# Effects of Different Packaging Materials on Storage Conditions of Blackgram Seeds

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## Abstract

The storage conditions of black gram seeds were investigated for 12 months under room temperature by using the different packaging materials: tin boxes, brown bottles, high density polyethylene bags (HDPE), cloth bags, combination of nylon net bags and low density polyethylene bags (LDPE) and control (before storage). Among the packaging materials, seeds stored in brown bottles gave the best maintenance of seed weight followed by the HDPE treated seeds. In addition, the best performance in seedlings such as the seeds germination, survival rate and growth of plant were observed after being stored in brown bottles and HDPE for 12 months. However, the excellent VQR (Visual Quality Rating) scoring was observed in all seeds stored up to 9 months of storage period only. The seeds stored after 12 months at room temperature could not maintain their seed quality and good seedling characteristics of black gram because of slightly fungal infection and low protein contents in all treatments. Thus black gram seeds should be stored under room temperature only for 9 months and brown bottles and HDPE plastic bags should be used as the packaging materials during storage.

**Key words:** Blackgram, Different packaging materials

## INTRODUCTION

Blackgram, *Vigna mungo* (L.) Hepper is a very nutritious grain legume and is popular in Asia. (Purseglove, 1974). In Myanmar, Blackgram is an important source of foreign exchange earning among agricultural commodities. Approximately 90% of the balckgram plantation area is situated in lower Myanmar. The major blackgram producing regions are Ayeyarwaddy and Bago Regions. Blackgram is produced for export as well as for local consumption. It has high demand in international market and is exported to India, Pakistan, Malaysia, UAE, Singapore, Japan, Srilanka and Korea (Bahl, 2004). Blackgram is a good source of proteins, vitamins and minerals for the human body.

Storage and upkeep of agricultural products are very important postharvest activities. Considerable amount of food grains is being spoiled after harvest due to lack of sufficient storage and processing facilities (Singh and Satapathy, 2003). An FAO estimate of worldwide annual losses in stored produce has been given as 10% of all store grain. The storage is an important aspect of post-harvest management because blackgram is seasonally produced but consumed throughout the year. Therefore, the supply has to be maintained by proper storage throughout the year.

Storage protects the quality of grains from deterioration and helps in stabilization of prices by regularizing demand and supply. Lack of storage facilities, forced the farmers to sell their produce at low price. It is essential that during storage, black gram should remain in good condition and not undergo any deterioration due to fungal and insect infection or attack by rodents (Pangale, 1976).

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Storage practices vary and there are small or big storehouses, indoor or outdoor, temporary or permanent and individual or community storage structure (Jain *et al*., 2004). Packaging is a practice to protect the produce from any damage during storage and protect the quality.

The good packaging of black gram not only facilitates convenience in transportation and storage but also attracts consumer to pay more. Improve conservation and storage structures to reduces post-harvest losses, improve nutrition standards; bring a better price to the grower (Kanade, 2006).

## MATERIALS AND METHODS

The seeds for this experiment were collected from the field of Vegetables and Fruit Research and Development Centre (VFRDC), Myanmar Agriculture Service, Yemon, Hlegu Township. During the experiment, storage room temperature was 26ºC- 32.8ºC and relative humidity (RH) was 55-89%. The qualitative characterization of blackgram seeds were carried out in Myanmar Foodstuff Industries, Development Centre for food Technology, Mayangon Township, Yangon Region, Myanmar.

### Experimental Design

This experiment consisted of 5 treatments, Tin box, Brown bottle, High Density Polyethylene bag (HDPE), Cloth bag and Nylon net bag + LDPE (Low Density Polyethylene bag) with 3 replications using completely randomized design (CRD). Each replicate involved 100 g weight of seeds.

### Data Collection

For quality testing, protein, carbohydrate, moisture, and ash contents of blackgram seeds were determined as an initial (before storage) and final (after storage).

Weight loss, relative humidity (RH) and temperature were recorded at 3 months interval during storage.

Germination and survival percentages, plant height, number of leaves and length of root were recorded at before storage (initial), after storage at 6 months and 12 months, respectively.

### Statistical Analysis

All results were analyzed by using IRRISTAT Software Program. All treatment means were compared by LSD (Least Significant Difference) at 5 % level of significance.

### Methods

Determination of protein, carbohydrate, moisture, and ash content from all seeds samples were analyzed by standard methods of AOAC (1995).

### Visual Quality Rating (VQR)

Visual Quality Rating (VQR) of black gram seeds during storage was determined using the following index of VQR scoring.

| VQR Scoring | Description |
|---|---|
| 9, 8 | excellent (no defects or fungal infections) |
| 7, 6 | good, defects minor |
| 5, 4 | fair, defects moderate |
| 3 | poor, defects serious, limit of sale ability |

### Determination of Germination and Survival Percentages

Blackgram seeds stored with different packaging materials for initial (before storage), and after storage at 6 and 12 months were planted in plastic bags. A total of 10 seeds per treatment were sown in each plastic bag. Each treatment consisted of three replications. The germination percentage was determined at one week after sowing.

The survival percentage was determined at two weeks after sowing. The percentages of germination and survival were calculated by the following formula.

$$\text{Germination}(\%) = \frac{\text{Total number of germinating seeds}}{\text{Total number of sown seeds}} \times 100$$

$$\text{Survival }(\%) = \frac{\text{Total number of survival seeds}}{\text{Total number of sown seeds}} \times 100$$

## RESULTS

### Seed Weight

The seeds weight was statistically significant differences among treatments during storage at 3 and 6 months of storage period. The total seeds weight of blackgram gradually increased overtime during storage compared to their initial seeds weight (before storage). At 3 and 6 months, seeds weights were significantly increased in the cloth bags and also increased in tin boxes at 9 and 12 months.

Among treatments, the least changes of seeds weight obtained in the brown bottles followed by HDPE plastic bags throughout their storage period (Table 1 and Figure 1).

Table 1. Seeds weight of blackgram after storing at room temperature

| **Packaging Materials** | **Seeds Weight of Blackgram (g/100 g)** | | | | |
|---|---|---|---|---|---|
| | **Storage Period (month)** | | | | |
| | **Control** | **3** | **6** | **9** | **12** |
| Tin box | 100 | 102.83 | 105.08 | 104.27 | 104.47 |
| Brown bottle | 100 | 100.74 | 101.33 | 101.31 | 101.34 |
| HDPE bag | 100 | 100.76 | 102.14 | 102.49 | 102.10 |
| Cloth bag | 100 | 105.98 | 110.32 | 103.67 | 102.67 |
| Nylon net bag +LDPE | 100 | 104.39 | 106.50 | 103.87 | 102.43 |
| F-test | ns | * | * | ns | ns |
| LSD (5%) | - | 2.36 | 2.57 | 2.5 | 2.58 |
| CV (%) | - | 1.2 | 1.3 | 1.3 | 1.3 |

Each value represents the mean from replications. Mean differences within each column determined by LSD. * = significant at 5%, ns = not significant.

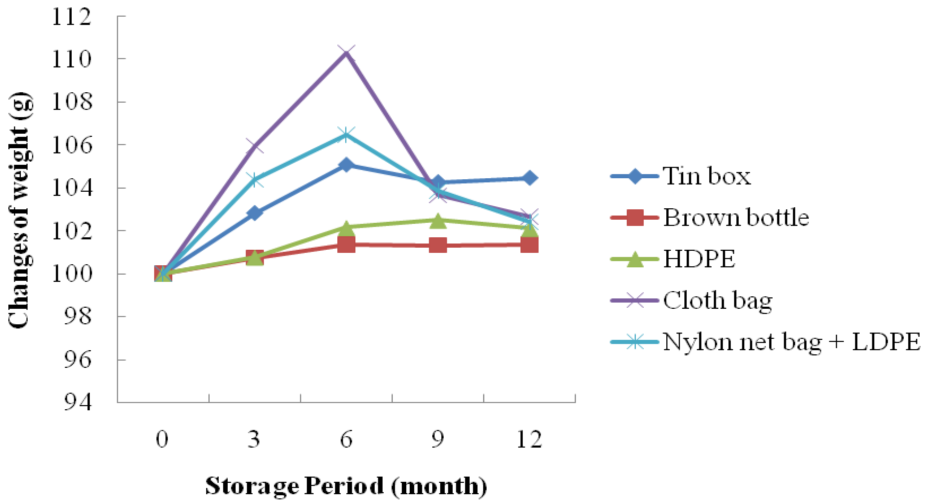


Figure 1. Seeds weight of blackgram after storing at room temperature

## Germination Percentage

Before storage using the different packaging materials, the initial germination percentage was 100% in all treatments (Table 2 and Figure2). At 6 months of storage period, seeds stored in all packaging materials were attained in 100% germination at 7 DAS except in seeds stored in tin boxes (96%).

After 12 months of storage, seeds stored in brown bottles had 100% seed germination followed by seeds storing in HDPE (93%) and tin box (90%). Among treatments, seeds packed with cloth bags were found to have the lowest percentages of seeds germination (30%) followed by seeds packed with nylon net bag + LDPE (70%).

Table 2. Germination percentages of blackgram seeds after storing at room temperature for 6 months and 12 months

| Packaging Materials | Germination Percentage of Blackgram Seeds at 7 DAS (%) | | |
|---|---|---|---|
| | Storage Period (month) | | |
| | Control | 6 | 12 |
| Tin box | 100 | 96 | 90 |
| Brown bottle | 100 | 100 | 100 |
| HDPE | 100 | 100 | 93 |
| Cloth bag | 100 | 100 | 30 |
| Nylon net bag +LDPE | 100 | 100 | 70 |

Each value represents the mean from 3 replications. DAS= day after sowing.

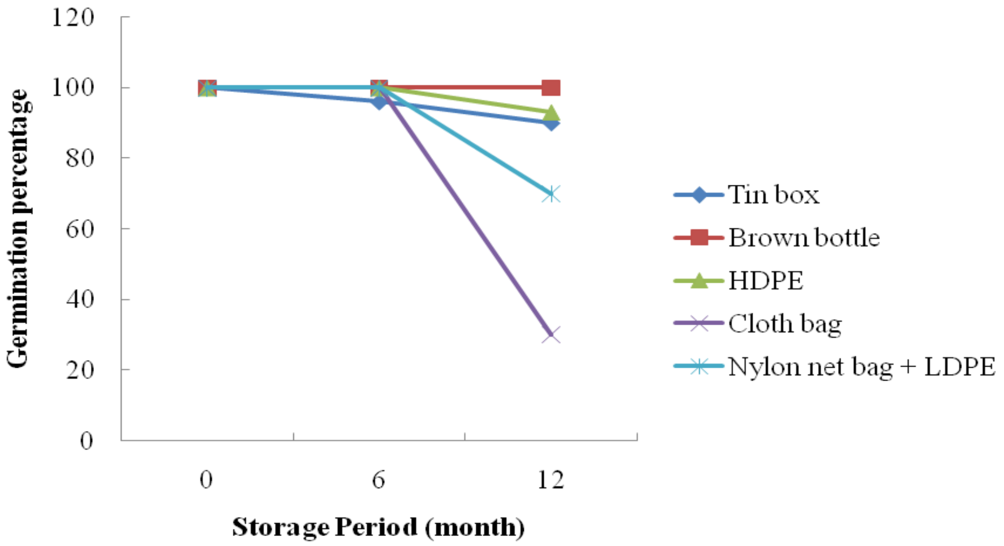


Figure 2. Germination percentages of blackgram seeds after storing at room temperature for 6 months and 12 months

**Survival Percentage**

At 14 DAS, the initial (before storage) survival percentage of blackgram seedlings was found to be 100% (Table 3 and Figure 3). After 6 months of storage period, 100% survival of seedlings was obtained in all treatments except in seeds stored in tin boxes (96%).

After storing for12 months, the highest percentage of survival (96%) was obtained from seeds stored in brown bottle followed by seeds stored in HDPE (93%) and seeds stored in tin box (90%) respectively. In contrast, the lowest percentage of survival rate was attained in seeds stored in cloth bags (30%) followed by seeds stored in nylon net bag + LDPE (66%).

Table 3. Survival percentages of blackgram seeds after storing at room temperature for 6 months and 12 months

| Packaging Materials | Survival Percentage of Blackgram Seeds at 14 DAS (%) | | |
|---|---|---|---|
| | Storage Period (month) | | |
| | **Control** | **6** | **12** |
| Tin box | 100 | 96 | 90 |
| Brown bottle | 100 | 100 | 96 |
| HDPE | 100 | 100 | 93 |
| Cloth bag | 100 | 100 | 30 |
| Nylon net bag + LDPE | 100 | 100 | 66 |

Each value represents the mean from 3 replications. DAS = days after sowing.

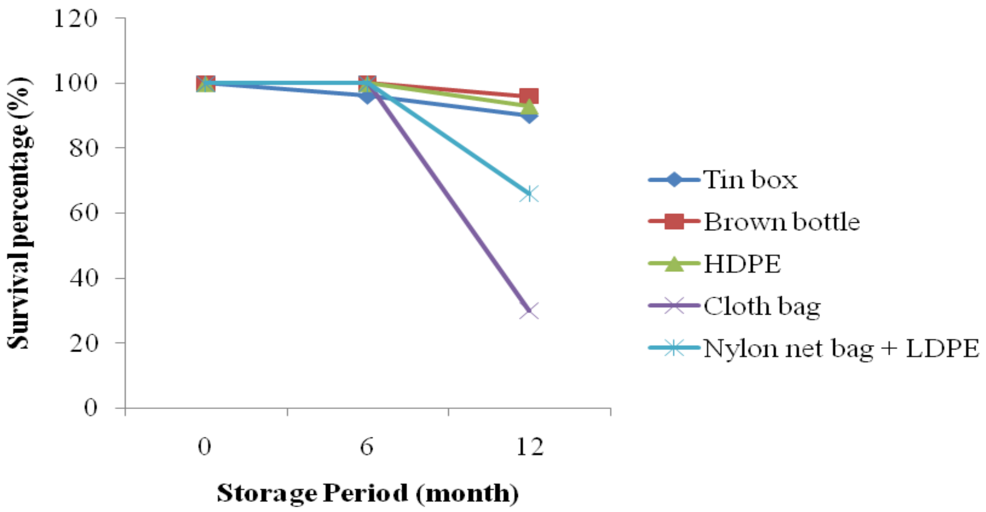


Figure 3. Percentages of survival blackgram seeds after storing at room temperature for 6 months and 12 months

**Height of Seedlings**

At 14 DAS, the height of seedlings had no significant differences among treatments after storing at 6 months (Table 4 and Figure 4). However, there were statistically significant differences among treatments after storing at 12 months. The height of seedlings was obviously reduced in all treatments compared to initial. Among treatments, the shortest height (15.81 cm) was obtained in seeds stored with cloth bags.

Table 4. Height of blackgram seedlings after storing at room temperature

| Packaging Materials | Height of Blackgram Seedlings at 14 DAS (cm/plant) | | |
|---|---|---|---|
| | **Storage Period (month)** | | |
| | **Control** | **6** | **12** |
| Tin box | 19.8 | 19.38 | 17.58 |
| Brown bottle | 19.8 | 19.82 | 17.19 |
| HDPE | 19.8 | 21.27 | 16.92 |
| Cloth bag | 19.8 | 21.82 | 15.81 |
| Nylon net bag + LDPE | 19.8 | 20.85 | 16.15 |
| F-test | ns | ns | ** |
| LSD (5%) | - | 2.44 | 0.88 |
| CV (%) | - | 6.3 | 2.8 |

Each value represents the mean from 3 replications. Mean differences within each column were determined by LSD. ** = significant at 1%, ns = not significant.

DAS = day after sowing.

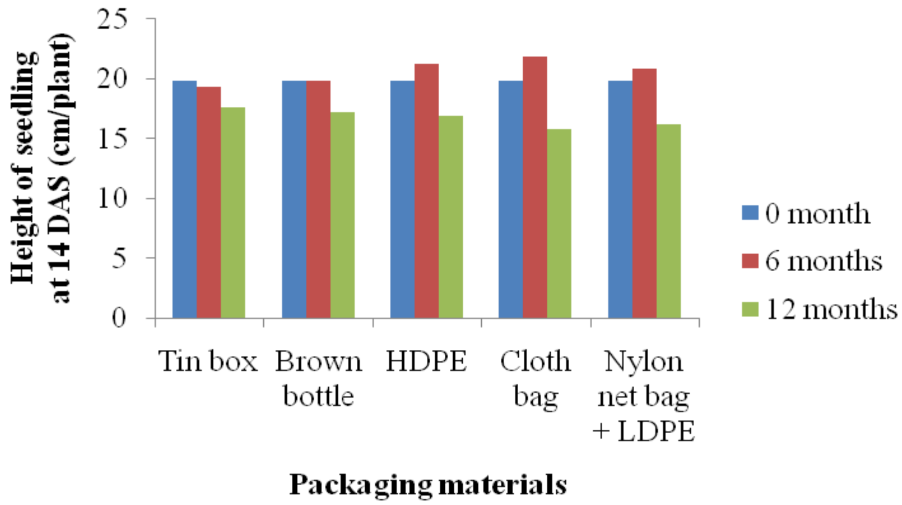


Figure 4. Height of blackgram seedlings after storing at room temperature

## Number of Leaves and Root Length of Seedling

At 14 DAS, leaves production and root length among treatments had no significant differences for 6 months and 12 months. After storing for 12 months, there were no changes in leaf production (only 1 leaf produced as in initial).

The root lengths of seedlings were decreased in all seeds stored at 12 months compared to initial (Table 5 and Figure 5).

Table 5. Number of leaves and root length of seedlings after 6 months and 12 months

| Packaging Materials | Total Number of Leaves/plant at 14 DAS | | | Root Length at 14 DAS (cm/plant) | | |
|---|---|---|---|---|---|---|
| | Storage Period (month) | | | Storage Period (month) | | |
| | Control | 6 | 12 | Control | 6 | 12 |
| Tin box | 1 | 1 | 1 | 4.58 | 5.1 | 3.51 |
| Brown bottle | 1 | 1 | 1 | 4.58 | 4.7 | 3.17 |
| HDPE | 1 | 1 | 1 | 4.58 | 4.78 | 3.74 |
| Cloth bag | 1 | 1 | 1 | 4.58 | 4.02 | 4.07 |
| Nylon net bag +LDPE | 1 | 1 | 1 | 4.58 | 4.52 | 2.82 |
| F-test | ns | ns | ns | ns | ns | ns |
| LSD (5%) | - | - | - | - | 1.31 | 2.1 |
| CV (%) | - | - | - | - | 15.1 | 3.5 |

Each value represents the mean from 3 replications. Mean differences within each column were determined by LSD. ns = not significant. DAS = day after sowing.

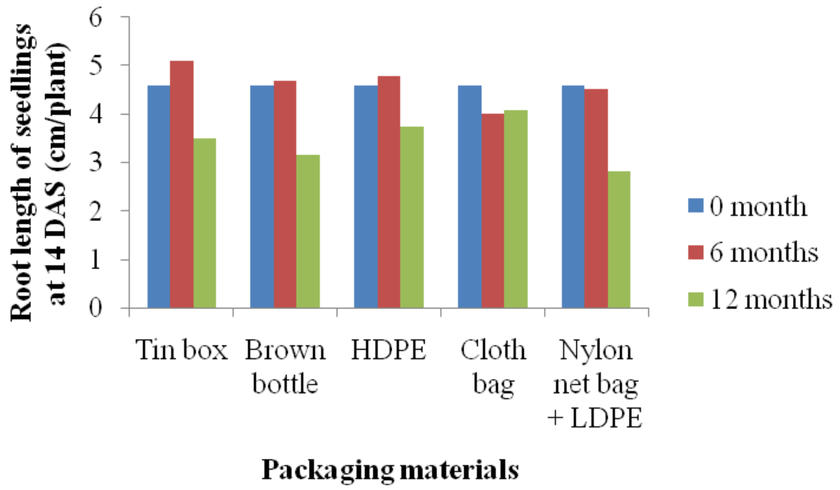


Figure 5. Root length of seedlings after storing at room temperature for 6 months and 12 months

**Visual Quality Rating (VQR)**

As shown in Table and Figure 6, blackgram seeds stored within the different packaging materials (tin box, brown bottle, HDPE, cloth bag, and nylon net bag + LDPE) had no defects or fungal infections (VQR 9, excellent) in all treatments after storing for 6 months under room temperature. However, VQR scores (8) were excellent in tin box, brown bottle up to 9 months storage and slightly decreased after 9 months and 12 months storage at room temperature (Table 6). After storing at room temperature for 12 months, all treated of blackgram seeds showed good quality in VQR scores which attained (VQR 6) because only minor defects or fungal infections occurred (Figure 6).

Table 6. Visual quality rating (VQR) of blackgram seeds after storing under room temperature for 12 months

| Packaging Materials | Visual Quality Rating (VQR) of Blackgram Seeds | | | | |
|---|---|---|---|---|---|
| | Storage Period (month) | | | | |
| | Control | 3 | 6 | 9 | 12 |
| Tin box | 9.00 | 9.00 | 9.00 | 8.00 | 6.00 |
| Brown bottle | 9.00 | 9.00 | 9.00 | 8.00 | 6.00 |
| HDPE | 9.00 | 9.00 | 9.00 | 7.67 | 6.00 |
| Cloth bag | 9.00 | 9.00 | 9.00 | 7.33 | 6.00 |
| Nylon net bag + LDPE | 9.00 | 9.00 | 9.00 | 7.67 | 6.00 |

Each value represents the mean from 3 replicates.

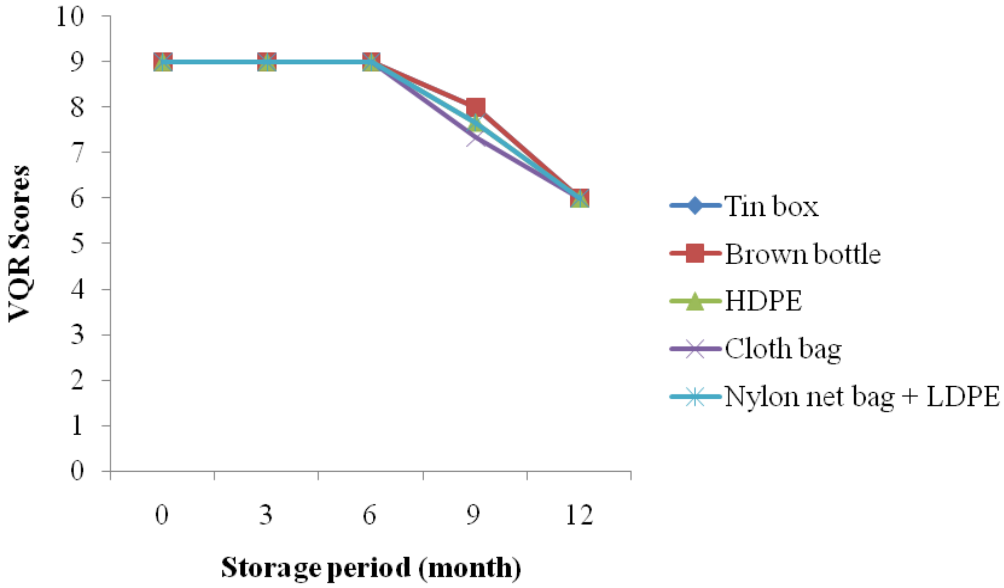


Figure 6. Visual quality rating (VQR) of black gram seeds after storing under room temperature for 12 months

**Room Temperature and Room Relative Humidity**

During storage, room temperature was 26.2 – 30.0ºC and relative humidity (RH) was 65 – 88% (Table 7). Temperature had not significantly increased or decreased throughout the storage period (Figure 7). However, the highest percentage of RH value (88%) was obtained at 3 and 6 months of storage period.

Table 7. Room temperature and room relative humidity (RH) during storage for 12 months

| Parameter | Storage Period at Room (month) | | | | |
|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 |
| Temperature (ºC) | 30.0 | 26.8 | 27.0 | 26.2 | 27.2 |
| Relative humidity (%) | 65.0 | 88.0 | 88.0 | 70.0 | 70.0 |

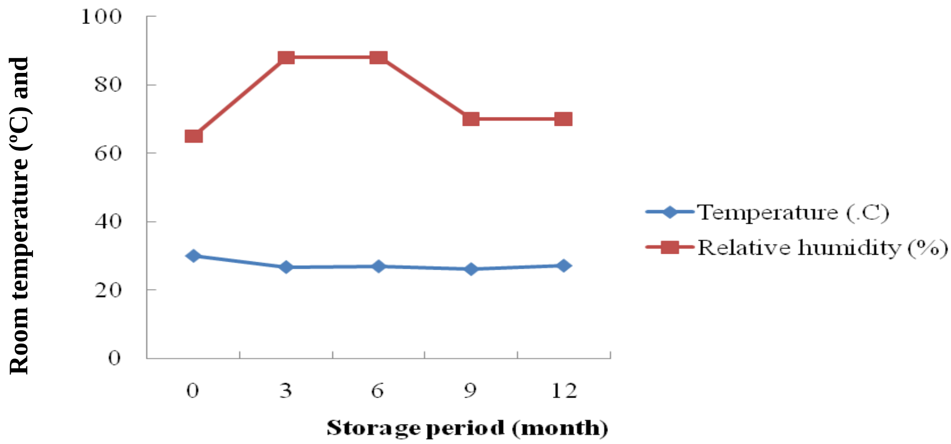


Figure 7. Room temperature and room relative humidity (RH) during storage for 12 months

**Nutrient Components of Blackgram Seeds Before and After Storing**

Before storage with the different packaging materials, the blackgram seeds possessed high values of protein content (21.4%). After storing for 12 months, the protein content was significantly decreased whereas the carbohydrate contents were vice versa to their protein contents. The moisture content of blackgram seeds stored in brown bottles showed lowest percentage (4.2%) when compared to the initial moisture contents (6.0%). However, seeds stored in tin box and HDPE had higher moisture contents 9.8% and 9.1% respectively. Ash content of blackgram seeds slightly declined in all treatments after storage compared to the results of before storage (Table 8 and Figure8).

Table 8. Nutrient components of blackgram seeds before and after storing

| Storage Conditions | | Nutrient Components of Blackgram Seeds (%) | | | |
|---|---|---|---|---|---|
| | | **Protein** | **Carbohydrate** | **Moisture** | **Ash** |
| Before storage (initial) | | 21.4 | 68.1 | 6.0 | 3.5 |
| After storage | Tin box | 14.8 | 71.3 | 9.8 | 3.1 |
| | Brown bottle | 16.5 | 75.3 | 4.2 | 3.0 |
| | HDPE | 15.0 | 71.7 | 9.1 | 3.2 |

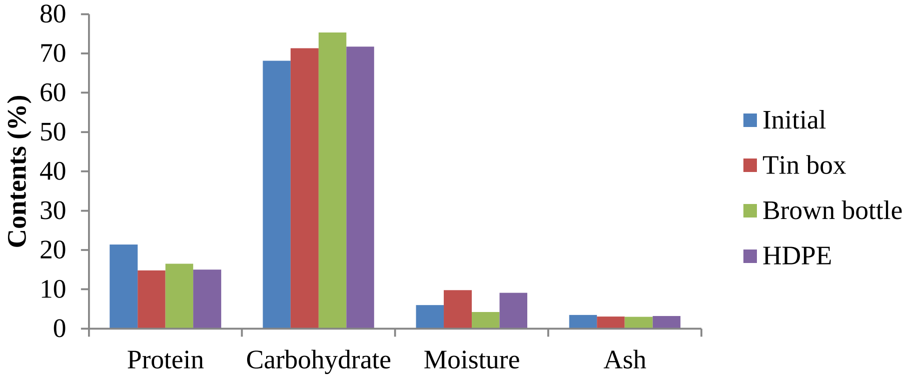


Figure 8. Percentage Nutrient contents of blackgram seeds before and after storing

## DISCUSSION AND CONCLUSION

This study was carried out to investigate the storage conditions of blackgram seeds using the different packaging materials under room temperature for 12 months. In this study, seeds store with the different packaging materials give many benefits during storage especially in less changes of their seeds weight and high value of visual appearance. Seeds stored in the brown bottles give the best performance of their seeds quality, especially the least changes of their seeds weight because the brown bottles can be maintained in moisture content and prevent the light penetration through the surfaces of the bottle.

According to the results of the study, the optimal temperature of storage room between 26°C – 30°C and 65 – 88% relative humidity. Kanade (2006) also described that temperature is an important abiotic factor governing the condition of pulses in store. The optimum temperature for breeding of most of insects in storage ranges between 27°C – 37°C and 70% relative humidity (RH). He also reported that the seeds stored within 85 – 90% RH may lose their germination capacity due to the pathogenic action of moulds.

According to the germination and viability test of blackgram seeds, 100% germination and survival rate was also observed in all treatments before storing under room temperature. Hanson *et al.* (2006) also revealed that the germination percent should not be below 85% for cultivated species. It also revealed that seeds with a high initial viability will also survive longer in storage. In this study, seeds packed with tin boxes, brown bottles, and HDPE bag were found to possess 90 – 100% of seed germination and survival percentage after 12 months storage. However, all treatments in the study, packaging with cloth bags showed the poor seed germination (only 30%) and nylon net bag + LDPE treatments (66%) which were lesser than the minimal range of (85%). In addition, the height of seedlings and root length were decreased in all seeds stored at 12 months compared to initial.

During storage for 12 months, the protein contents of blackgram seeds decreased whereas the carbohydrate contents increased in all treatments. However, the moisture contents of blackgram decreased in seeds stored inside the brown bottles and seeds stored in tin boxes and HDPE were increased. Moreover, the ash contents before and after storage conditions did not obviously change in all treatments. Thus, the nutrients contents of blackgram seeds during storage cannot be maintained in all treatments because of the process of respiration.

According to the results of the study, changes of moisture content can be maintained in seeds stored in brown bottles during storage because of less change in seed weight and high value of visual appearance on stored seeds among treatments. Thus, packaging with brown bottles would provide the best storage condition, especially in good quality of seeds when storing under room temperature. Talekar (1990) reported that seed moisture content was the most important physical quality. The higher moisture reduced the longevity of seed drastically. If the moisture is above the recommended limits for safe storage (3-7%) for long term conservation depending on species drying is required.

The present study indicated that packaging with brown bottles would provide the best storage condition, especially in good quality of blackgram seeds storing under room temperature. Thus, brown bottle should be suitable to use in a small-scale storage system.

Farmers can also use it for storing grains for their personal need because it is a very successful storage material. However, for large scale storage, brown bottles are not feasible for storing grains.

Thus, HDPE packaging materials should be used to store seeds because it will provide the good germination rate and survival rate about 90%. All the above storage materials are comparatively cheap and impart high shelf life to the stored commodities and are highly effective in preventing insect infestation.

These storage materials could be applied in modern storage areas with very minor modifications and this could save food produce that would otherwise be destroyed by insects.

Tribal and rural people have a wealth of knowledge on storage system. Even though chemical methods of management of stored pests are highly successful, even though they leave behind toxic residues. Therefore, proper storage structure and seed moisture content play an important role to maintain the postharvest quality and to prolong their storage life.

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## References

AOAC, 1995. **Official Methods of Analysis.** Association of Official Analytical Chemists**,** International, Washington, D.C

Bahl,P.N. 2004. **Pulses Training Manual**. Improved grain legumes production technologies project. TCP/MYA/0166 (A) Myanmar

Hanson,J., N. Kameswara Rao and L.Michael 2006. **Manual of seed handling in genebanks.** Handbook for genebanks No.8. Biodiversity International, Italy.

Jain D.,K.K.Satapathy and E. L.Wahlong, 2004. **Traditional postharvest technology of North Eastern Hill Region**. ICAR Research Complex for NEH Region, India.

Kanede R. S.,2006. **Postharvest profile of black gram.** Government of India, Ministry of Agriculture,Nagpur

Pangale S.V. 1976. **Handling and Storage of food grains.** India.

Purseglove, J.W.,1974. Tropical Crops, Dicotyledons, $2^{nd}$ publish Printed in Singapore by the print house (Pte)Ltd

Singh R. K. P. and K.K.Satapathy, 2003. **Zero Energy Cool Chamber: a low cost storage structure.** Journal of the North Eastern Council.

Talekar, N.S.1990. **Agromyzid flies of food legumes in the tropics**. New Delhi, India: Wiley Eastern Limited.