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Quantitative and Qualitative Losses in Green Gram Stored in Different Containers and Temperatures

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Abstract: Quantitative and qualitative losses in green gram, when stored in jute bags, polythene bags and tin containers, at room temperature and at 25±2°C and 5±2°C for 12 months after harvest are reported in this paper. The infestation of seeds with bruchids, *Callosobruchus maculatus* Fab., increased with the storage period and was high on seeds stored in jute bags as compared to those in polythene bags, both at room temperature and at 25°C. The seeds stored at 5°C escaped from bruchids attack in all the three storage materials tested. There was significant increase in crude protein, crude fibre, ash and reducing sugars and decrease in soluble carbohydrate, total soluble sugars, nonreducing sugars and starch with storage time at room temperature and at 25°C. These changes were minimum at 5°C. The maximum adverse effects were observed on storage in jute bags, and minimum in polythene bags.

Key words: Green gram, seed weight, soluble sugars, starch, crude protein, bruchids.

The importance of the storage life of seeds, for retaining them as viable seeds and unspoiled food reserves, are known. Regardless of how the grains are stored, they are subjected to continued chemical changes, which affect their nutritive value. The most vulnerable place is the farmer's store, both at farm and at home, where 60-70% of produce is retained. Losses are maximum here, since storage methods at the farm and at home are still traditional in several areas. Improper storage conditions affect the pulses, both in quantity and quality. Although attempts have been made to quantify the losses (Girish *et al.*, 1975; Sudhakar and Pandey, 1981; Vimala and Pushpamma, 1983), very little research has been done on quantitative and qualitative changes in stored pulses, especially on home level storage of pulses. Hence, the present investigation was undertaken to assess the quantitative and qualitative losses in green gram at different temperatures, an important protein-rich pulse crop of Asia and Africa.

Materials and Methods

The evaluation trials of different materials, viz., jute bags, polythene bags and tin containers, were conducted at room temperature and constant temperature of 25±2°C and 5±2°C. Seeds (500 g) of green gram were stored in three replications for single treatment, and the experiment was laid in a completely randomised design in Post-harvest technology laboratory. Initial observations like moisture content, insect infestation, nutritive and biochemical analysis of seed material were made. After these observations, the storage structures were closed and sealed. Subsequent observations were recorded after 3, 6 and 12 months of storage.

Representative samples of 100 seeds were taken out randomly from each replication and separated into infested and normal seeds. Percentage seed damage and loss in seed weight were calculated following Adam and Schulton (1978).

Moisture content of seeds was determined following standard method of AOAC (1975). Crude protein, ether extract, crude fibre and ash were also determined according to AOAC (1975). Reducing sugars were estimated by the method of Nelson (1944) and total soluble sugars and starch were determined by using the method of Yemm and Willis (1954). Non-reducing sugars were estimated by substracting reducing sugars from total soluble sugars. The results were statistically analysed using analysis of variance for storage containers and storage time.

Results and Discussion

The statistical analysis of the data showed that infestation of seeds of green gram was significantly higher ($P<0.01$) by storage period at room temperature and at 25°C, and by storage containers when stored at 25°C (Table 1). Green gram seeds in the present study were infested by *Callosobruchus maculatus* Fab. (Bruchidae). Infestation of green gram seeds stored in jute bags was high as compared to storage in polythene bags. Maximum infestation of seeds occurred in jute bags at 25°C after 12 months of storage. The seeds stored at 5°C, however, escaped bruchid attack in all the stored materials tested.

Moisture content of green gram increased significantly ($P<0.01$) as the period of storage increased in all the stored materials and at all three temperatures tested in the present study. The moisture content of grain varied from 4.14 to 14.52% in all the three storage containers. Increase in moisture content was lowest at 5°C as compared to that at room temperature and 25°C after 12 months of storage. In general, the moisture content was higher in seeds stored in jute bags at all the three temperatures at 6 and 12 months of storage. The level of infestation increased with the increase in moisture content of seeds ($r = 0.712$), as has also been cited in literature (Vimala and Pushpamma, 1983). Large insect populations produce more water as a result of their metabolic activity which further increases seed moisture (Khare, 1972; Yadav and Pant, 1978). Srivastava *et al.* (1988) have shown that Pigeon pea seeds stored for 12 months in mud bin can have moisture content of 15.7%.

There was significant increase in seed weight loss with respect to storage period at all the three storage temperatures. However, loss was minimum at 5°C. Loss in seed weight was significantly higher in jute bags at room temperature. Loss in seed weight was also more in jute bags storage at 25°C, but was not statistically significant. Increasing trend of insect infestation and seed weight loss with storage period at room temperature have also been reported earlier (Kapoor *et al.*, 1972).

Soluble carbohydrate of green gram decreased significantly ($P<0.05$) when stored in jute bags at room temperature (63.02%) and at 25°C (49.02%), as compared to those in polythene bags (66.39 and 64.19%) and tin containers (65.05 and 64.56%). However, there was no effect at 5°C in all the three containers tested. Although soluble carbohydrate decreased with period of storage at room temperature and 25°C, it was statistically non-significant.

*Table 1. Influence of different storage conditions on insect infestation, moisture and weight of green gram seeds**

Containers	Infestation (%)			Loss in seed weight (%)			Moisture (%)		
	Room temp.	25°C	5°C	Room temp.	25°C	5°C	Room temp.	25°C	5°C
Polythene bags	9.25 (14.17)**	22.0 (19.96)	0.00 (0.00)	4.52 (10.29)	19.24 (20.99)	4.66 (10.82)	7.35 (15.22)	8.51 (16.36)	8.03 (15.96)
Tin containers	14.35 (17.85)	30.66 (28.30)	0.00 (0.00)	5.47 (11.37)	7.78 (13.98)	4.47 (10.59)	7.45 (15.32)	8.37 (16.25)	6.73 (12.60)
Jute bags	31.0 (29.32)	43.79 (40.96)	0.00 (0.00)	10.57 (22.68)	30.54 (34.79)	4.61 (10.75)	8.40 (16.28)	9.99 (17.58)	7.07 (15.04)
CD (1%) for containers	N.S.	(21.832)	N.S.	(13.914)	N.S.	N.S.	N.S.	N.S.	N.S.
CD (5%) for containers		(14.417)		(9.185)					
Period (months)									
0	–	–	–	–	–	–	4.14 (11.68)	4.14 (11.68)	4.14 (11.68)
3	4.75 (11.37)	6.22 (11.52)	0.00 (0.00)	6.89 (12.46)	11.07 (18.59)	5.46 (13.51)	4.04 (11.63)	4.16 (11.78)	4.08 (11.68)
6	27.05 (30.90)	34.19 (34.39)	0.00 (0.00)	16.11 (22.42)	29.62 (31.33)	6.36 (14.46)	8.88 (17.27)	13.01 (21.08)	8.83 (17.22)
12	41.0 (39.51)	91.0 (75.74)	0.00 (0.00)	16.42 (22.72)	48.05 (43.10)	6.51 (14.77)	13.88 (21.86)	14.52 (22.4)	12.05 (20.29)
CD (1%) for period	(21.555)	(25.210)	N.S.	(16.067)	(34.171)	(1.073)	(3.463)	(3.041)	(5.455)
CD (5%) for period	(14.228)	(16.641)		(10.606)	(22.556)	(0.708)	(2.286)	(1.989)	(3.601)

* Average of 3 replications; ** Figures in parentheses show angular transformed values.

Total soluble sugars, nonreducing sugars and starch content of stored green gram decreased significantly ($P<0.05$) when stored in jute bags at room temperature (Table 2). Statistically significant ($P<0.01$) decrease in soluble sugars and non-reducing sugar was also observed with storage time at all the three storage temperatures. Decrease in total soluble sugars was maximum at room temperature (5.96%) after 12 months of storage, compared to those stored at 25°C (6.01%) and 5°C (7.77%). The starch content, however, decreased only at room temperature and at 25°C. Minimum decrease in soluble sugars, non-reducing sugars and starch was observed at 5°C in various storage containers. Reducing sugars increased significantly ($P<0.01$) with storage period at room temperature and at 25°C when stored for 12 months.

The decrease in soluble carbohydrate, total soluble sugars, non-reducing sugars and starch during one year of storage in present study could be attributed to metabolic turnover of carbohydrates in seeds and consumption of sugars by the insects. These findings are in accordance with those reported earlier by several earlier workers (Khare, 1972; Srivastava *et al.*, 1988). Ovcharov (1977) observed that seed respiration increased with increase in seed moisture. It has been reported that amylase and mainly starch phosphorylase play key role in degradation of starch to sugars. In present study, increase in reducing sugars might be due to degradation of starch, as has also been reported by Eskin *et al.* (1971).

The crude protein, crude fibre and ash content of stored green gram samples in different storage containers at different storage temperatures are given in Table 3. The crude protein content of green gram increased in all the storage containers at the end of six month storage period at room temperature and at 25°C. The differences were significant with respect to storage period and storage containers

*Table 2 Changes in reducing sugars, non-reducing sugars and starch content of stored green gram seeds**

Containers	Reducing sugars (%)			Non reducing sugars (%)			Starch (%)		
	Room temp.	25°C	5°C	Room temp.	25°C	5°C	Room temp.	25°C	5°C
Polythene bags	0.28 (3.00)**	0.29 (3.00)	0.26 (2.85)	6.51 (14.77)	6.85 (15.15)	7.50 (15.89)	28.37 (32.16)	25.72 (30.36)	30.20 (33.33)
Tin containers	0.28 (3.00)	0.30 (3.14)	0.27 (2.85)	6.61 (14.89)	6.73 (15.03)	7.47 (15.87)	29.15 (32.65)	24.60 (29.65)	30.40 (33.45)
Jute bags	0.37 (3.46)	0.44 (3.67)	0.26 (2.85)	6.18 (14.35)	6.23 (14.44)	7.51 (15.95)	24.82 (29.82)	19.95 (25.87)	31.85 (34.35)
CD (1%) for containers	N.S.	N.S.	N.S.	(0.584)	N.S.	N.S.	(3.040)	N.S.	N.S.
CD (5%) for containers				(0.387)			(2.007)		
Period (months)									
0	0.20 (2.56)	0.20 (2.56)	0.20 (2.56)	7.70 (16.11)	7.70 (16.11)	7.70 (16.11)	30.60 (33.85)	30.60 (33.58)	30.60 (33.58)
3	0.30 (3.14)	0.33 (3.20)	0.23 (2.56)	6.57 (14.88)	7.02 (15.37)	7.51 (15.96)	29.53 (32.88)	30.46 (33.49)	31.70 (34.26)
6	0.34 (3.25)	0.40 (3.63)	0.31 (3.14)	5.90 (14.05)	6.15 (14.36)	7.38 (15.75)	23.70 (29.11)	16.50 (23.76)	29.96 (33.18)
12	0.40 (3.63)	0.45 (3.77)	0.32 (3.14)	5.56 (13.64)	5.55 (13.64)	7.40 (15.79)	25.96 (30.59)	16.40 (23.69)	31.30 (33.83)
CD (1%) for period	(0.767)	(1.026)	N.S.	(0.067)	(1.040)	(0.267)	(3.510)	(6.446)	N.S.
CD (5%) for period	(0.506)	(0.677)		(0.447)	(0.688)	(0.176)	(2.317)	(4.255)	N.S.

* Average of 3 replications; ** Figures in parentheses show angular transformed values.

*Table 3. Effect of different storage conditions on chemical composition of green gram seeds**

Containers	Crude protein (%)			Crude fibe (%)			Ash (%)		
	Room temp.	25°C	5°C	Room temp.	25°C	5°C	Room temp.	25°C	5°C
Polythene bags	23.92 (29.28)**	24.60 (29.74)	23.50 (28.99)	5.03 (12.95)	5.41 (13.46)	5.18 (13.17)	4.03 (11.60)	4.59 (12.37)	4.24 (11.89)
Tin containers	23.99 (29.31)	24.00 (29.33)	23.53 (29.00)	5.28 (13.27)	5.52 (13.60)	5.25 (13.27)	4.45 (12.16)	4.64 (12.50)	4.23 (11.86)
Jute bags	25.49 (30.30)	29.87 (33.08)	23.34 (25.89)	5.62 (13.71)	10.21 (18.18)	5.11 (13.05)	4.63 (12.44)	9.55 (17.35)	4.20 (11.82)
CD (1%) for containers	(1.305)	(0.943)	N.S.	(0.786)	N.S.	N.S.	N.S.	N.S.	N.S.
CD (5%) for containers	(0.861)	(3.735)		(0.518)					
Period (months)									
0	23.51 (29.00)**	23.51 (29.00)	23.51 (29.00)	5.00 (12.92)	5.00 (12.92)	5.00 (12.92)	4.01 (11.54)	4.01 (11.54)	4.01 (11.54)
3	24.27 (29.50)	25.67 (30.42)	23.58 (29.06)	5.20 (13.17)	5.64 (13.75)	5.25 (13.26)	4.12 (11.72)	4.64 (12.37)	4.24 (11.87)
6	26.04 (30.67)	27.51 (31.59)	23.58 (29.06)	5.48 (13.30)	8.44 (16.49)	5.38 (13.43)	4.59 (12.36)	8.18 (16.11)	4.35 (12.06)
12	24.05 (29.34)	27.94 (31.85)	23.16 (28.74)	5.90 (13.84)	9.10 (17.18)	5.10 (13.05)	4.76 (12.65)	8.33 (16.27)	4.31 (11.97)
CD (1%) for period	(1.506)	N.S.	(0.262)	(0.907)	N.S.	N.S.	(1.168)	N.S.	N.S.
CD (5%) for period	(0.994)	N.S.	(0.173)	(0.598)			(0.771)		

* Average of 3 replications; ** Figures in parentheses show angular transformed values.

at room temperature, whereas at 25°C the differences were significant with respect to storage containers only. Increase in crude protein was significant in jute bags at both the temperatures, while at storage temperature of 5°C it remained almost the same after 12 months of storage in all the three storage containers. Srivastava *et al.* (1988) and Sudhakar and Pandey (1981) reported an increase in protein with increase in infestation. Hira *et al.* (1988) observed increase in crude protein upto 5th month of storage. The increase in crude protein with time in the present study could be due to loss of seed carbohydrates. Besides this, addition of nitrogenous components such as urine and saliva of the insects to seeds also contributed to increase in seed protein. Similar results have been reported by Doharey *et al.* (1985) in green gram.

The crude fibre of green gram increased significantly with storage period ($P<0.05$) and storage containers ($P<0.05$) at room temperature. The increase in crude fibre was also observed with storage period at 25°C but it was not statistically significant. The increase in crude fibre was more in green

gram stored in jute bags and minimum in green gram stored in polythene bags at 25°C and room temperature. However, appreciable changes were not observed in crude fibre when stored at 5°C in all the three containers. The observed increase in crude fibre might be attributed to increased infestation with a decrease in non-fibre constituents like starches.

Ether extract of green gram stored in different storage containers at different storage temperatures did not change significantly. The ether extract of seeds ranged from 1.10 to 1.32%. On the contrary Srivastava *et al.* (1988) observed decrease in crude fat content during storage. The ash content of stored green gram increased significantly ($P<0.05$) with storage period at room temperature. The changes in ash content were minimum in polythene bags and maximum in jute bags at room temperature and 25°C but the differences were non-significant. This increase in ash and crude fibre may be due to the selective feeding of cotyledon and embryo portion of the seed by insects, leaving aside major part of the seed coat as such. Since the seed coat is rich in minerals (13%) and fibre (98%) (Singh *et al.*, 1968) substantial increase in seed coat portion in a seed lot resulted in significant increase in total ash and crude fibre content of the seed.

It is concluded that significant changes in chemical constituents occurred during storage of green gram for a period of 12 months at room temperature and at 25°C. These changes were minimum at 5°C. The maximum adverse effects were observed in green gram stored in jute bags at room temperature and at 25°C. Green gram stored in polythene bags was found to be unaffected.

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