

Original Research Article

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Comparative Study of Quality and Nutritive Parameters of Insect Infested Bengal Gram under Vacuum and Modified Atmosphere Storage in Laminated LDPE Bags

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ABSTRACT

The effect of vacuum and modified atmospheric storage on quality parameters of insect infested bengal gram was studied. The bengal gram samples were packed with five insects of *Callosobruchus chinensis* under vacuum, modified atmosphere and ambient storage conditions for 120 days, in laminated LDPE bags. To find the effect of vacuum and nitrogen gas as modified storage on the parameters viz., moisture content, germination percentage, change in weight, rehydration capacity and protein content of bengal gram were analysed on every 30 days interval for 120 days. At each interval of storage, the significant differences were observed in increase in moisture content, rehydration capacity and change in weight and decrease in protein content and germination percentage in respective storage conditions. The observation found that increase in moisture content on wet basis ranged from 8.2% to 8.46%, 8.86% and 9.86%, rehydration capacity has increased from 0.210 to 0.235, 0.243 and 0.250g/g, change in weight from 0.0g/g to 0.333, 1.767 and 2.5 g/g and protein content has decreased from 19.650% to 18.063, 16.338 and 16.063% and germination percentage has decreased from 100% to 99.333%, 95%, 84.667% in vacuum, modified storage and ambient condition respectively. The results showed that vacuum is the best storage technique for bengal gram storage.

Keywords

Bengal gram,
Modified atmospheric
storage, Vacuum,
Insect infestation,
Quality parameters.

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Introduction

Pulses are rich source of protein (lysine), low fat, high carbohydrates, fiber, low sulfur containing amino acids, micronutrients and vitamins, which help to get rid of protein malnutrition among vegetarian people especially children and nursing mothers. Bengal gram (*Cicer aritinum L.*) is the third most important pulse crop, produced in the world after dry bean and peas (<http://www.aicrpchickpea.res.in>). Bengal gram is widely used as protein rich supplement to achieve better health in developing countries. Though, pulses have

high protein content, suffer very high insect infestation and thus undergo heavy losses during storage.

During storage, some chemical changes occur in pulses and the result is significant change in quality losses due to external living organisms such as insects, rodents and microorganisms, discoloration, darkening due to oxidation, broken/cracked/split/peeled seeds, sprouting, odour, heat damage, etc. under natural conditions. Such deterioration results from interaction among physical,

chemical, physiological and biological variables. It's stability as well as viability should be preserved by high-quality scientific storage methods. Scientific storage of pulses viz., hermetic storage, vacuum and modified atmosphere storage, mix storage, fumigation for in-situ treatment of stored materials and on structure with varying materials considerably important to check the deterioration, protects the quality of grain and help to stabilize the economy/ prices. It helps to supply of grain over time. To provide safe grains storage continuous research is going on at different research institution in the country.

In modified atmosphere storage, disinfestations of stored seeds using the alteration of the natural storage gases such as carbon dioxide, oxygen and nitrogen to create the lethal atmosphere to pests. It includes neither the alteration of the storage atmosphere by addition of toxic gases such as phosphine or methyl bromide nor atmospheric water content (Vasudevan *et al.*, 2014). Studies in the 1860s on modifying atmospheres by adding N₂ or "burned air" to grain storages were also reported by Sigaut (1980).

In Vacuum packaging, the product to be packed is placed under low atmospheric or negative pressure by drawing out the air from the pack prior to the final sealing to obtain insect kill within reasonable periods, it gives the significant effect on insect mortality (Navarro, 2006).

This increases storage or shelf life by inhibiting the growth of microorganisms and improves hygiene by reducing the danger of cross contamination, Meena *et al.*, (2017). Sanjeev *et al.*, (2006) and Meena *et al.*, (2017) noted that vacuum packaging and gas flushing techniques are used for the purpose to extend the shelf life and prevention of food spoilage by oxidation.

Hence, the objectives of this study were to compare the effect of vacuum and modified atmosphere storage on nutritive value (protein) and quality parameters of sample of bengal gram.

Materials and Methods

The samples were procured from local market of Jabalpur, Madhya Pradesh. Each sample was stored for 120 days to evaluate the parameters viz., percent moisture content, germination percentage, rehydration capacity, percent protein content and change in weight at the regular interval of 30 days. The stored material was packed in laminated LDPE bags under vacuum and modified atmosphere packaging through purging of nitrogen gas along with five insects named *Callosobruchus chinensis* (Modgil *et al.*, 1997; Chandel *et al.*, 2015). These were also compared with ambient condition. To create vacuum inside the laminated LDPE bags, vacuum sealing machine was used. For modified storage, samples were kept first in vacuum condition and then nitrogen gas was released in the bags from liquid nitrogen gas cylinder through a special valve and pipe system. Consequently, bags were sealed by thermal sealer.

Quality and nutritive parameters of bengal gram

Moisture content

Moisture content of bengal gram was determined by indirect method i.e. using Universal Moisture Meter (Chandel, 2015).

Seed germination

The seeds were germinated by laboratory Seed Germinator. Fifty seeds were placed in wet towel paper. The spacing between seed to seed was kept five times the width of seed. Then the wetted paper was properly folded

and one side was kept open for growth of seedlings.

Then this rolled paper was covered with butter paper for retaining proper humidity inside the towel paper. It was then placed in Seed Germinator at $25\pm 1^{\circ}\text{C}$ and close to saturation point. After 12 days the rolled paper were unfolded and germinated seeds were counted and germination percentage was found by following formula-

$$\text{Germination \%} = \frac{\text{Number of germinated seed} \times 100}{\text{Number of seeds kept for germination}}$$

Rehydration capacity

20 g samples were taken and steeped in water for 12hr. at ambient temperature. Grain were removed and placed on filter paper to remove free surface water, then weighed. Similar method was adopted by Shimelis (2006) and Oluwatosin *et al.*, (2016). Rehydration capacity was determined by following formula-

$$\text{Rehydration capacity} = \frac{\text{Weight of soaked grain} - \text{Weight of unsoaked grain}}{\text{Weight of Sample}}$$

Protein percentage

Protein content of samples was determined by using Micro-kjeldahl Digestion and Distillation Procedure as given by AOAC (1965). Protein percentage was found by following formula-

$$\text{protein \%} = \frac{\text{Normality of H}_2\text{SO}_4 \times \text{Titrated value} \times 14 \times 6.25 \times 100}{\text{Weight of Sample} \times 1000}$$

Change in weight

Change in weight was determined for stored samples under different storage conditions at a particular storage period using electronic weighing balance (Mekali Jayashree *et al.*, 2013).

Results and Discussion

Effect of storage period at different storage conditions on moisture content of bengal gram

The moisture content of stored bengal gram increased with an increase in storage period for vacuum, modified atmosphere and ambient condition. The minimum increment in moisture content of 8.46 % was found in vacuum followed by modified atmosphere of 8.86 % and ambient condition of 9.86 % respectively (Table 1). This is due to insect's metabolism which released heat and moisture. It also may be due to temperature and moisture gradients within stored products under ambient storage conditions. Therefore moisture increment had found minimum in vacuum storage followed by modified storage and ambient condition. The result showed maximum increment in moisture content in ambient conditions.

Effect of storage period at different storage conditions on germination capacity of bengal gram

The result showed that germination percentage of bengal gram stored in laminated LDPE bags decreased with an increase in storage time for vacuum, modified atmosphere and ambient condition. At the end of storage period i.e. 120 days, the best result was found in vacuum i.e. 99.333 %, followed by modified atmosphere of 95 % and ambient condition of 84.667 % respectively (Table 2). This may be due to respiration by grain as well as insects, mites and microorganisms during storage under ambient conditions and the result in loss of germination ability ([http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/crop1204](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop1204)) and (Meena *et al.*, 2017). The same trend was also found by Roberts *et al.*, (1968a) in peas.

Effect of storage period at different storage conditions on rehydration capacity of bengal gram

The rehydration capacity of bengal gram stored in laminated LDPE bags increased with an increase of storage time for vacuum, modified atmosphere and ambient condition.

The rehydration capacity increased from 0.210g/g to 0.235g/g in vacuum followed by modified atmosphere of 0.243g/g and ambient condition of 0.250g/g respectively (Table 3). Similar trend also was found by Oluwatosin *et al.*, (2016) for *Moringa oleifera* kernels and by Deepa *et al.*, (2013) for stored chili seeds under vacuum.

Table.1 Effect of storage period on moisture content (%) of stored bengal gram under different storage condition in laminated LDPE

Storage period (days)	Moisture content (% , wb) at different storage conditions		
	Vacuum	N ₂ purged storage	Ambient condition
0	8.2	8.2	8.2
30	8.3	8.6	8.9
60	8.4	8.73	9.1
90	8.46	8.76	9.58
120	8.46	8.86	9.86

Table.2 Effect of storage period on germination (%) of stored bengal gram under different storage condition in laminated LDPE

Storage period (days)	Germination (%) at different storage conditions		
	Vacuum	N ₂ purged storage	Ambient condition
0	100	100	100
30	100	97.667	94.333
60	99.333	97	92
90	99.333	95.333	87.333
120	99.333	95	84.667

Table.3 Effect of storage period on rehydration capacity (g/g) of stored bengal gram under different storage condition in laminated LDPE

Storage period (days)	Rehydration capacity (g/g) at different storage conditions		
	Vacuum	N ₂ purged storage	Ambient condition
0	0.210	0.210	0.210
30	0.237	0.240	0.227
60	0.228	0.245	0.237
90	0.227	0.243	0.233
120	0.235	0.243	0.250

Table.4 Effect of storage period on protein content (%) of stored bengal gram under different storage condition in laminated LDPE

Storage period (days)	Protein content (%) at different storage conditions		
	Vacuum	N ₂ purged storage	Ambient condition
0	19.650	19.650	19.650
30	18.925	17.925	17.063
60	18.925	17.363	17.006
90	18.338	17.063	16.625
120	18.063	16.338	16.063

Table.5 Effect of storage period on change in weight (g) of stored bengal gram under different storage condition in laminated LDPE

Storage period (days)	Change in weight (g) at different storage conditions		
	Vacuum	N ₂ purged storage	Ambient condition
0	0	0	0
30	0	0.033	0.4
60	0.067	0.3	0.833
90	0.233	1.067	2.167
120	0.333	1.767	2.5

Effect of storage period at different storage conditions on protein percentage of bengal gram

With an increase in storage period, the protein percentage decreased for stored bengal gram under different storage condition. The maximum protein percentage of 18.063 % was found in vacuum followed by modified atmosphere of 16.338 % and ambient condition of 16.063 % respectively (Table 4). It could be due to property of protein chains, which form loose mesh with increase in moisture content, when sample stored at room temperature in control conditions and under vacuum and modified atmosphere storage, it was found in decreased state. This trend was also found by Deepa *et al.*, (2013) for chili seeds stored under vacuum.

Effect of storage period at different storage conditions on change in weight of bengal gram

The change in weight of stored bengal gram increased with storage time for vacuum, modified atmosphere and ambient condition. The minimum change in weight of 0.333 g was found in vacuum followed by modified atmosphere of 1.767 g and ambient condition of 2.5 g respectively (Table 5). Under ambient conditions the heating occurs within stored grains due to respiration of grain as

well as insects and microorganism, which may be responsible for loss in weight ([http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/crop1204](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/crop1204)). Vacuum packaging inhibit the dehydration and weight loss in the stored product. Same trend was also found by Mekali Jayashree, (2013) at different concentration of CO₂ for sorghum seeds and Divya *et al.*, (2016) for horsegram stored under CO₂ rich atmosphere.

The work were carried out for stored bengal gram in laminated LDPE bags under different storage conditions i.e. vacuum, modified atmosphere storage and ambient conditions for 120 days. It was found that increase in moisture content, rehydration capacity and change in weight with storage period had minimum in vacuum in comparison to modified atmosphere and ambient conditions. The minimum loss in protein content and germination percentage were found under vacuum condition than others. Therefore the storage of bengal gram under vacuum condition had significantly effective followed by modified atmosphere and ambient conditions.

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