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Influence of Different Packaging Materials on the Seed Quality Parameters of Chickpea

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A B S T R A C T

Studies were carried out to find out the influence of different packaging materials on the seed quality parameters of chickpea. Freshly harvested and fully matured chickpea grains (cv. GJG-3) were cleaned, sorted, graded and dried up to 7.6 % (w.b.) moisture content for safe storage. The dried grains were packed in different packaging materials viz., jute bag (control), polyethylene lined jute bag, polypropylene (PP) woven laminated bag, high density polyethylene (HDPE) bag with vacuum, multilayer coextruded plastic bag with vacuum, polyethylene laminated aluminium foil bag with vacuum, per due improve crop storage (PICS) bag with 5.0 kg sample size. All the bags were stored at room temperature (13.2 °C-38.5 °C, 18.8-91.1 % RH) for twelve months in the laboratory. The quality parameters of the grain were analysed at two-month interval during storage. Moisture content of the grain was recorded maximum in jute bag and minimum was observed in polyethylene laminated aluminium foil bag during entire storage period. The Insect population (46 number/500g) was found only in chickpea grain stored in jute bag at the end of twelve months of storage period. Maximum grain damage was found only in jute bag (26.30 %) at the end of storage period. Swelling capacity (0.248 ml/grain) was found maximum in PP woven laminated bag at the end of the storage. Swelling capacity of the grain was found lower in vacuum packed materials. Germination (91.33 %) and seed vigour index (1114) was found maximum in PP woven laminated bag at the end of the storage. Germination (70.67 %) and seed vigour index (829)of the grain was found lowest in jute bag at the end of storage period.

Keywords

Chickpea grain, Packaging materials, Storage life, Seed quality

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Introduction

The chickpea (*Cicer arietinum* L.) is one of the most important pulse crop cultivated throughout the world. India is the largest chickpea producing country accounting for 72% of the global chickpea production. In India, the area under chickpea cultivation was 95.4 lakh ha with an annual production of 90.8 lakh tons during the year 2016-17 (Anon., 2017). It is a good source of carbohydrates, important vitamins, minerals, essential amino acids and nutritionally important unsaturated fatty acids. It is a major and cheap source of protein for millions of vegetarians in the developing countries. Chickpea is predominantly consumed in the form of whole grain, dhal, flour, sprouted grain, green or matured dry seeds and is used in the preparation of a variety of snacks, sweets and condiments (Jukanti *et al.,* 2012).

Pulses are more difficult to store than cereals and suffer much greater damage from insects and microorganisms. The post-harvest losses of food grains are estimated to be 10 to 20% in India (Chahal, 2011). The pulse beetle and bruchids are mostly found during the storage of chickpea and reduces the market value of seed, germination percent and nutrition value which make chickpea unfit for marketing as well as human consumption (Modgil and Mehta, 1994).

Many synthetic insecticides have been found effective against this pest, but are hazardous and toxic, due to their residual effect in the food. Insect resistance to phosphine is a global issue now and control failures have been found in some countries. Methyl bromide has been identified as a major contributor to ozone depletion and is, therefore, being phased out completely (Taylor 1989). Proper packaging and storage methods are essential for good storage stability for food grains. Traditionally, jute has been used for bulk packaging of food grains and pulses. Plastic materials *viz*., HDPE and PP woven sacks, multi-layer co-extruded film, triple-layer bags and aluminium foil are used very widely for food grain and seed storage due to the excellent barrier to moisture, air, odors and microorganisms. Polyethylene lining in jute bag or in PP woven bag are also useful to protect the products from moisture ingress. Vacuum packaging increases storage life of food products by inhibiting the growth of microorganisms and improves hygiene by reducing the danger of cross contamination (Meena *et al.,* 2017). Looking to the above facts, the present research work was undertaken to retain the quality and reduce post-harvest loss of the grain.

Materials and Methods

A storage experiment was carried out for a period of 12 months i.e. from May-2017 to April-2018 at Department of Processing and Food Engineering, College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh. The freshly harvest and uniformly matured desi chickpea grain (*GJG-3*) was procured from the Agricultural Research Station, Dhari, JAU, Junagadh. The grain was cleaned and graded by cleaner-cum-grader machine. The grain was then cleaned and sorted out manually to remove extraneous materials such as dust, dirt, stones, chaff, immature grains, insect infested and damaged grains. The chickpea grain was dried for 6 h in open yard for sun drying up to 7.6 % (w.b.) final moisture content for safe storage. The grains were packed in different packaging materials with 5.0 kg sample size. The jute bags, polyethylene lined jute bags and PP woven laminated bags were packed and sewed by portable stitching machine (Revo bag closer, Surat) after filling the grain. For PICS bags packaging, the grains were filled and sealed inner double layer HDPE bags and packed in outer PP bags and sewed by portable stitching machine. HDPE bags, multilayer coextruded plastic bags and polyethylene laminated aluminium foil bags were packed with vacuum (700 mm Hg) in vacuum packaging machine (Packmech Engineers, Ahmedabad).All the bags were stored at the end of month of April, 2018 at room temperature (13.2-38.5 °C, 18.8 - 91.1 % RH) for twelve months on platform in the laboratory for rat control.

Details of treatments

Independent parameters

1. Jute bag (JB) (control)
2. Polyethylene lined jute bag (JBP)
3. PP woven laminated bag (PPL)

4. HDPE bag with vacuum (HDPEV)
5. Multilayer coextruded plastic bag with vacuum (MCPV)
6. Polyethylene laminated aluminium foil bag with vacuum (ALPEV)
7. Perdue improve crop storage bag (PICS)
8. No. of Replications: 3 (Three)
9. Statistical Design: Completely Randomized Design (CRD)

All the seed quality parameters of the grains were recorded during two-month of storage by standard methods. The environmental parameters such as temperature and relative humidity were recorded daily with using data logger at room conditions in the laboratory during storage. Moisture contents of the samples were determined by using hot air oven method as suggested by Sadasivam and Manickam (1996).The insect population was recorded by taking500 g of sample for recording insect population like pulse beetle and bruchid. The total number of adults obtained from each sample was counted and recorded. Grain damage percentage was calculated by taking sample of 200 Nos. chickpea grains for counting damaged grains from the sample. The grain damage was determined using following formula.

$$\text{Grain damage (\%)} = \frac{\text{Number of damaged grains}}{\text{Number of grains in sample}} \times 100$$

Swelling capacity of the grains were determined using following equations as reported by Williams *et al.*, (1983).

$$\text{Swelling capacity, ml/grain} = \frac{\text{Volume after soaking} - \text{Volume before soaking}}{\text{Number of grains}}$$

Germination percentage was calculated by using the method given by International Seed Testing Association (ISTA, 1996). Seed vigour index was determined as reported by ISTA (1996) by using following formula:

Seed vigour index = Average seedling length (root + shoot) (cm) × Germination (%)

Statistical analysis was carried out by Completely Randomized Design with three replications. All the treatments were compared at 5% level of significance using the critical difference test.

Results and Discussion

Environmental parameters

Maximum temperature (38.5 °C) was recorded in the month of May while minimum temperature (13.2 °C) was observed in the month of January. Maximum RH was recorded in the month of July (91.1 %) while minimum RH was found in the month of March (18.8 %).

Seed quality parameters of chickpea grains

Moisture content (%)

It is evident from Figure 1 that moisture content of the grain increased drastically for JB followed by JBL and PPL up to four months of storage period. However, little variation was observed in other treatments. The increase in moisture content of the grain up to four months (up to August) of storage period might be due to hygroscopic nature of the grain and moisture exchange in a pervious material during high RH in monsoon season (Harrington, 1972; Malarkodi, 1997; Roberts, 1986). The moisture content of the grain deceased after four months of storage period for all the treatments. The maximum moisture content of the chickpea stored in JB, JBL and PPL was found 12.38 %, 10.39 %, and 10.12 %, respectively on four months of storage. Minimum moisture content was observed in

ALPEV followed by MCPV, HDPEV and PICS *i.e.* vacuum packaging and triple layer PICS bags during entire storage. It might be attributed to their lesser permeability in plastic packaging materials as well as vacuum packaging (Sumathi, 2010). The similar results for moisture content were also reported by Asha (2012) in maize, Kurdikeri *et al.,* (1995) in maize and Shaw (1998) in green gram during storage.

Insect population(number/500g)

Insect was not observed up to two months of storage period in the chickpea grain. It is apparent from the Table 1 that the insect population of pulse beetle (*Callosobruchus chinensis* L.) was only found in jute bag. However, it started in JB on four months of storage and the insect population increased cumulative as storage progressed. *i.e.,* 46 numbers/500 g of sample at the end of twelve months of storage period. The increase in insect population in the grain might due to higher moisture content and aeration which enhanced grain deterioration (Monira *et al.,* 2012). JBP, PPL, HDPEV, MCPV, ALPEV and PICS treatments were observed free from insect infestation throughout the storage period. It might be due to reduced pressure and resulting oxygen content interfered with insect movement, feeding and respiration (Adler *et al.,* 2016).These findings are fairly matched with Haile (2015) in chickpea, Martin *et al.,* (2015) in wheat and Baributsa*et al.,* (2017) in chickpea grain.

Grain damage (%)

Grain damage was not observed up to two months of storage period in the chickpea grain is presented in Table 2. From the table, it can be observed that the grain damage in JB increased with increase in storage period. Grain damage increased in the grain might be due to the insect infestation increased during storage. The JB was recorded the highest grain damage (26.33 %) at the end of storage period and thus found susceptible to pulse beetle. JBP, PPL, HDPEV, MCPV, ALPEV and PICS treatments were observed free from grain damage during entire storage period. Similar results for increase in grain damage were also reported by Sharma *et al.,* (2007) in chickpea, Shaw (1998) in green gram Regmi and Dhoj (2013) in chickpea and Basavegowda and Arunkumar (2013) in chickpea.

Swelling capacity

It is obvious from Figure 2 that swelling capacity of chickpea grain decreased with increase in storage period. The effect of different packaging materials on swelling capacity was found significant during entire storage period. PPL resulted significantly highest swelling capacity (0.248 ml/grain) at the end of storage period. However, JBP and JB were found at par with PPL during entire storage period. Swelling capacity of the grain was found minimum for ALPEV (0.117 ml/grain) and it was at par with MCPV throughout storage period. It might be due to formation of structural change and harder texture of pulse grain, increase in electric conductivity and solute leaching during storage which rendered the cells resistant to water absorption (Bressani, 1993 and Kilmer *et al.,* 1994, Nasar-Abbas *et al.,* 2008).

Germination percentage

It is evident from the Figure 3 that the germination of chickpea grain reduced with increase in storage period might be attributed to insect infestation and grain damage. The decline in germination percentage over the storage period irrespective of treatment was due to ageing effect leading to depletion of food reserves, seed deterioration, fluctuating temperature, relative humidity and grain moisture content as influenced by storage packaging materials (Kumar *et al.,* 2007).

Table.1 Effect of different packaging materials on insect population (number/500g) of chickpea grain during storage

Treatment	Storage period, Months				
	4	**6**	**8**	**10**	**12**
JB	1.64* (2.3)	2.32* (5.0)	4.01* (15.7)	4.91* (23.7)	6.81* (46.0)
JBP	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
PPL	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
HDPEV	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
MCPV	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
ALPEV	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
PICS	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
S.Em.±	0.099	0.095	0.082	0.079	0.106
C.D. at 5 %	0.299	0.288	0.249	0.238	0.322
C.V. %	20.290	17.520	12.060	10.410	11.630

* Data subjected to square root transformation
Figures in parentheses are original values

Table.2 Effect of different packaging materials on grain damage (%) of chickpea grain during storage

Treatment	Storage period, Months				
	4	**6**	**8**	**10**	**12**
JB	1.27* (1.2)	1.98* (3.5)	2.96* (7.5)	3.53* (12.0)	5.38* (26.3)
JBP	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
PPL	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
HDPEV	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
MCPV	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
ALPEV	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
PICS	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)	0.71* (0.0)
S.Em.±	0.064	0.084	0.050	0.057	0.044
C.D. at 5 %	0.194	0.253	0.152	0.172	0.134
C.V. %	14.07	16.28	8.61	8.82	5.7

* Data subjected to square root transformation
Figures in parentheses are original values

Fig.1 Effect of different packaging materials on moisture content of chickpea grain

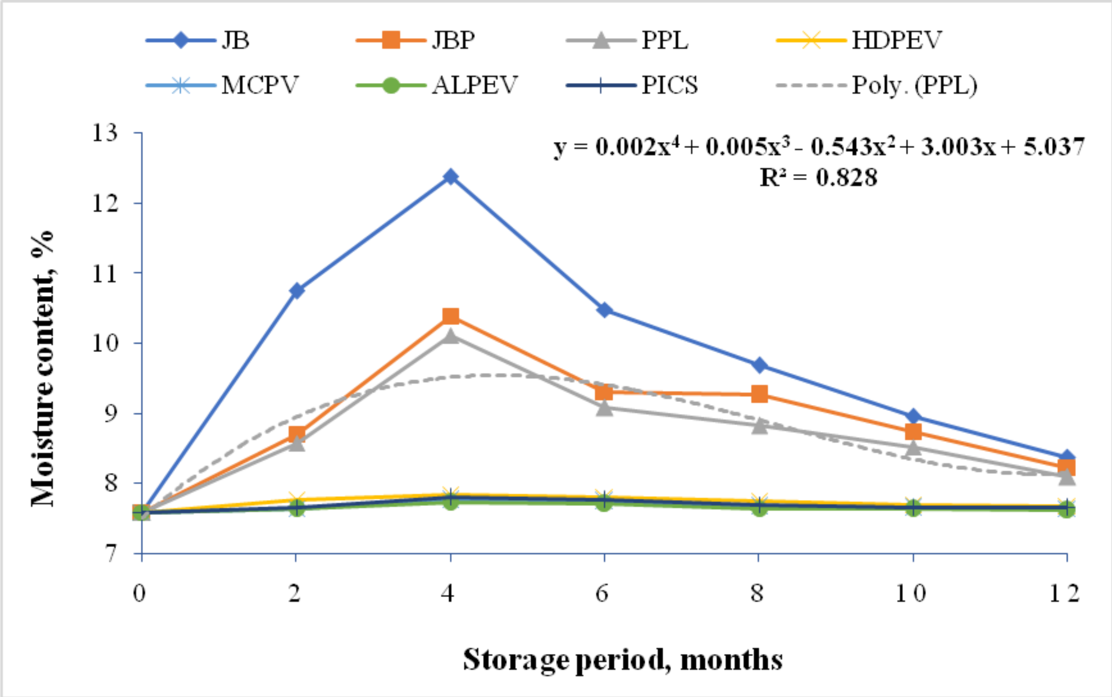


Fig.2 Effect of different packaging materials on swelling capacity of chickpea grain

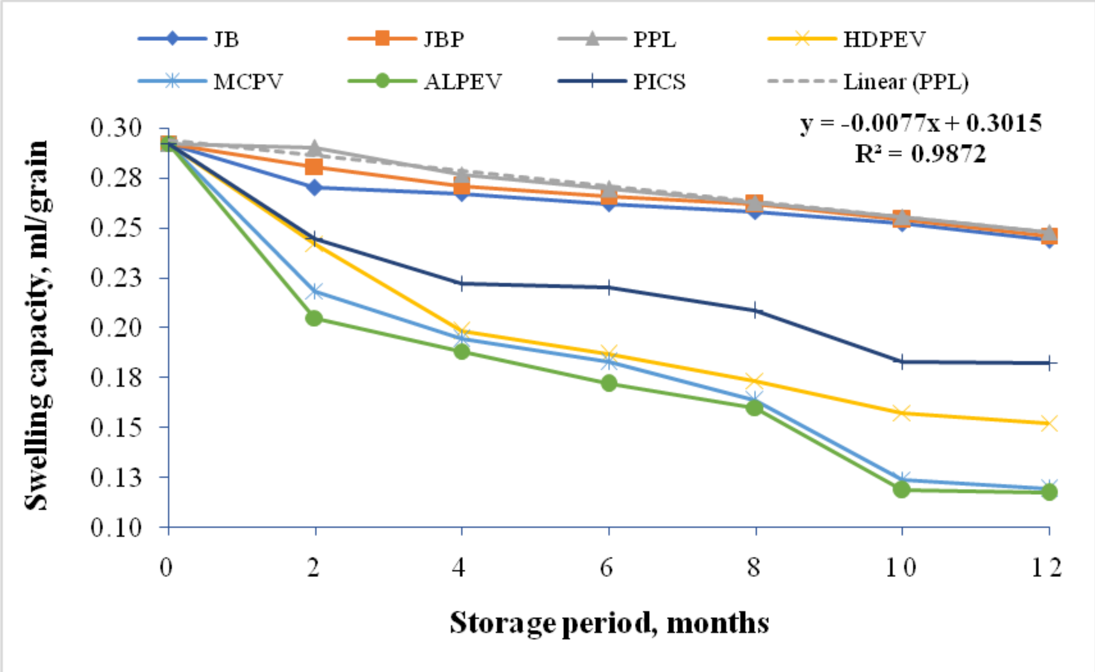


Fig.3 Effect of different packaging materials on germination of chickpea grain

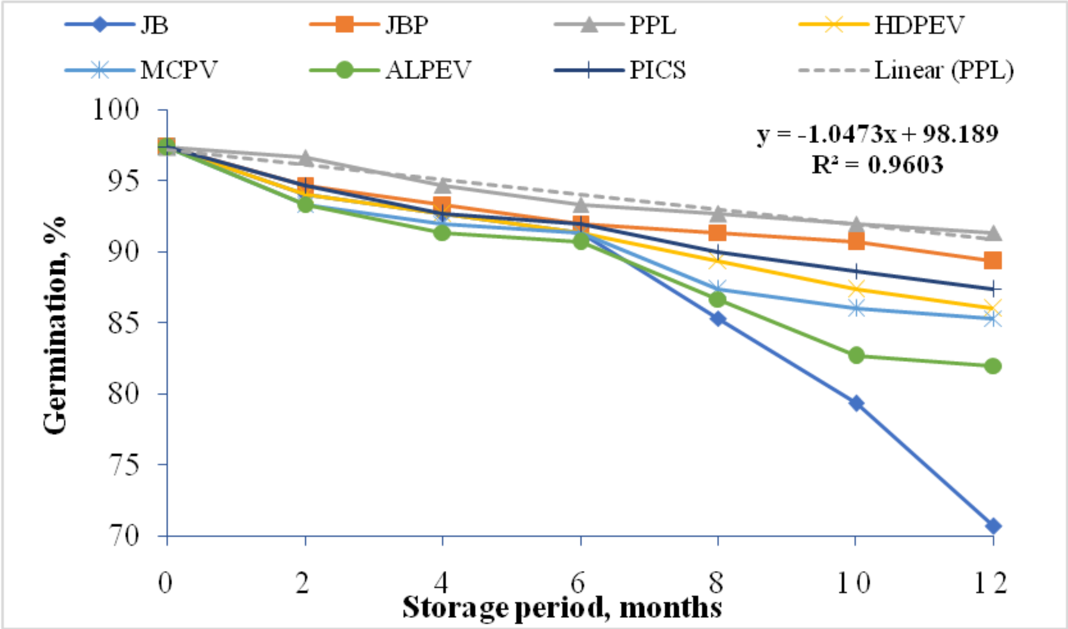
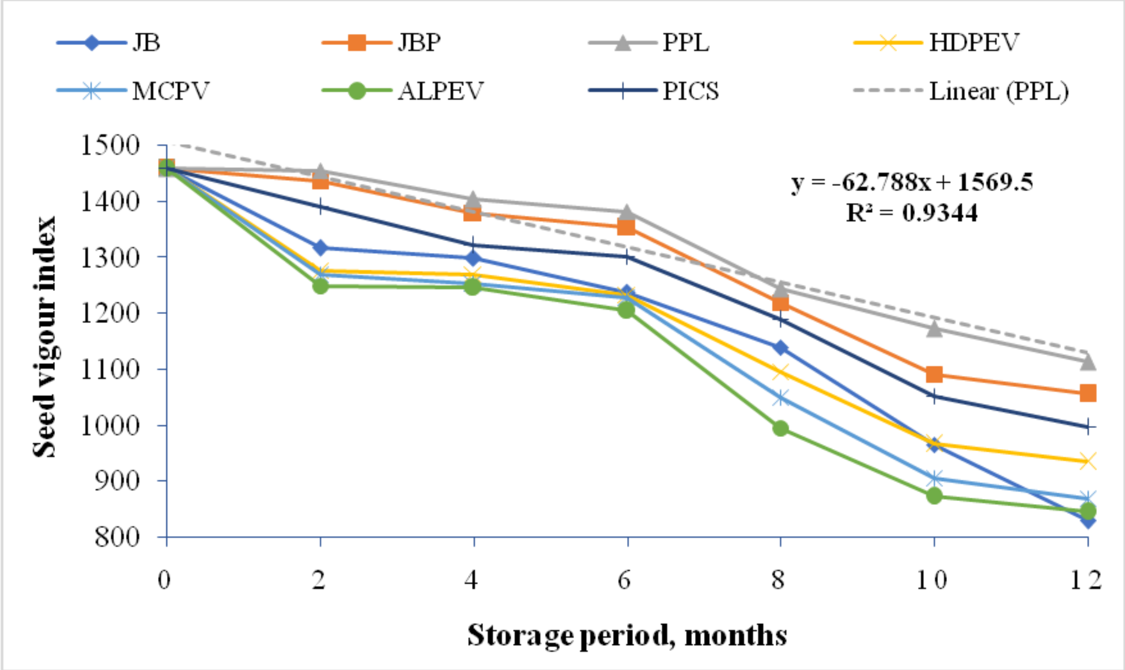


Fig.4 Effect of different packaging materials on seed vigour index of chickpea grain



The initial germination of the grain was observed 97.33 % before packaging and storage. Maximum germination was recorded in PPL (91.33 %) followed by JBP (89.33 %) and PICS (87.33 %) at the end of storage period. Germination of the grain for HDPEV, MCPV and ALPEV was found 86.00 %, 85.33 % and 82.00%, respectively. Minimum germination was recorded in JB (70.67 %) at the end of storage period. The decrease in germination during storage was also reported by Mookherjee *et al.,* (1970) in chickpea, and Jagtap (2006) in sorghum.

Seed vigour index

Seed vigour index declined with increase in storage period irrespective of packaging materials (Fig. 4). It might be due to changes in free radical scavenging enzymes, increase in free radical production, degradation of protein and DNA, increase in amino acid pool for reduction in vigour and viability during ageing (McDonald, 2004). Significantly highest seed vigour index was recorded in chickpea grain stored in PPL (1114) followed by JBP (1056) at the end of storage period. Seed vigour index for PICS, HDPEV, MCPV and ALPEV was found 996, 935, 869 and 846, respectively. Minimum seed vigour index was recorded by JB (829) at the end of twelve months of storage. The results of present study are in agreement with Chormule *et al.,* (2015) in chickpea, Meena *et al.,* (2017) in cotton and Naguib *et al.,* (2011) in wheat.

From the results, it may be concluded that JBP, PPL, HDPEV, MCPV, ALPEV and PICS were found to be the best over the jute bag which did not contain insect population and grain damage during entire storage period. Vacuum packed materials viz., ALPEV, MCPV and HDPEV had minimum moisture content, germination and seed vigour index of chickpea grain. Maximum moisture content, insect population and grain damage as well as minimum germination and seed vigour index of the grain was recorded in jute bag. Considering the overall aspects of the study, it may be concluded that PPL was observed to be best packaging material amongst all treatments having highest swelling capacity, germination and seed vigour index, no insect population, no grain damage and moderate moisture content of chickpea grain for twelve months of storage.

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