Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.5954

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 1661-1667 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Packaging Materials, Desiccant on Longevity of Summer Groundnut (*Arachis hypogaea* L.) cv. G2-52 Stored Both in the form of Pod and Kernel

Vijayalakshmi, N.[*] and Malabasari, T. A.[**]

Department of Seed Science and Technology, College of Agriculture, UAS, Dharwad-580005, Karnataka

*Corresponding Author E-mail: vijjinpalliga@gmail.com

Received: 30.10.2017 | Revised: 27.11.2017 | Accepted: 3.12.2017

ABSTRACT

An experiment was conducted in Seed Quality Research Laboratory of National Seed Project, Seed Unit, University of Agricultural Sciences, Dharwad during 2016-2017 to evaluate the effect of packaging materials, desiccant on longevity of summer groundnut (Arachis hypogaea L.) cv. G2-52 stored both in the form of pod and kernel. The groundnut seeds were stored both in the form of pod and kernel. The seed moisture content was reduced to desired level by adding desiccant zeolite beads with a specific bead to seed ratio and stored in four different packaging materials. Among the four different packaging materials pods stored in PICS bag recorded highest germination (83.67 %), oil content (47.39) and protein content (27.52) and maintained the lowest moisture content (5.03 %). Whereas, the seeds stored in gunny bag deteriorated rapidly in all the seed quality parameters and recorded the lowest germination (54 %), oil content (45.01 %) and protein content (25.32 %) with fluctuating higher moisture content (12.03 %) at the end of eighth month of storage period.

Key words: *Near infrared machine, zeolite beads, PICS bag.*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), is King of oil seed crops is believed to be native of Brazil (South America). Groundnut is also called as wonder nut and poor men's cashew nut. Groundnut is also called as "Poor man's almond" because of its high oil content (44-50 %) and protein content (25-35 %). It can supply about 5.6 and 5.8 calories per gram of kernel in the raw and roasted form respectively.

Groundnut is one of the poor storers. Storing seeds after harvest till the next cropping season without impairing the quality is of prime importance for successful seed production. Being an oil seed crop groundnut seed has short life and looses its viability quickly under ambient conditions. Ageing in groundnut seed leads to increased lipid peroxidation, decreased activities of several free radical and peroxide scavenging enzymes[10]. Groundnut seeds are more sensitive to storage conditions like high temperature; high seed moisture content and light exposure.

Cite this article: Vijayalakshmi, N. and Malabasari, T.A., Effect of Packaging Materials, Desiccant on Longevity of Summer Groundnut (*Arachis hypogaea* L.) cv. G2-52 Stored Both in the Form of Pod and Kernel, *Int. J. Pure App. Biosci.* **6(1):** 1661-1667 (2018). doi: http://dx.doi.org/10.18782/2320-7051.5954

The qualitative loss of seed can be attributed to biochemical changes in protein, carbohydrates, fatty acids and vitamins[4] rate of ageing mainly depends on genotype, moisture and temperature. In rapid and slow ageing (natural ageing), the pattern of deterioration proceeding to the death is the same whether seed survives for few hours or decades.

The problem of loss of seed viability is more serious in groundnut harvested in the summer season and about 50 per cent viability could be lost within 4 to 5 months of storage in such produce. Seeds with high oil content, appear to loose their germination and vigour in a short time despite the precaution taken during harvesting and drying[9].

In storage the viability and vigour of seeds not only vary from genera to genera and variety to variety but also regulated by many physico-chemical factors like moisture content, atmospheric relative humidity, temperature, initial seed quality, physical and chemical composition of seed, gaseous exchange, storage structures and packaging materials *etc*.[3], As the seed is hygroscopic in nature, seed quality is affected by variation in moisture content, relative humidity, temperature *etc*. To combat these factors, it's better to store the seeds in moisture vapour proof containers like polythene bags, gunny bag lined with polythene with or without desiccating agent to maintain the quality of seed for longer period. It is known that for storage of seeds in vapour proof containers, seeds have to be dried to a lower level compared to storing in vapour pervious containers. This extra drying may not be possible always. Hence, a simple method of adding required quantity of desiccant in the package could serve the same purpose, as the seed get dried in the package itself to required moisture content. It is therefore; increasingly evident that control of seed moisture content and storage environment is a must to safe guard the shelf life of seed[12]. Hence, in this study influence of desiccant along with suitable containers on storability of seed is investigated.

However, storability of summer produce is an additional constraint to maintain the seedling establishment in the field. Such problem is generally due to high temperature prevailing during drying period and subsequent storage during *kharif* season where in, high humidity causes rapid seed deterioration. Therefore, several attempts have been made by several workers in many crops to develop methods for maintaining the viability and vigour of seeds for longer period during storage. It is known fact that the choice of suitable form of seed (Both pod and kernel), use of desiccants, containers selected for storing the seeds and storage environment exert a positive effect on the viability and vigour of the seeds in storage.

In this direction, presently groundnut seeds are stored in the form of pod which involves bulk handling and huge area required for storage. Hence, storage of kernel can be thought off. But, as such kernel cannot not be stored without proper drying and storing them in suitable packaging materials.

MATERIAL AND METHODS

The storage experiment was conducted in the Seed Quality Research Laboratory of National Seed Project, Seed Unit, University of Agricultural Sciences, Dharwad on **"**Effect of packaging materials, desiccant on longevity of summer groundnut (*Arachis hypogaea* L.) cv. G2-52 stored both in the form of pod and kernel". The experiment was conducted during the period of July 2016 to March, 2017. Seeds of groundnut cv. G2-52 were obtained from the Seed Unit, UAS, Dharwad which were harvested from 2016 summer produce. Both pod and kernel forms were used for storage studies. The pods were hand shelled and used for studies.

Four packaging materials were used for the experiment like PICS (P_1-Perdue improved crop storage bag), HDPE bag (P_2), polythene bag 700 gauge (P_3), gunny bag (P_4).

Description of zeolite beads used under experiment

Seed drying beads are modified ceramic materials (Aluminium silicates or "zeolites") that specifically absorb and hold water molecules very tightly in their microscopic

pores. The beads will continue to absorb water until all of their pores are filled, up to 20 to 25 per cent of their initial weight. First moisture percentage of seed is calculated with the help of hygrometer for relative humidity and temperature. Then required bead quantity to bring down at required percentage level of seed (4-8 % for small and large seeds) was also calculated with the help of hygrometer. The amount of beads required for lowering the moisture percentage of seed depends upon several factors: i) the water-holding capacity of the beads; ii) the quantity of seeds to be dried; iii) the initial seed moisture content and iv) the final desired seed moisture content. After knowing the initial moisture content percentage of seed and the desired moisture content percentage, the required quantity of zeolite beads is calculated. In the present experiment the initial moisture content was 7.12 per cent. Hence, depending upon initial seed moisture content (7.12 %) bead capacity are calculated in prescribed bead to seed ratio. *i.e* 110:1000 of zeolite beads are used to dry the one kilogram of groundnut seed to reduce its moisture content to 5 per cent[5].

Description of PICS (Perdue Improved Crop Storage) bag used under experiment

The PICS bag is a triple bagging hermetic technology consisting of two liners made out of high-density polyethylene (HDPE) and an outer woven layer of polypropylene that provides protection during handling. Together, these bags create a low-oxygen environment that reduces development of stored-grain insects[6].

Germination percentage

The standard germination counts were taken on 5th day and 10th day as first and final count. Total germination percentage was calculated on the basis of number of normal seedlings obtained in the final count expressed in percentage.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedling obtained on final count}}{\text{Number of seeds put for germination}} \times 100$$

Seed moisture content

Seed moisture content per cent was determined by using high constant temperature method as per[1]. Five grams of seed sample was taken at random from each treatment in two replications, ground and dried in oven at 130 ± 10 ^{0}C for two hours. The seed moisture content was determined by using the following formula and it was expressed on wet weight basis.

$$\text{Moisture content (\%)} = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

Where, M_1 - Weight of the container without seed (g), M_2 – Weight of the container + seed before drying (g), M_3 – Weight of the container + seed after drying (g).

Oil content

Oil content of each treatment was recorded monthly by near infrared (NIR) machine and expressed as percentage by weight basis.

Protein content

Protein content of each treatment was recorded monthly with near infrared (NIR) machine and expressed as percentage (%) by weight basis.

Treatment combinations: 16 as follows

T_1: $P_1D_0F_1$ → PICS bag + without zeolite beads + pod
T_2: $P_1D_0F_2$ → PICS bag + without zeolite beads + kernel
T_3: $P_1D_1F_1$ → PICS bag + with zeolite beads + pod
T_4: $P_1D_1F_2$ → PICS bag + with zeolite beads + kernel
T_5: $P_2D_0F_1$ → HDPE bag + without zeolite beads + pod
T_6: $P_2D_0F_2$ → HDPE bag + without zeolite beads + kernel
T_7: $P_2D_1F_1$ → HDPE bag + with zeolite beads + pod
T_8: $P_2D_1F_2$ → HDPE bag + with zeolite beads + kernel
T_9: $P_3D_0F_1$ → Polythene bag + without zeolite beads + pod
T_{10}: $P_3D_0F_2$ → Polythene bag + without zeolite beads + kernel
T_{11}: $P_3D_1F_1$ → Polythene bag + with zeolite beads + pod
T_{12}: $P_3D_1F_2$ → Polythene bag + with zeolite beads + kernel
T_{13}: $P_4D_0F_1$ → Gunny bag + without zeolite beads + pod
T_{14}: $P_4D_0F_2$ → Gunny bag + without zeolite beads + kernel
T_{15}: $P_4D_1F_1$ → Gunny bag + with zeolite beads + pod
T_{16}: $P_4D_1F_2$ → Gunny bag + with zeolite beads + kernel

RESULTS AND DISCUSSION

The results of laboratory and field experiments conducted during 2016-2017 with a view to predict storability of groundnut (*Arachis hypogaea* L.) through various parameters are presented below.

Germination (%)

The germination percentage did not differ significantly due to interaction of packaging materials, desiccants and forms throughout the storage period. During the storage period, the highest germination 79.33 per cent was recorded in T_3, which was on par with T_{14} (78.33 %) and the lowest value was recorded

in kernel stored in gunny bag without and with zeolite beads (48.33 and 50.67 %, respectively) followed by pod stored in gunny bag without zeolite beads (58.67 %) are presented in Table 1.

Seeds stored in gunny bag showed rapid reduction in germination compared to slow reduction in other containers, which may be possibly due to pervious nature of containers to moisture vapour leading to greater fluctuation in moisture content and deterioration of seeds besides increased activity of storage fungi and pests, even though desiccant added to it due to pervious nature there was no effect of desiccant in gunny bag. The seeds stored with desiccant in moisture impervious containers showed slow reduction in germination percentage.

Moisture content (%)

The moisture content did not differed significantly due to interaction of packaging materials, desiccants and forms throughout the storage period. During the storage, the lowest moisture content (5.04 %) was recorded in T_3 which was on par with T_4 (5.08 %). While, the highest was recorded in T_{14} and T_{16} (12.28 and 12.24 %, respectively) at the end of ninth month of storage period are presented in Table 1. Biological activities occur only when sufficient moisture is present in the seed. Seeds absorb water from the ambient air when they are stored in humid environment and lose water when stored in low relative humidity or dry weather. Therefore, moisture content (MC) of the seed as well as the moisture content of the surrounding air was important for safe storage. In the current study, desiccant zeolite beads dried the seeds very rapidly due to their micro pores form of alumina silicate minerals and have strong affinity specifically to absorb and hold water molecules very tightly in their microscopic pores, which reduced the moisture content to a desired level. The experiment confirmed that the beads dry seeds within 3-5 days. These results are in conformity with the observations of Nassari *et al*.[8], in Tomato seeds.

Oil content (%)

The oil content did not differed significantly due to interaction of packaging materials, desiccants and forms throughout the storage period. During the storage, the highest oil content (46.98 %) was observed in T_3, which was on par with T_4 (46.89 %), while lowest oil content was recorded in T_{14} and T_{16} (44.81 and 45.23 %, respectively) at the end of ninth month of storage period are presented in Table 2.

It is observed that oxidation of lipids and increase in content of free fatty acids during the storage period are the main causes of the fast deterioration of seeds of oil-seed crops, such as the sunflower seeds[2]. Decrease of seed quality is connected with biochemical changes in the seeds of oil crops. These seeds had a quick deterioration due to auto oxidation of lipids and the increase of the content of free fatty acids during storage period.

Protein content (%)

The protein content did not differed significantly due to interaction of packaging materials, desiccants and forms throughout the storage period. During the storage, the highest protein content (27.32 %) was observed in T_3 which was on par with T_4 (27.25 %). While, the lowest was recorded in T_{14} and T_{16} (25.16 and 25.48 %, respectively) at the end of ninth month of storage period are presented in Table 2.The decrease in protein content was observed as ageing advanced. These results were in agreement with findings of Narayanamurthy *et al*.[7] in green gram. Protein deterioration was mainly due to condensation, rearrangement, fragmentation, strecker degradation and polymerization. Tatipata[11] studied the effect of storage period on inner membrane of mitochondria in soybean seeds. Increase in phospholipase activity was observed resulting in hydrolysis of phospholipids thus decreasing the content of phospholipids in the membrane. This event caused disorganization of membrane, so loss of membrane integrity or loss of selective permeability. The loss of phospholipids membrane content may change the shape of proteins embedded in the lipid bilayer of the membrane which might be attributed to reduction in protein content.

Table 1: Effect of packaging materials and forms on germination (%) and seedling vigour index Table 1a: Effect of packaging materials, desiccant and forms on germination (%) in groundnut variety G2-52

Treatments		Germination (%) Months after storage					Moisture content (%) Months after storage				
		Initial month	2nd month	4th month	6th month	8th month	Initial month	2nd month	4th month	6th month	8th month
Packaging materials (P)	(P_1)	93.00 (74.68)*	91.17 (72.74)	87.42 (69.33)	83.67 (66.28)	80.50 (63.87)	7.01	6.09	6.06	6.16	6.11
	(P_2)	93.00 (74.68)	84.92 (67.21)	75.42 (60.32)	71.92 (58.03)	66.50 (54.67)	7.01	9.66	10.33	10.82	10.05
	(P_3)	93.00 (74.68)	90.50 (72.10)	86.08 (68.18)	81.58 (64.64)	78.25 (62.25)	7.01	6.15	6.13	6.34	6.24
	(P_4)	93.00 (74.68)	83.67 (66.19)	68.00 (55.61)	64.25 (53.31)	58.33 (49.81)	7.01	10.88	12.16	12.34	12.04
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE m±	**0.32**	**0.38**	**0.57**	**0.54**	**0.45**	**0.00**	**0.08**	**0.05**	**0.06**	**0.06**
	CD (0.01)	**NS**	**1.03**	**1.55**	**1.48**	**1.23**	**NS**	**0.23**	**0.15**	**0.17**	**0.16**
Desiccant (D)	(D_0)	93.00 (74.68)	86.96 (69.01)	78.17 (62.56)	74.00 (59.59)	69.46 (56.67)	7.01	8.71	9.23	9.49	9.20
	(D_1)	93.00 (74.68)	88.17 (70.11)	80.29 (64.16)	76.71 (61.54)	72.33 (58.63)	7.01	7.68	8.11	8.34	8.02
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE m±	**0.23**	**0.05**	**0.08**	**0.08**	**0.06**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**
	CD (0.01)	**NS**	**0.149**	**0.224**	**0.213**	**0.178**	**NS**	**0.033**	**0.021**	**0.024**	**0.022**
Forms (F)	(F_1)	93.00 (74.68)	88.33 (70.18)	81.04 (64.53)	77.00 (61.62)	72.75 (58.80)	7.01	8.04	8.55	8.82	8.50
	(F_2)	93.00 (74.68)	86.79 (68.93)	77.42 (62.19)	73.71 (59.51)	69.04 (56.50)	7.01	8.35	8.79	9.00	8.71
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE m±	**0.23**	**0.05**	**0.08**	**0.08**	**0.06**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**
	CD (0.01)	**NS**	**0.149**	**0.224**	**0.213**	**0.178**	**NS**	**0.033**	**0.021**	**0.024**	**0.022**
Interaction (P X D)	P_1D_0	93.00 (74.68)	90.50 (72.06)	86.00 (68.07)	81.50 (64.56)	78.33 (62.28)	7.01	7.07	7.07	7.20	7.14
	P_1D_1	93.00 (74.68)	91.83 (73.42)	88.83 (70.59)	85.83 (67.99)	82.67 (65.46)	7.01	5.10	5.04	5.12	5.09
	P_2D_0	93.00 (74.68)	84.33 (66.73)	74.67 (59.82)	70.67 (57.24)	65.67 (54.16)	7.01	9.67	10.52	11.04	10.27
	P_2D_1	93.00 (74.68)	85.50 (67.70)	76.17 (60.81)	73.17 (58.82)	67.33 (55.18)	7.01	9.64	10.15	10.59	9.82
	P_3D_0	93.00 (74.68)	89.83 (71.45)	85.17 (67.44)	80.17 (63.58)	76.50 (61.02)	7.01	7.17	7.14	7.35	7.32
	P_3D_1	93.00 (74.68)	91.17 (72.74)	87.00 (68.92)	83.00 (65.70)	80.00 (63.48)	7.01	5.12	5.13	5.33	5.16
	P_4D_0	93.00 (74.68)	83.17 (65.81)	66.83 (54.90)	63.67 (52.97)	57.33 (49.23)	7.01	10.93	12.19	12.36	12.05
	P_4D_1	93.00 (74.68)	84.17 (66.56)	69.17 (56.33)	64.83 (53.66)	59.33 (50.39)	7.01	10.84	12.12	12.33	12.02
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE m±	**0.45**	**0.22**	**0.33**	**0.31**	**0.27**	**0.01**	**0.05**	**0.03**	**0.04**	**0.03**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.13**	**0.09**	**0.10**	**0.09**

- Figures in parenthesis indicates arcsine transformed values.
- Packaging materials (P): P_1- PICS Bag, P_2- HDPE Bag, P_3- Polythene bag, P_4- Gunny bag.
- Desiccant- D_0- Without Zeolite beads, D_1-With Zeolite beads. Seed forms (F): F_1-Pod, F_2-Kernel.

Treatments		Germination (%) Months after storage					Moisture content (%) Months after storage				
		Initial month	2nd month	4th month	6th month	8th month	Initial month	2nd month	4th month	6th month	8th month
Interaction (P X F)	P_1F_1	93.00 (74.68)*	91.33 (72.90)	87.67 (69.53)	84.17 (66.69)	81.17 (64.37)	7.01	6.05	6.03	6.14	6.04
	P_1F_2	93.00 (74.68)	91.00 (72.58)	87.17 (69.14)	83.17 (65.87)	79.83 (63.37)	7.01	6.13	6.08	6.18	6.19
	P_2F_1	93.00 (74.68)	86.50 (68.47)	77.67 (61.82)	74.50 (59.68)	69.50 (56.50)	7.01	9.19	10.00	10.53	9.76
	P_2F_2	93.00 (74.68)	83.33 (65.96)	73.17 (58.82)	69.33 (56.38)	63.50 (52.83)	7.01	10.13	10.66	11.11	10.34
	P_3F_1	93.00 (74.68)	90.67 (72.27)	86.33 (68.40)	82.00 (64.95)	78.83 (62.66)	7.01	6.12	6.11	6.31	6.21
	P_3F_2	93.00 (74.68)	90.33 (71.92)	85.83 (67.96)	81.17 (64.32)	77.67 (61.84)	7.01	6.18	6.16	6.37	6.27
	P_4F_1	93.0 (74.68)	84.83 (67.09)	72.50 (58.38)	67.33 (55.16)	61.50 (51.65)	7.0	10.80	12.05	12.32	12.01
	P_4F_2	93.0 (74.68)	82.50 (65.28)	63.50 (52.85)	61.17 (51.46)	55.17 (47.97)	7.0	10.96	12.26	12.37	12.06
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE M±	**0.39**	**0.22**	**0.33**	**0.31**	**0.26**	**0.01**	**0.05**	**0.03**	**0.04**	**0.03**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.13**	**0.09**	**0.10**	**0.09**
Interaction (D X F)	D_0F_1	93.00 (74.68)	87.75 (69.64)	80.08 (63.79)	75.75 (60.70)	71.17 (57.70)	7.01	8.55	9.12	9.40	9.12
	D_0F_2	93.00 (74.68)	86.17 (68.38)	76.25 (61.32)	72.25 (58.48)	67.75 (55.65)	7.01	8.87	9.34	9.58	9.27
	D_1F_1	93.00 (74.68)	88.92 (70.73)	82.00 (65.27)	78.25 (62.55)	74.33 (59.89)	7.01	7.52	7.98	8.25	7.88

	D_1F_2	93.00 (74.68)	87.42 (69.48)	78.58 (63.06)	75.17 (60.54)	70.33 (57.36)	7.01	7.83	8.24	8.43	8.16
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE M±	**0.32**	**0.11**	**0.16**	**0.15**	**0.13**	**0.01**	**0.02**	**0.02**	**0.02**	**0.02**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction (P x D x F)	T_1 - $P_1D_0F_1$	93.00 (74.68)	90.67 (72.22)	86.33 (68.34)	82.00 (64.93)	78.67 (62.50)	7.01	7.03	7.05	7.18	7.04
	T_2 - $P_1D_0F_2$	93.00 (74.68)	90.33 (71.91)	85.67 (67.80)	81.00 (64.19)	78.00 (62.06)	7.01	7.11	7.08	7.22	7.24
	T_3 - $P_1D_1F_1$	93.00 (74.68)	92.00 (73.59)	89.00 (70.71)	86.33 (68.44)	83.67 (66.24)	7.01	5.06	5.01	5.10	5.03
	T_4 - $P_1D_1F_2$	93.00 (74.68)	91.67 (73.25)	88.67 (70.47)	85.33 (67.54)	81.67 (64.68)	7.01	5.14	5.07	5.13	5.14
	T_5 - $P_2D_0F_1$	93.00 (74.68)	85.67 (67.76)	77.00 (61.36)	73.67 (59.14)	68.33 (55.78)	7.01	9.21	10.23	10.75	10.13
	T_6 - $P_2D_0F_2$	93.00 (74.68)	83.00 (65.69)	72.33 (58.29)	67.67 (55.35)	63.00 (52.54)	7.01	10.12	10.81	11.33	10.42
	T_7 - $P_2D_1F_1$	93.00 (74.68)	87.33 (69.17)	78.33 (62.28)	75.33 (60.23)	70.67 (57.23)	7.01	9.16	9.77	10.30	9.39
	T_8 - $P_2D_1F_2$	93.00 (74.68)	83.67 (66.22)	74.00 (59.35)	71.00 (57.42)	64.00 (53.13)	7.01	10.13	10.52	10.88	10.25
	T_9 - $P_3D_0F_1$	93.00 (74.68)	90.00 (71.62)	85.33 (67.63)	80.67 (63.95)	77.00 (61.35)	7.01	7.13	7.11	7.32	7.31
	T_{10} - $P_3D_0F_2$	93.00 (74.68)	89.67 (71.28)	85.00 (67.24)	79.67 (63.21)	76.00 (60.69)	7.01	7.22	7.18	7.38	7.32
	T_{11} - $P_3D_1F_1$	93.00 (74.68)	91.33 (72.92)	87.33 (60.16)	83.33 (65.96)	80.67 (63.96)	7.01	5.10	5.11	5.30	5.10
	T_{12} - $P_3D_1F_2$	93.00 (74.68)	91.00 (72.56)	86.67 (68.67)	82.67 (65.43)	79.33 (62.99)	7.01	5.14	5.14	5.36	5.21
	T_{13} - $P_4D_0F_1$	93.00 (74.68)	84.67 (66.96)	71.67 (57.84)	66.67 (54.77)	60.67 (51.16)	7.01	10.83	12.08	12.34	12.03
	T_{14} - $P_4D_0F_2$	93.00 (74.68)	81.67 (64.65)	62.00 (51.95)	60.67 (51.16)	54.00 (47.29)	7.01	11.02	12.30	12.38	12.08
	T_{15} - $P_4D_1F_1$	93.00 (74.68)	85.00 (67.22)	73.33 (58.91)	68.00 (55.56)	62.33 (52.14)	7.01	10.77	12.02	12.31	12.00
	T_{16} - $P_4D_1F_2$	93.00 (74.68)	83.33 (65.91)	65.00 (53.75)	61.67 (51.76)	56.33 (48.64)	7.01	10.90	12.22	12.36	12.04
	Mean	**93.00 (74.68)**	**87.56 (69.56)**	**79.23 (63.36)**	**75.35 (60.56)**	**70.90 (57.65)**	**7.01**	**8.19**	**8.67**	**8.91**	**8.61**
	SE m±	**0.64**	**0.436**	**0.654**	**0.623**	**0.520**	**0.009**	**0.097**	**0.062**	**0.071**	**0.066**
	CD (0.01	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2: Effect of packaging materials and forms on oil content (%) and protein content (%)

Treatments		Oil content (%)					Protein content (%)				
		Months after storage					Months after storage				
		Initial month	2nd month	4th month	6th month	8th month	Initial month	2nd month	4th month	6th month	8th month
Packaging materials (P)	**(P_1)**	48.91	48.37	47.92	47.61	46.98	28.68	28.26	28.08	27.71	27.22
	(P_2)	48.91	47.80	47.06	46.22	45.94	28.68	27.73	27.31	26.67	26.30
	(P_3)	48.91	48.18	47.65	47.14	46.63	28.68	28.10	27.87	27.37	27.01
	(P_4)	48.91	47.34	46.74	45.87	45.51	28.68	27.47	26.84	26.07	25.64
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**27.89**	**27.52**	**26.96**	**26.54**
	SE m±	**0.06**	**0.49**	**0.49**	**0.15**	**0.14**	**0.22**	**0.29**	**0.27**	**0.25**	**0.20**
	CD (0.01)	**NS**	**NS**	**NS**	**0.41**	**0.39**	**NS**	**NS**	**NS**	**0.96**	**0.77**
Desiccant (D)	**(D_0)**	48.91	47.78	47.18	46.48	46.05	28.68	27.80	27.39	26.77	26.38
	(D_1)	48.91	48.07	47.51	46.94	46.48	28.68	27.98	27.66	27.15	26.71
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**27.89**	**27.52**	**26.96**	**26.54**
	SE m±	**0.04**	**0.07**	**0.07**	**0.02**	**0.02**	**0.15**	**0.20**	**0.19**	**0.18**	**0.14**
	CD (0.01)	**NS**	**NS**	**NS**	**0.059**	**0.056**	**NS**	**NS**	**NS**	**NS**	**NS**
Forms (F)	**(F_1)**	48.91	48.00	47.44	46.87	46.44	28.68	28.26	28.08	27.71	27.22
	(F_2)	48.91	47.85	47.25	46.55	46.09	28.68	27.73	27.31	26.67	26.30
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**28.00**	**27.70**	**27.19**	**26.76**
	SE m±	**0.04**	**0.07**	**0.07**	**0.02**	**0.02**	**0.15**	**0.20**	**0.19**	**0.18**	**0.14**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction (P X D)	**P_1D_0**	48.91	48.13	47.65	47.17	46.65	28.68	28.10	27.90	27.37	26.98
	P_1D_1	48.91	48.62	48.19	48.05	47.30	28.68	28.43	28.27	28.06	27.47
	P_2D_0	48.91	47.74	47.01	46.15	45.87	28.68	27.70	27.25	26.59	26.22
	P_2D_1	48.91	47.87	47.11	46.29	46.01	28.68	27.77	27.38	26.75	26.38
	P_3D_0	48.91	47.99	47.37	46.76	46.29	28.68	27.96	27.67	27.09	26.77
	P_3D_1	48.91	48.38	47.93	47.52	46.97	28.68	28.24	28.07	27.66	27.25
	P_4D_0	48.91	47.28	46.68	45.83	45.40	28.68	27.45	26.76	26.03	25.56
	P_4D_1	48.91	47.40	46.80	45.90	45.62	28.68	27.49	26.91	26.12	25.73
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**28.03**	**27.75**	**27.25**	**26.84**
	SE m±	**0.08**	**0.28**	**0.28**	**0.09**	**0.08**	**0.31**	**0.41**	**0.39**	**0.35**	**0.28**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

- Packaging materials (P): P_1- PICS Bag, P_2- HDPE Bag, P_3- Polythene bag, P_4- Gunny bag.
- Desiccant- D_0- Without Zeolite beads, D_1-With Zeolite beads. Seed forms (F): F_1-Pod, F_2-Kernel.

Treatments		Oil content (%)					Protein content (%)				
		Months after storage					Months after storage				
		Initial month	2nd month	4th month	6th month	8th month	Initial month	2nd month	4th month	6th month	8th month
Interaction (P X F)	**P_1F_1**	48.91	48.43	47.99	47.70	47.09	28.68	28.29	28.14	27.78	27.28
	P_1F_2	48.91	48.32	47.86	47.52	46.87	28.68	28.24	28.02	27.65	27.17
	P_2F_1	48.91	47.83	47.10	46.38	46.06	28.68	27.82	27.44	26.85	26.48
	P_2F_2	48.91	47.77	47.02	46.06	45.82	28.68	27.65	27.19	26.49	26.12
	P_3F_1	48.91	48.27	47.76	47.39	46.77	28.68	28.15	27.92	27.44	27.06
	P_3F_2	48.91	48.10	47.54	46.89	46.49	28.68	28.05	27.82	27.31	26.96

	P_4F_1	48.9	47.48	46.91	45.99	45.85	28.7	27.54	26.97	26.17	25.84
	P_4F_2	48.9	47.20	46.58	45.74	45.17	28.7	27.40	26.70	25.98	25.45
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**27.89**	**27.52**	**26.96**	**26.54**
	SE M±	**0.07**	**0.28**	**0.28**	**0.09**	**0.08**	**0.26**	**0.17**	**0.16**	**0.14**	**0.12**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction (D X F)	D_0F_1	48.91	47.85	47.28	46.64	46.24	28.68	27.86	27.49	26.87	26.50
	D_0F_2	48.91	47.72	47.08	46.33	45.86	28.68	27.75	27.30	26.66	26.26
	D_1F_1	48.91	48.16	47.59	47.10	46.64	28.68	28.04	27.74	27.25	26.82
	D_1F_2	48.91	47.98	47.42	46.78	46.31	28.68	27.92	27.57	27.05	26.59
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**27.89**	**27.52**	**26.96**	**26.54**
	SE M±	**0.06**	**0.14**	**0.14**	**0.04**	**0.03**	**0.22**	**0.08**	**0.08**	**0.07**	**0.06**
	CD (0.01)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction (P x D x F)	T_1 - $P_1D_0F_1$	48.91	48.17	47.72	47.25	46.79	28.68	28.12	27.96	27.42	27.03
	T_2 - $P_1D_0F_2$	48.91	48.10	47.59	47.10	46.52	28.68	28.08	27.83	27.31	26.93
	T_3 - $P_1D_1F_1$	48.91	48.70	48.25	48.15	47.39	28.68	28.46	28.32	28.14	27.52
	T_4 - $P_1D_1F_2$	48.91	48.54	48.12	47.94	47.21	28.68	28.39	28.21	27.98	27.41
	T_5 - $P_2D_0F_1$	48.91	47.77	47.03	46.28	45.99	28.68	27.79	27.38	26.78	26.38
	T_6 - $P_2D_0F_2$	48.91	47.71	46.98	46.02	45.75	28.68	27.61	27.12	26.39	26.05
	T_7 - $P_2D_1F_1$	48.91	47.90	47.16	46.48	46.14	28.68	27.85	27.49	26.91	26.58
	T_8 - $P_2D_1F_2$	48.91	47.72	47.05	46.10	45.89	28.68	27.68	27.26	26.59	26.18
	T_9 - $P_3D_0F_1$	48.91	48.04	47.48	47.04	46.42	28.68	28.01	27.72	27.16	26.81
	T_{10} - $P_3D_0F_2$	48.91	47.84	47.26	46.49	46.15	28.68	27.91	27.61	27.02	26.73
	T_{11} - $P_3D_1F_1$	48.91	48.50	48.04	47.75	47.13	28.68	28.29	28.12	27.72	27.31
	T_{12} - $P_3D_1F_2$	48.91	48.27	47.83	47.29	46.82	28.68	28.18	28.02	27.59	27.18
	T_{13} - $P_4D_0F_1$	48.91	47.42	46.88	45.97	45.78	28.68	27.51	26.90	26.13	25.79
	T_{14} - $P_4D_0F_2$	48.91	47.14	46.48	45.69	45.01	28.68	27.38	26.62	25.92	25.32
	T_{15} - $P_4D_1F_1$	48.91	47.54	46.93	46.00	45.92	28.68	27.56	27.04	26.21	25.88
	T_{16} - $P_4D_1F_2$	48.91	47.27	46.68	45.79	45.33	28.68	27.42	26.78	26.03	25.58
	Mean	**48.91**	**47.92**	**47.34**	**46.71**	**46.26**	**28.68**	**27.89**	**27.52**	**26.96**	**26.54**
	SE m±	**0.119**	**0.561**	**0.561**	**0.173**	**0.164**	**0.431**	**0.331**	**0.315**	**0.286**	**0.231**
	CD (0.01	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

- Packaging materials (P): P_1- PICS Bag, P_2- HDPE Bag, P_3- Polythene bag, P_4- Gunny bag.
- Desiccant- D_0- Without Zeolite beads, D_1-With Zeolite beads. Seed forms (F): F_1-Pod, F_2-Kernel.

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