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Seed Quality Behaviour Variation of Moth Bean during Storage in Different Packaging

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An experiment was carried out in order to assess the behavior of the moth bean seed quality in 4 types of packaging including cloth, gunny, HDPE, and vacuum-packed bags for 18 months. After two months of storage, the moisture content of the seeds fluctuated greatly in cloth, gunny, and HDPE bags (conventional packaging) because these materials are pervious, but the moisture content of the seeds did not vary in vacuum packed bags as the polythene bag used for the vacuum package was thicker, had a lower water vapor and oxygen transmission rate. Further, seeds in conventional packaging's developed bruchid infestations after 4 months of storage but no infestation was found in vacuum-packed bags until 18 months. The bruchid infestation caused the germination rate of the seeds to drop to less than 20%. In comparison to the initial state, even after 18 months of storage, there was little change in the parameters used for measuring seed quality (germination, total seedling length, seedling dry weight, moisture content, and protein content). Therefore, without the use of chemicals, moth bean seeds can be safely stored using vacuum packaging technology.

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Keywords: Bruchids; conventional packaging's; moth bean seeds; vacuum packaging.

1. INTRODUCTION

Variations in temperature, rainfall patterns and the frequency and severity of climatic events such as floods and droughts may have a significant impact on agricultural production [1]. Furthermore, a shortage of suitable processing and storage facilities is causing significant damage to food grains following harvest. The FAO calculated that 10% of grains are lost annually worldwide during storage [2]. Multiple strategies are needed to ensure global food security, such as reducing post-harvest loss and improving and diversifying staple food crops. In India, the risk of damage from post-harvest storage to the tune of 25–30% is a serious problem [3] for pulses because of inadequate storage facilities, as well as a lack of expertise in post-harvest pulse management and storage.

Short-duration pulses, like moth bean, need to be preserved for a long time in order to be available year-round as a grain or as seeds. Therefore, in order to meet demand, these seeds need to be properly preserved. As pulses contain significant amounts of protein and are more susceptible to insect infestation, pulses are harder to store than cereals [4,5].

Callosobruchus spp., (Bruchids) are a major pest of grain legumes that can cause significant economic losses in a variety of pulses, including chickpea, mung, peas, cowpea, lentil, and arhar, both in the field and in storage [6,7]. Because of the bruchids' higher rate of multiplication, which can result in a 30-fold increase in population with each generation that lasts for roughly four weeks [8]. The seeds can be treated with different hazardous chemicals such as methyl bromide, carbon disulfide, or phosphine, or numerous insecticides can be dust-applied to suppress these bruchids. Though These substances are effective, but their use in storage is discouraged since it threatens food safety and the environment [9].

Some plant-derived extracts, such as banana plant juice, soybean, maize and neem oil, and hot pepper powder, have shown benefits in addition to chemical control [10,11]. Despite their many benefits, these plant-derived extracts have certain drawbacks, such as their slow action and easy degradation. Due to the drawbacks of using artificial and plant-derived chemicals to manage bruchids during storage, studies on chemical-free storage have been carried out to assess the storability of moth bean seeds using various packaging materials.

2. MATERIALS AND METHODS

2.1) A storage experiment was conducted under ambient conditions at the University of Agricultural Sciences, Dharwad, Karnataka, India for 18 months (15 November 2019 to 15 May 2021). Average data related to temperature (^{o}c) and relative humidity (%) that prevailed in the storehouse of ambient condition were recorded with the help of Anemometer. Freshly harvested healthy seeds of moth bean were collected from farmers' fields and then sun-dried. After sun drying, seeds were packed in different packaging cloth viz., cloth bag, gunny bag, HDPE bag and also vacuum packed. The seeds (3 kgs) were (Fig. 1) packed in the cloth, gunny and high density polythene bag and replicated five times. However, in the case of vacuum packaging, 1 kg of seeds were packed into 9 bags and replicated five times. It is also important to note that in storage, bags were not stacked, ensuring that each bag was equally exposed to the environment. The storehouse's average temperature and relative humidity is presented in Fig. 2. Table 1 lists the features of the polythene bags used for vacuum packaging. An OLPACK 501/V vacuum packer, made by INTERPRISE–BRUSSELS S.A., BRUXTAINER DIVISION, Belgium, was utilized for vacuum packaging.

2.2) Observation Recorded: Prior to storage, various parameters related to seed quality were measured and recorded, including germination percentage, total length of seedlings (cm), dry weight (mg), moisture content (%), and protein content (%). Further, samples were taken from all treatments on the fifteenth of every other month to evaluate the quality of the seed up to eighteen months.

a) Germination (%) and Total seedling length (cm): Germination (%) was calculated as per the standards described in the International Seed Testing Association, 2013. In order to measure the total length of the seedlings, which is expressed in centimeters, 10 normal seedlings were randomly chosen from each treatment on the last day of the above germination test.

b) Seedling dry weight: Ten standard seedlings, which were utilized to measure

seedling length, were wrapped in butter paper and dried for twenty-four hours at seventy degrees Celsius in a hot air oven. Following cooling, the seedlings were weighed, and the average weight was determined.

c) **Moisture content (%):** It was calculated on a dry weight basis as per the International Seed Testing Association, 2013 [12].

d) Protein content: The protein content was obtained by multiplying per cent nitrogen content of seeds with a factor 6.25 [13].

2.3) Data Analysis: Completely Randomized Design (CRD) was used to test the significance of various variables and the results are presented in graphical format [14].

3. RESULTS AND DISCUSSION

Moth bean seeds were stored in cloth, gunny, HDPE and vacuum-packed bags with 95.5% germination, total seedling length (44.1 cm), seedling dry weight (281.1 mg), moisture content (7-80%), and protein content (23.48%). With the exception of moisture content, none of the characteristics examined changed significantly after two months (Fig. 3). The pervious nature of the packaging materials used to store seeds is the reason for the rise in moisture content of the seeds in cloth, gunny, and HDPE bags. Furthermore, because they are hygroscopic by nature, seeds absorb and release moisture in response to environmental factors. Shankar et al. [15] in Blackgram have observed similar results of an increase in moisture content in pervious packaging material.; Malimath et al. [16] in gardenpa; Khaldun et al. [17] *i*n cucumber.

Since vacuum packed bags have a higher thickness and a much lower rate of oxygen and water vapour transmission (Table 1) than pervious packaging materials (cloth, gunny and HDPE bags) and due to these characters, the hygroscopic nature of seeds holds good only when seeds are stored pervious packaging materials. Despite changes in the surrounding environmental conditions, the moisture content of the seeds remained constant during the storage period because of the unique properties of the polythene bag used for vacuum packaging. Similar findings indicating that the moisture content of vacuum-packed seeds remains unchanged have been reported by Chetti et al. [18] in chilli; Khanna et al. [19] in chickpea; Meena et al. [20] in soybean.

Table 1. Characters of polythene bag used for vacuum packaging

S. No.	Characters	Unit	Results
1	Thickness (Microns)	Microns	149.40
2	Water vapor transmission rate	g/m^2/24 hrs at 38ºC and 90.0 % Relative humidity	0.95
3	Oxygen transmission rate	cc/(m^2 × day × atm)	0.91

Fig. 1. Different packaging used for moth bean storage

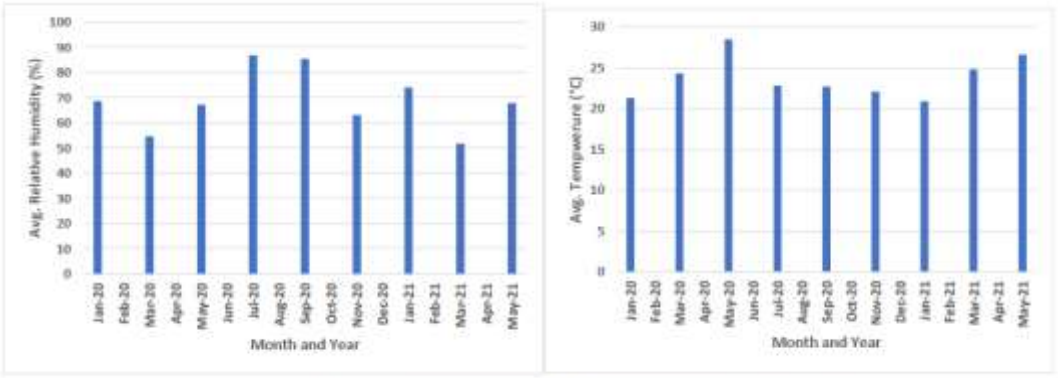

Fig. 2. Average temperature and relative humidity of store house

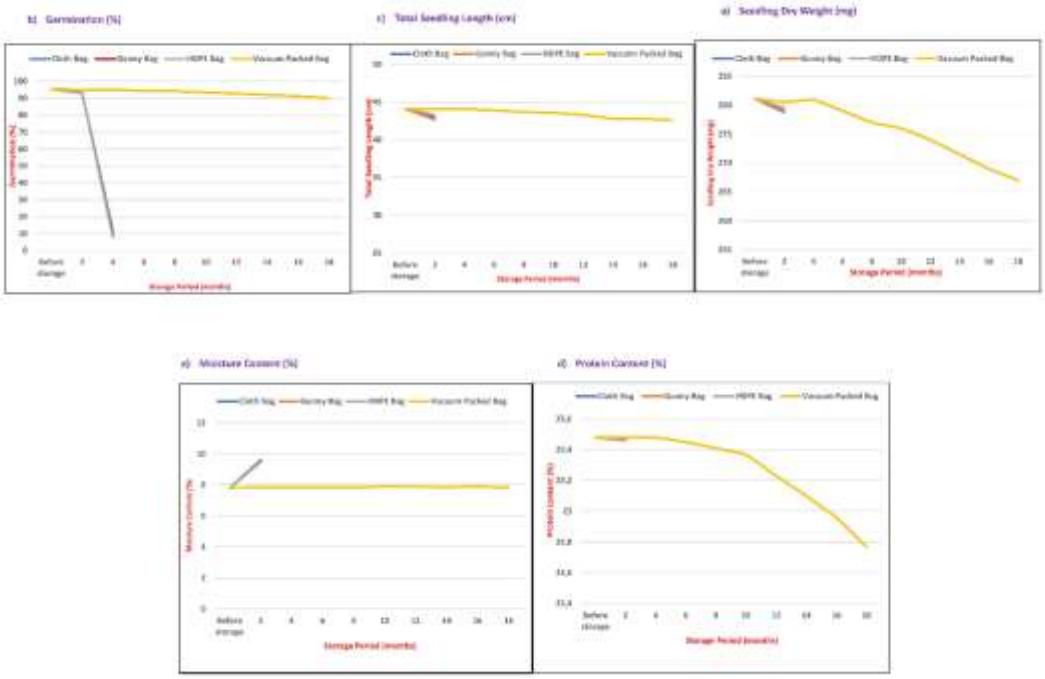

Fig. 3. Germination (%), Total seedling length (cm), Seedling dry weight (mg), Moisture content (%) and Protein content (%) of moth bean seeds as influenced by different packaging at different time intervals of storage

Note: Observations in cloth, gunny, and HDPE bag treatments have been discontinued as a result of bruchid infestation after 4 months of storage

With the exception of vacuum-packed bags, there was an infestation of seeds with bruchids to the extent of more than 80 %. The bruchid infestation of seeds in cloth, gunny, and HDPE bags is caused due to the packaging material's permeable nature, which allowed the bruchids to enter material and grow. Similar results of an infestation of seeds with insects in pervious packaging were reported by Patel et al. [20] and Khadtar et al. [21]. Due to internal feeding behaviour of bruchids, seeds were completely deteriorated and because of complete deterioration there was a reduction in germination and other seed quality parameter's, which caused heavy losses and there by seeds become unsuitable any purpose. Similar results of seed deterioration due to bruchids infestation in pervious packaging materials have been reported by Charjan et al. [22] in arhar; Miah et al. [23] in greengram; Swamy et al. [24] in black gram, greengram and redgram.

Germination was reduced to less than 20 per cent due to bruchid infestation in conventional packaging materials such as cloth, gunny, and HDPE bags. This was significantly lower than the minimum seed germination of 75 per cent for moth beans, as stated by the Central Seed Certification Board, Department of Agriculture & Co-operation, Ministry of Agriculture, Government of India. Hence, further observations in these treatments have been stopped. Furthermore, because of the type of packaging, the bruchid infestation was not noticed in the vacuum-packed bag even after an 18-month period of storage (Fig. 3). Thakur et al. [25] in Blackgram reported similar results of non-infestation of seeds with bruchids in vacuum packed bags.

Due to the aging factor of the seeds, there was a slight decline in the percentage of germination, total length of seedlings, seedling dry weight, and protein content of vacuum-packed seeds as the storage period progressed. Our findings are consistent with those of Tripathi et al. [26] for onions, Khanna et al. [19] for chickpeas, and Ashok et al. [27] for onions, who reported that seeds can be stored in vacuum-packed bags for a longer period of time without significant deterioration.

4. CONCLUSION

The current study's findings indicate that vacuum packaging technology can be used to safely store moth bean seeds for a long period of time without any requirement of chemicals.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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