RP Current Trends In Applied Sciences
Vol. 2, No. 1 (January – March 2023) pp. 9–12
e-ISSN: 2583-7486

RESEARCH PLATEAU PUBLISHERS

Cite this article: Sangeeta, A comparative analysis of insect activity on basmati rice stored in various packaging and circumstances, *RP Cur. Tr. Appl. Sci.* **2** (2023) 9–12.

Original Research Article

A comparative analysis of insect activity on basmati rice stored in various packaging and circumstances

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ARTICLE HISTORY
Received: 30 October 2022
Revised: 15 January 2023
Accepted: 18 January 2023
Published online: 20 January 2023

KEYWORDS
Basmati; pests; insects; Pusa 1121; grains; silo (plastic); packaging; moisture contents.

ABSTRACT
All around India, the practise of storing rice for a brief period of time in sacks is used; basmati rice is stored in woven sacks composed of jute, cotton, and other native plant fibres; however, in recent years, polypropylene bags have replaced woven sacks in urban India. Using chemicals has proven to be effective, but the leftover toxins have been a major cause for concern. Traditional storage practises make rice more susceptible to insect infestations and deterioration. To determine the vulnerability and effects of pest on basmati rice stored in woven jute bag containers, bamboo straw container, polypropylene, and silo (plastic), a comparative study was undertaken. The investigation's findings demonstrated that basmati rice stored in woven bags was more susceptible to pest infestation, while rice stored at lower moisture contents below 8% was found to have fewer pest and bug infestations. Basmati rice varieties Pusa 1121, Basmati 385, Muradabadi 6465, 386 Haryana, and Basmati 198 were employed in the study. The packaging materials and adulteration were also blamed for the impact of pest infestation and moisture variation within the grains in the samples taken for the trials. The percentage of pest attack in each layer of each package was discovered, with woven jute bags having the highest bug infection. After 48 weeks of storage in various storage containers, the main pests detected in basmati rice types were Sitophilus oryzae (L.), Rhyzopertha dominica (F.), Oryzaephilus surinamensis (L.), and Oryzaephilus Mercator.

1. Introduction

The lack of appropriate technologies to store food grains in excess over the brief harvest time periods, rather than a decreased production, is the main cause of the food shortage in India [1, 2]. As a result of poor storage and processing facilities, a sizable amount of food grains deteriorate after harvest. Significant variations in periodicity and environmental elements like temperature, humidity, and rainfall may also have an impact on the production of food grains [2]. The primary function of a grain storage system or building is to safeguard food grains against insect and rodent attack as well as to prevent grain spoiling owing to microbiological development brought on by moisture [3].

In India, post-harvest grain losses ranged from 12 to 16 million metric tonnes annually. According to the World Bank, this loss in food grains could feed one-third of the poorest Indians. 9.5% of India's entire production of pulses is thought to be lost [4]. The largest loss of 7.5% among all post-harvest unit operations is ascribed to grain storage. Compared to storage losses of 2.5% in wheat, 3.5% in maize, and 5% in pulses, paddy accounts for up to 2.5% of India's total production [5].

The infestation of pests and insects in food grains that have been stored can be blamed for all of these losses. Other factors that contribute to these outcomes include a lack of appropriate post-harvest storage and management practises for food grains, poorly constructed storage structures, and subpar storage materials.

Rice and other food grains can be stored in polyvinyl chloride tanks that function as effective hermetic containers. One significant benefit is that PVC storage tanks can be quickly and readily transformed into a variety of shapes and sizes. To make it simple to discharge the stored rice grains, plastic PVC storage tanks or containers bearing the silo brand are maintained indoors, in the shade, and out of direct sunlight [6].

Bamboo splits are used to build a house out of bamboo and are joined together by carpenters to store a lot of rice and other grains. Bamboo splits are used to build the walls, and they are all tightly fitted together with no gaps. To keep bugs, rats, and birds out, the bamboo walls are covered in cow dung, and cow urine is sprayed all over the place. To provide a storage capacity of 1000 kg, the house can be built in a rectangular or square shape with dimensions of 4m × 4m × 3m [7].

Throughout the storage time, rice must be kept dry and at a relatively low temperature. The investigation for safe, dependable, and viable storage systems that do not negatively impact secondary consumables, other commodities, or the environment has been prompted by the numerous natural resources connected to the approval of artificial pesticides. In order to ascertain the many parameters that affect insect infestation in basmati rice stored in various packing materials, this investigation was started.

2. Materials and Method

Selection of feedstock and storage material:

Basmati rice varieties Pusa 1121, Basmati 385, Muradabadi 6465, 386 Haryana, and Basmati 198 were employed in the study. The three distinct storage containers composed of three different materials were used to store the three types of basmati rice that were chosen for the current study. The materials used to create the storage containers included woven jute, bamboo straw, silo (plastic), and polypropylene.

Solarisation of basmati rice varieties

Solarization is the process of cooking rice in the sun to destroy insect pests [6]. In order to assure and prevent any form of infestation during the study, this procedure was used to make sure that the insects that were present in the rice and other fungal infections were warded off. By placing the rice grains on cement floors and covering them with a bamboo mat to lower the moisture content and kill the majority of the pests, the basmati rice varieties were sun-dried.

Experimental Conditions

Basmati 385, Muradabadi 6465, 386 Haryana, and Pusa 1121 were the kinds of basmati rice used for the study. Basmati 198 was also included. The basmati rice varieties chosen for the experiment were bought from a nearby market, then they were packaged and kept in 25 kg storage containers. Four different storage containers were used to hold the various types of basmati rice. Different types of basmati rice were kept in plastic silos, woven jute bags, bamboo straw containers, and polypropylene silos.

The 50 kg samples of basmati rice were kept in four separate storage containers for 48 weeks while being frequently examined for insect infestations and fungal growths. A total of 20 different sampling packages or containers were employed in the experiment. Once a week, samples of basmati rice were obtained from each container for analysis. The samples of rice were examined for moisture content, insect and fungal diseases, and pest infestation. Basmati rice samples were examined for moisture content using methods compliant with ASTM E871-82(2013) and the types of insects discovered in the various depths and layers of each sample in various packages.

3. Results

Once every four weeks, samples of basmati rice from each storage container were examined for moisture content. The moisture content of the different rice kinds kept in the woven jute bag containers saw a very slight increase. The initial moisture content of the various rice types is provided in Table 1. Before being used in the study, the moisture values of the provided samples were recorded. Room temperature was maintained for the duration of the study in a shaded, dry, well-ventilated area away from the sun.

At the conclusion of the 48-week storage period, moisture addition was noticed in all varieties of basmati rice stored in jute bags, according to Table 2's average moisture content data. When compared to all the basmati rice kinds stored in the other containers, the moisture addition in plastic silo containers was extremely low to nonexistent. The least amount of moisture permeated into plastic storage containers, closely followed by polypropylene containers, which showed a similar moisture content at the conclusion of the testing.

Table 1: Initial moisture content of the basmati rice varieties at the beginning of the trails

Variety	Moisture content (%)
Pusa 1121	8.0
Basmati 385	9.5
Muradabadi 6465	9.0
386 Haryana	9.5
Basmati 198	9.5

Table 2: Final moisture content of the basmati rice varieties after 48 weeks of storage in various containers made of different materials

Average moisture (%) at the end of 48 weeks				
Varieties	Type of storage materials			
	Jute	Bamboo	Polypropylene	Silos
Pusa 1121	8.5	8.4	8.0	8.0
Basmati 385	10.2	9.9	9.6	9.6
Muradabadi 6465	9.5	9.5	9.1	9.2
386 Haryana	10.2	10.0	9.6	9.6
Basmati 198	10.1	9.9	9.6	9.5

From each of the storage containers, random samples were taken and examined for insect infestation. The basmati rice kept in the four separate storage containers included four primary pests. Weevils, fauvel, surinamensis, and dominica were the four pests that were found.

The woven jute bag containers used to store different types of basmati rice were discovered to be contaminated with all of the aforementioned pests, however there were no signs of fungal growth inside the containers over the course of the study. As sampling was carried out at various layers and bugs were identified, it was found that the pests were present in various layers of all the containers.

The Sitophilus oryzae (L.) species of beetle was found in basmati rice varieties kept in woven jute bags, and it had an average length of 5 mm. All of the kinds contained these weevil insects, however the Pusa 1121 variety had a somewhat shorter growth period, with adults measuring only 3 mm in length. Regardless of the type of basmati rice that was stored in them, the Oryzaephilus Mercator was discovered in all of the containers, and it was also determined to be present in various layers of the containers. These fauvel beetles were measured at 2.5 mm in length and were noted as having a flattened look when seen with the unaided eye. The Basmati 198 kept in all the containers was found to be predominately populated by Oryzaephilus surinamensis (L.). These were found to have a length of 2.7 mm and were characterised as having a dark brownish colour. There were twelve of these insects found in the Basmati 198 that was kept in bamboo pots. Rhyzopertha dominica (F.), a pest with larger populations discovered in rice types housed in woven jute bag containers, was measured at 2.6 mm in length.

Galvanised iron and used oil barrels are used to create the metal silos that are used to store rice grains. Due to their tendency to be hydrophobic and airtight, metal silos have shown to be the most effective and economical storage containers for lengthening the shelf life of rice grains. When kept in a metal silo, rice and other food grains cannot possibly be accessed by pests. Steel silos are far more effective at keeping out insects and water contamination; as a result, metal silos are the best storage options for grains. However, metal silos should be positioned with adequate ventilation and shade to avoid exposure to direct sunlight and any other heat sources that can cause condensation inside the storage container [8].

While Sitotroga cerealella (Olivier) is much more capable of infesting rice grains that are segregated as complete hulls, Sitophilus oryzae (L.), more commonly known as the rice weevils, do not feed on rice grains that have intact rice hulls [3, 8]. Additionally, Rhyzopertha dominica (F.) and Angoumois grain moths are attributed to lower boring of rice grains. These two species' larvae are thought to enter the rice grain through the hull or by forcing their way in through the spaces between the palea and lemma. These gaps are so small that even with extreme magnification, it is impossible to see and identify them. Both of these pests are known to penetrate rice grains through the scars left behind by abscission at the base of the grain [9, 10].

Rhyzopertha dominica (F.), a rice grain borer of minor relevance, boasts the potential to emerge as the most devastating pest to infest rice that has been kept. Rhyzopertha dominica (F.) is a member of the family Bostrichidae, also known as the powder post beetles. This beetle is elongated and cylindrical in shape, with a head that is abruptly bent downward beneath the hood-like prothorax, which is the anterior part of an insect's thorax and bears the first pair of legs. Grain borers called Rhyzopertha dominica (F.) are about 3 mm long and 1 mm wide. It was noted that the beetle had a dark, brownish look. When their presence is discovered in the storage containers, the insect multiplies rapidly, can survive deep inside a mass of rice grains, and feeds on piles of rice. The females of the older adult beetles can deposit 300 to 500 eggs on grain mass, and they can feed and reproduce for weeks [11].

As soon as the larvae emerge, they begin to bore into the rice kernels and then proceed to develop like weevils. When they reach adulthood, they have a tendency to have great flying abilities that let them to migrate to new locations [6], making it simple for infestations to spread from isolated populations in storage bins and warehouses to freshly harvested rice grain. If the unit is not cleaned within uses, residual infections are certain to exist in all types of grain storage areas and transportation carriers [10]. Under storage conditions, rice grains from a contemporary mill serve as a somewhat poor medium for the proliferation of insects. This is a result of polishing, which removes vital nutrients [12].

The degree of milling directly correlates with the susceptibility of milled rice grains to infection. Rice that has been lightly milled is substantially more prone to pest infestation than rice that has been polished [13, 14]. Currently, rice that has been harvested has a moisture percentage of around 20%; this moisture content is subsequently decreased to less than 12.5% by drying the rice with hot air. Until [4] showed that the rice grain maturity and moisture content varied greatly across the panicles of rice plants in the same field and also between the rice grains on the same panicle, high moisture rice in the crop field appeared to be unsuitable for pest growth. Additionally, in standing rice crop fields, pheromone-baited insect traps are frequently used to capture Angoumois grain moths and meagre grain borers [7].

Agricultural goods are often harmed while being kept, processed, and supplied by pests and insects. Food grains like rice and wheat are particularly expensive to lose after harvest. The value of the capital expenditures made on the grain crop is at its maximum point; the relatively small post-harvest loss percentages are significant from a financial standpoint. Only 50 pests are deemed to be harmful, despite the fact that many bug species are associated with grains of stored food and rice [11].

Any country that wants to export its agricultural products should be particularly concerned about preventing insect infestation or contamination of exported food grains, whether they are rice or other grains [13].

One of the food grains that serves as a major source of the caloric needs for people all over the world, as well as in the form of animal feed, is rice. Millions of people worldwide, including large populations that are undernourished, lack food as a result of the spoilage of rice grains during storage. The various basmati rice storage methods and methodology used in this study are meant to give the rice a longer shelf life that is resistant to environmental variables and insect infestation.

4. Discussion

Although there are many other types of pests that impact rice grains, weevils are the most common category for the pests that are found in rice grains. In storage regions with warm, humid climates, pests are frequently observed, and under such favourable circumstances, they can cause significant grain losses during storage. Basmati rice is susceptible to insect infestations since it is grown, harvested, and stored in tropical and subtropical climates. Because the grain hull partially protects the edible area, rough rice is less vulnerable to pest infestations than other food grains. Even yet, infestation in rough rice cannot be totally avoided by the rice hull. A small percentage of the harvested basmati rice grains have flaws in the grain hull that are home to pest insects. The state of the rice hull can vary depending on the many types of harvesting, drying, handling, and storing techniques used for basmati rice as well as the climate during the growing season.

The type of rice itself plays a significant role in pest infestation. Despite the complete hulls of the rice grains, only a small number of pest species are capable of identifying various entry points into the grains. The kernels are infested with numerous larvae and pest in clumps, which are connected to one another by a web of grains. When the grain is washed before processing, these clumps are removed from the rice and dumped with straw and rubbish. In order to get rid of the insect carcasses and residues, rice grains that have been milled and processed must be fumigated.

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