests throughout the growing cycle being commencing from the spawning stage to the harvest as they are typically grown in enclosed environments and ultimately results in substantial crop loss. Additionally, the risk of rapid

spread of insect pests and diseases is high, as the conditions are ideal for their unchecked multiplication. Some of the most significant mushroom pests include flies from the families Sciaridae, Phoridae, Cecidomyiidae, Scatopsidae, Drosophilidae, and Dolichopodidae, as well as moths from the Tineidae family, and beetles from the Nitidulidae family. In India, key arthropod pests affecting cultivated mushrooms include the sciarid fly, phorid fly, springtails, and mites (Teja *et al*., 2021). Insect, fly, and midge infestations that damage mushroom mycelia and fruiting bodies can lead to yield losses of up to 100% (Rina and Singh 2016). Additionally, mushroom mites such as *Luciaphorus perniciosus* Rack, *Formicomotes heteromorphus* Magowski, *Dolichocybe indica* Mahunka and *Histiostoma bakeri* Hughes & Jackson are commonly found infesting mushrooms, often causing losses ranging from 20-80% of the harvested crop (Jompong *et al*., 2015). Mushroom flies also contribute to the spread of mites and other pathogens by transporting them on their bodies to the mushroom beds. Sciarids, in particular, contaminate the compost with their faeces, causing it to become soggy and unfit for the spawn run (Limbule *et al*., 2021). As a result, managing a number of pests is crucial for achieving the best possible mushroom output on farms (Rijal *et al*., 2021). The information regarding occurrence of insect and non-insect pests including rodents on different types of mushroom grown in Gujarat is scanty. During primary survey on mushroom entrepreneurs, house rat became the major pest by consuming both the mushroom bags and the spawn layers. Hence the present study was undertaken to assess the rodent damage in oyster mushroom.

MATERIALS AND METHODS

In South Gujarat, October to April is the main season for oyster mushroom cultivation. This is because of fresh availability of raw material *i.e.*, paddy straw after harvest of paddy crop. The incidence of rodent in oyster mushroom was evaluated at mushroom entrepreneur located at Village- Nani Chikhali, Block Vyara, Dist. Tapi (Gujarat) (lies between Latitude of 21°06'29.43"N and Longitude of 73°26'41.15"E) who had 6 to 7 year experience in mushroom cultivation. All the recommended package of practices was followed while mushroom cultivation. Good quality spawn i.e. seeds of mushroom (spores) is the basic need of mushroom cultivation which has been grown mostly on cereal grains especially wheat or sorghum. Spawning is the process of filling sterilized substrate (wheat/paddy straw) mixed with spawns in different layers in polythene bags. After spawning the polythene bags are kept for incubation up to 18 to 20 days on bamboo racks allowing the spawn to colonize at 28°C to 30°C and 60 to 70% relative humidity. After colonization substrates was entirely covered with myceliumwhich appears milky white and then the polythene bags are shifted in fruiting compartment in which temperature was maintained at 24°- 28°C and kept at related humidity about 90% or above for further fruiting. The weight of every bag was approximately 4.5 to 5 kg. Rodent damage in terms of per cent infestation was worked out at both incubation and fruiting phases. For this, month wise total umber bags filled and numbers of infested bags at incubation and fruiting phase were noted. Based on this per cent infestation was calculated by using following formula

$$\text{Per cent rodent infestation} = \frac{\text{Number of bags infested}}{\text{Total number of bags filled}} \times 100$$

To evaluate the influence of *R. rattus* infestation on mushroom yield, an experiment was laid in paired-t test design with five replications. The healthy bags and rat infested bags were used as treatments and bag considered as replication. Ten bags were examined under each treatment (two bags/replication). After the incubation phase of 18 to 20 days, to assess the yield performance randomly five bags from healthy and rat infested were selected from October to April months. As soon as pin heads was commenced, plastic bags were removed and maintain the humidity, proper light and ventilation in fruiting compartment for further growth of mushroom. The growth of the mushroom mycelium on bags was also observed. Bags were allowed for total three harvesting. Fruiting bodies were harvested from each bag and noted the yield.

Similarly, to assess the effect of *R. rattus* on morphological parameters and characteristics of fruiting body of oyster mushroom, observation was recorded during a growing cycle of October to November, 2022. Total number of days for mycelium colonization, days to first harvest, days for total harvesting and days to complete total crop cycle in healthy bags and rat infested bags were recorded. At every flush, the harvested fruiting bodies were counted; weight and mushroom size was also noted. The length and thickness of stipe, diameter of cap, and number of effective fruiting body per bunch were measured at the first, second and third flush and the means were also determined. At the end of the harvest period, the accumulated data were used to calculate total yield.

RESULTS AND DISCUSSION

During the survey of mushroom entrepreneurs in South Gujarat, it was observed that the house rat, *Rattus rattus* Gray, damaged the substrate of mushroom bags while they were incubating (Fig. 1-a, b, c) and fruiting (Fig. 1-d). The rat damage was ranged between 7.49 to 12.30 per cent during incubation phase and 3.21 to 5.74 per cent during fruiting phase of oyster mushroom cultivation throughout the growing season (Table 1). Table clearly showed that, incubation period was the most susceptible than fruiting phase. This may be due to attraction of rats by the rotten smell of grains used for spawning material. Secondly, partial darkness with closed condition to maintain high level of CO_2 in the mushroom houses is also ideal condition for rat to damage and to reproduce. This condition always maintains nocturnal habitat and keeps the rat active even in day time. Average 8.95±1.64 per cent damage was noted during incubation phase as compared to fruiting phase (4.77±0.94%).

Table 1: Damage caused by *R. rattus* in oyster mushroom cultivation during 2022.

Sr. No.	Month	No. of bags filled	Incubation phase		Fruiting phase	
			No. of Infested bags	Per cent Infestation	No. of Infested bags	Per cent Infestation
1	October	157	15	9.55	9	5.73
2	November	177	16	9.04	9	5.08
3	December	166	14	8.43	8	4.82
4	January	155	12	7.74	6	3.87
5	February	161	13	8.07	8	4.97
6	March	122	15	12.30	7	5.74
7	April	187	14	7.49	6	3.21
	Max.	187	16	12.30	9	5.74
	Min.	122	12	7.49	6	3.21
	Avg. ± SD	**157±20.53**	**14.14±1.35**	**8.95±1.64**	**7.57±1.27**	**4.77±0.94**

Fig. 1. Rodent damage during cultivation of oyster mushroom- Mushroom bags damaged by *R. rattus* during incubation (a, b, c); during fruiting (d); Contamination of mushroom house with rodent hair, urine, excrement (e), poor mycelium growth in rat infested bags (f), Spent substrate kept near the mushroom house-act as a source of rat infestation (g), Cultivating mushrooms in backyards, unused sheds, or rooms adjoining the house which makes ideal condition accessible to rats (h, i, j).

Furthermore, it was pointed out that the majority of small-scale tribal mushroom entrepreneurs did not have structures that were specifically designed for mushroom cultivation. Cultivating mushrooms was done by them in backyards, unused sheds, or rooms adjoining their house (Fig. 1 h, i, j). This condition allows rats to make entry in mushroom house. The mushroom house is accessible to rats due to this condition. Besides, the spent substrate kept near the mushroom house was also act as a source of infestation of rat (Fig. 1g). Contamination of mushrooms with rodent hair, urine, excrement, and pathogenic microorganisms cannot be excluded in mushroom houses infested with rodents (Fig. 1e). Rodent damage to mushrooms has been reported for the first time in Gujarat.

The results pertaining to influence of rat infestation on yield performance of oyster mushroom was presented in Table 2. Results were found significant throughout the cropping season wherein significantly highest mushroom yield was observed in healthy bag as compared to bags infested with *R. rattus*. The yield was observed in the range of 1.69 kg to 2.43 kg per bag with an average of 2.00 kg/bag in healthy bags as against 1.01 to 1.43 kg with an average of 1.27 kg/bag in rat infested bag throughout the growing period from October to April.

Table 2: Yield performance of oyster mushroom in healthy and rat infested bags.

Sr. No.	Month	Yield per bag (Kg)[#]		T statistic
		Healthy bags	Infested bags	
1.	October	1.75	1.01	8.632**
2.	November	1.69	1.11	5.982**
3.	December	1.92	1.43	7.225**
4.	January	1.96	1.3	4.839**
5.	February	2.09	1.47	6.395**
6.	March	2.16	1.25	6.811**
7.	April	2.43	1.32	7.98**
	Avg.	**2.00**	**1.27**	9.038**

[#]mean of ten bags (five bags per replication), * Significant at 5 % level, ** Significant at 1 % level,
For individual month, 2.776 (T 0.05) and 4.604 (T 0.01),
For average of 7 months, 2.447 (T 0.05) and 3.707 (T 0.01)

This may be due to maximum damage was occurred during incubation phase wherein maximum spawn (grain used for mycelium growth) were eaten by the rodent which leads to poor mycelium growth (Fig. 1-f) and thereby ultimately reducing the mushroom yield. The results in Table 3 showed that, there were significant difference in morphological parameter and fruiting body characteristics of healthy and rat infested bags. Significantly lowest days for total mycelium colonization, first harvest, harvesting period and total crop cycle was observed in healthy bags to the tune of 20.6, 27.2, 25.2 and 47.4 days, respectively as against infested bags (24.2, 30.8, 29.2 and 52.4 days, respectively). This might be due to mycelium growth was disturbed during incubation phase in rat infested bags which leads to increase in total colonization days, days to first harvest, total harvesting period and ultimately total crop cycle. Similarly, fruiting body characteristics was also affected. Significantly lowest cap diameter (84.72 mm), stipe length (32.08), stipe thickness (7.0), number of effective fruiting bodies (6.8) and fruiting body bunch weight (54.4 g) as against healthy bags (96.56 mm, 38.66 mm, 9.8 mm, 9.6, and 66.0 g, respectively) (Table 3).

Table 3: Effect of *R. rattus* damage during incubation on morphological parameters and characteristics of fruiting body of oyster mushroom.

Sr. No.	Parameter	Healthy bags	Infested bags	T-statistics
1.	Total colonization period (day)	20.6	24.2	-9.000**
2.	First harvest (day)	27.2	30.8	-9.000**
3.	Harvesting period (day)	25.2	29.2	-7.303**
4.	Cap diameter (mm)	96.56	84.72	4.852**
5.	Stipe length (mm)	38.66	32.08	4.561*
6.	Stipe thickness (mm)	9.8	7	4.811**
7.	No. of effective fruiting bodies/ bunch	9.6	6.8	3.586*
8.	Mushroom weight (g/bunch)	66	54.4	11.267**
9.	Total crop cycle (days)	47.4	52.4	-5.270**

* Significant at 5 % level, ** Significant at 1 % level, 2.776 (T 0.05) and 4.604 (T 0.01)

Earlier, Thomas *et al.* (1995) performed a survey in Jabalpur and discovered that the house rat, *Rattus rattus* Gray, was causing damage to both the spawn and the mushroom's growth. *R. rattus* harmed the polythene bags that were stored for incubation after spawning and consumed the spawn. Recently, Gopalakrishnan *et al.* (2023) reported that rats are the pests of mushrooms, consuming both the mushroom bags and the spawn layers. The harm caused by rats feeding on the cereal grains employed as a substrate for spawn production, as well as their frequent disturbance and destruction to the beds, was highlighted by Prasad (2021). These findings are consistent with the current findings.

CONCLUSIONS

From the present findings it can be concluded that, house rat, *R. rattus* could be the major pests of oyster mushroomconsuming both the substrate in mushroom bags and the spawn layersin absence of specifically designed mushroom house. Incubation phase was the most susceptible than fruiting phase. House rat damage directly influences the yield performance, morphological parameters and characteristics of fruiting body of oyster mushroom.

FUTURE SCOPE

There is a great scope to reduce the rodent damage in oyster mushroom cultivation by
— Designing the rat proof house
— Creating awareness among mushroom entrepreneurs about establishment of rat proof house, preparation of poison baits and mouse traps.

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Conflict of Interest. None.

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