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Seed Physiological and Biochemical parameters of onion as Influenced by different Packaging materials and storage conditions

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ABSTRACT
A lab experiment was carried out to study that seed physiological and biochemical parameters of onion as influenced by different packaging materials and storage conditions. Onion seeds were stored in different packaging materials viz., cloth bags and aluminium bags and vacuum packed bags stored at room temperature (25 ± 2º C) and cold storage (4 ± 1º C) for a period of 18 months. The treatments having six combinations and consisting of different containers viz., cloth bags, aluminium bags and vacuum packed bags were replicated four times in both cold and ambient storage conditions in completely randomized design. The results of the study revealed that the seed biochemical parameters such as α-amylase, lipase and protease enzymes activity and seed physiological parameters viz., mineral content (Cu, Mn, Zn and Mn), moisture content and electrical conductivity values were higher in vacuum packed seeds than cloth, Aluminium bags for onion seeds stored under cold storage compared to room temperature throughout the storage period. Among the containers, the seeds stored in vacuum packed bags maintained the seed biochemical and seed physiological parameters with least deterioration compared to seeds stored in cloth bags and aluminium bags.
Keywords: *Moisture content, electrical conductivity, mineral content, biochemical parameters, vacuum packaging and cold storage.*

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INTRODUCTION
Seed is the foundation of agriculture for enhancing crop production. But the availability of quality seed is the main constraint to crop production in developing country like India. The use of quality seed can contribute significantly to increased grain yield as well as to increased availability of every day's food intake. The production of quality seed is thus very important and the Government has recently given the topmost priority for seed sector. Therefore, the constraints related to availability of quality seeds for production of agricultural crops, assess post harvest losses and determine the quality of farmers' home grown seeds and develop policy options for quality seed production at farmers' level for increasing crop yield and production towards attaining food security. Research on storability of seeds in India is of recent origin with the development of organized seed production and marketing. It is stipulated that 80 per cent of certified seeds produced in India require storage for one planting season and 20 per cent of seeds is carried over for subsequent sowing [7]. However, when the awareness and infrastructure is developed, substantial quantity of seeds can be stored for few planting seasons as a safeguard against monsoon failure and as a precaution against production of poor quality seeds.
Onion (*Allium cepa* L.) is one of the major bulb crops of the world and important commercial vegetable grown all over the world. India accounts for 16 per cent of the world area (2.97 m ha) and 19.9 per cent of the world production (75.91 m tons) with a productivity of 19.2 tons per ha [4]. India ranks first in total area under onion cultivation, second in production and third after the Netherlands and Spain in export. At present, the area under onion is 7.41 per cent of the total output of vegetables in the country. In India it is being grown area 1.04 m ha and production of 15.11 m tons with the productivity of 14.20 tons per ha,

which is very low. Most of the onion produced in India comes from the states of Maharashtra, Orissa, Gujarat, Karnataka and Uttar Pradesh. Among different states, Maharashtra accounts for 30-40 per cent of the total production, which mainly comes from Nasik district, Karnataka alone occupies an area of 2.0 lakh ha with a production of 27.21 lakh tons and the average productivity is 13.61 tons per hectare [3], which is again very low compared to national productivity average. Onion, accounts for 90 per cent of the export of vegetables from India in terms of value. Good seed is a basic input in vegetable production. Successful olericulture programme depends on the quality of seeds used for sowing. Thus, the seed producers hold greater responsibility in maintaining genetically pure seeds and to preserve the quality of seeds from harvest to next sowing. Onion seed is however classified as poor storer; it loses viability within a year under ambient storage conditions.

Onion seed is a poor storer. Storing seeds after harvest till the next cropping season without impairing the quality is of prime importance for successful seed production. The problem of loss of seed viability is more severe in onion harvested in the summer season and about 50 per cent viability could be lost within 4-5 months of storage. Research on storability of seeds in India is of recent origin with the development of organized seed production and marketing [2]. Seed deterioration has been ascribed to physical, physiological, bio-chemical and pathological detrimental changes occurring in seeds leading to death and has been characterized as inexorable, irreversible, inevitable, and minimal at the time of physiological maturity and variable among kinds of seeds, varieties and seed lots [13].The farmer's practice of storing crop seeds in cloth bags as well as in cloth bags hastens up the seed quality deterioration process, thus resulting in poor seed quality. The use of high density polyethylene (Aluminium) and metallised polyester polyethylene (MPP) packaging materials in seed storage were found to retain the quality, but for a limited period. Oxidation of seed food reserves ingredients such as carbohydrates, protein, lipids, vitamins, pigments and aroma compounds is one of the most important causes of quality loss during processing and storage [7].A better solution therefore could be the use of low oxygen atmosphere packing system. Vacuum packaging is a technology that is being widely used in the meat industry, wherein the product is placed in a pack of low oxygen permeability, air is evacuated and the package sealed. The relative high cost of crop seeds and the overwhelming importance of retaining their seed quality for next season justify the selection of proper packaging strategy.

MATERIAL AND METHODS

A storage experiment was carried out for a period of 18 months at Department of Crop Physiology, University of Agricultural Sciences, Dharwad. Freshly harvested onion seeds (Arka Kalyan) were dried under sun and stored under different storage conditions and containers. The temperature maintained in the cold storage was around (4 °C ± 1°C) and relative humidity was 85 to 90 per cent throughout the storage period while, for ambient storage, bags were stored in the laboratory at room temperature (25 ± 2 °C). Onion seeds were packed in 10 g in vacuum packed bags (The machine used for vacuum packaging of different seeds was OLPACK 501/V manufactured by INTERPRISE–BRUSSELS S.A., BRUXTAINER DIVISION, Belgium) and & aluminium bags while 500 g into cloth bags. After packaging of all the seeds in different containers, 50 % bags were stored properly in the iron racks without stacking so that all the bags were uniformly exposed to the particular treatment condition; while 50 % bags were stored under cold storage. The treatments having six combinations and consisting of different containers viz., cloth bags, aluminium bags and vacuum packed bags were replicated four times in both cold and ambient storage conditions in completely randomized design. The observations on various seed physiological parameters viz., electrical conductivity [42], and the per cent moisture were obtained by using MB 45 Halogen Moisture Analyzer from Ohaus, USA, while estimation of mineral content **i.e.** Copper (Cu), Zinc (Zn), Iron (Fe) and Manganese (Mn) contents in seed were estimated using Atomic Absorption Spectrophotometer (AAS-4141, Electronic Corporation of India Ltd.) and determination of all the biochemical parameters i.e. α-amylase activity, lipase enzyme activity and protease enzyme activity was estimated by methods devised by [8], [25], and [43],, respectively at bimonthly interval upto18 months. The analysis and interpretation of the experimental data was done as suggested by [41], with level of significance used as P = 0.01

RESULTS AND DISCUSSION

Influence on seed physiological parameters

Moisture content (%)

The moisture content (%) of onion seeds (Table 1) indicated significant differences between the treatments at all the stages of storage upto 18 months except at the initial stages i.e., before packaging. In general, no much change was observed in the moisture content of vacuum packed seeds as well as aluminium packed seeds during storage upto 18 months and there was a slight decline in the moisture content with advancement in the storage period, and it was almost negligible. Lot of fluctuations in the moisture content of onion seeds were noticed in cloth bags, kept at room temperature or cold storage during storage period. At 18 months of storage, the maximum moisture content (10.05 %) was observed in cloth bags at cold storage followed by cloth bags at room temperature (7.54 %). Significantly lower values of moisture content (5.92 and 5.83 %) was observed in aluminium packed seeds followed by vacuum packed seeds (5.81 and 5.50 %) at cold storage or room temperature. The value for moisture content of cloth bag seeds differed significantly cold storage or room temperature, but no significant difference was observed between aluminium packed and vacuum packed seeds during storage even upto 18 months. It is clear from the results, that the containers in cold storage shown higher moisture content values compared to those containers under room temperature throughout the storage period. These results are in agreement with the findings of [13], in shelled peanuts, [33] in wheat, [49] in groundnut kernels, [42], [12]& [45], in chilli powder, [47] in whole chilli and [29] in soybean storability for longer period.

Table-1. Influence of packaging and storage conditions on moisture content (MC, %) at different time intervals of storage in onion seeds

Treatments	Storage period (months)									
	0	2	4	6	8	10	12	14	16	18
T_1 - Cloth bag (CS)	5.97	10.83	10.85	10.73	10.53	10.50	10.42	10.29	10.08	10.05
T_2 -Cloth bag (RT)	5.97	7.96	7.95	7.89	8.88	8.99	8.87	8.56	7.86	7.54
T_3 - Aluminium bag (CS)	5.97	6.56	6.52	6.38	6.21	6.18	6.03	5.98	5.95	5.93
T_4 - Aluminium bag (RT)	5.97	6.11	6.10	5.99	5.97	5.96	5.93	5.90	5.88	5.83
T_5 - Vacuum packed (CS)	5.97	6.09	6.07	6.05	6.03	6.02	6.00	5.96	5.83	5.81
T_6 -Vacuum packed (RT)	5.97	5.99	5.98	5.99	5.94	5.90	5.89	5.74	5.60	5.50
S.Em (±)	**0.05**	**0.01**	**0.02**	**0.04**	**0.11**	**0.05**	**0.09**	**0.02**	**0.05**	**0.03**
C. D. (1%)	**NS**	**0.03**	**0.06**	**0.11**	**0.31**	**0.15**	**0.26**	**0.05**	**0.15**	**0.08**

NS = Non significant CS = Cold storage RT = Room temperature

Table 2. Influence of packaging and storage conditions on electrical conductivity (EC, dSm^{-1}) at different time intervals of storage in onion seeds

Treatments	Storage period (months)									
	0	2	4	6	8	10	12	14	16	18
T_1 - Cloth bag (CS)	0.419	0.423	0.428	0.447	0.458	0.480	0.501	0.529	0.547	0.558
T_2 -Cloth bag (RT)	0.419	0.426	0.435	0.461	0.474	0.493	0.522	0.538	0.568	0.573
T_3 - Aluminium bag (CS)	0.419	0.422	0.427	0.436	0.446	0.451	0.477	0.490	0.501	0.515
T_4 - Aluminium bag (RT)	0.419	0.424	0.429	0.441	0.453	0.461	0.482	0.504	0.519	0.531
T_5 - Vacuum packed (CS)	0.419	0.420	0.422	0.425	0.428	0.429	0.432	0.433	0.436	0.439
T_6 -Vacuum packed (RT)	0.419	0.421	0.424	0.427	0.431	0.432	0.434	0.435	0.438	0.441
S.Em (±)	**0.005**	**0.034**	**0.006**	**0.001**	**0.003**	**0.001**	**0.004**	**0.001**	**0.001**	**0.002**
C. D. (1%)	**NS**	**NS**	**0.019**	**0.003**	**0.010**	**0.002**	**0.012**	**0.002**	**0.003**	**0.006**

NS = Non significant CS = Cold storage RT = Room temperature

Electrical conductivity (dSm^{-1})

The data pertaining to electrical conductivity (d Sm^{-1}) of onion seeds as influenced by different packaging and storage conditions indicated significant differences upto 18 months of storage period (Table 2). At 18 months of storage, the vacuum packed seeds recorded significantly lower values of electrical conductivity (0.439 and 0.441 d Sm^{-1}) at cold storage and room temperature as compared to aluminium bags (0.515 and 0.531 d Sm^{-1}) and cloth bags (0.573 and 0.578 d Sm^{-1}), respectively. It is clear from the results that the vacuum packed seeds could maintain lower electrical conductivity compared to aluminium bags followed by cloth bags during the storage. Vacuum packed seeds stored in cold storage and room temperature did not show significant difference with each other. While, the cloth bags and the aluminium bags differed significantly to each other throughout the storage period. The values of electrical conductivity of seeds stored different in all the containers at cold storage recorded lesser than those stored at room temperature throughout the storage period.. Similar results were obtained by [44] in rice , [38] in brinjal seeds, [36] in groundnut, [54] in soybean, [35] in sunflower, [46] in chilli and [6] in maize seeds.

Mineral's content

Copper content (Cu, ppm)

Copper content (ppm) of onion seeds differed significantly between treatments and there was a gradual decline with progress in storage period (Fig.,1).

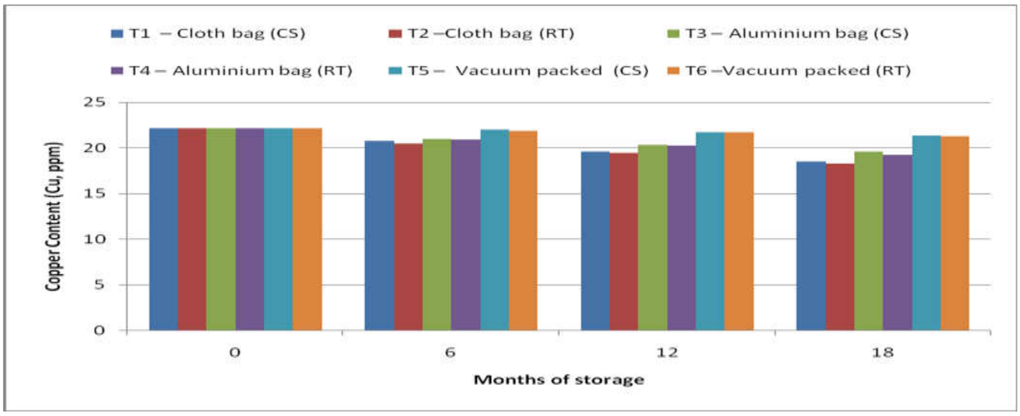

Fig. 1. Influence of packaging and storage conditions on copper content (Cu, ppm) at different time intervals of storage in onion seeds

The reduction was greater in cloth bags as well as aluminium packed seeds from the initial stage i.e., 8 months to 18 months of storage, stored under room temperature. At the end of 18 months of storage, the vacuum packed bag seeds kept under cold storage and room temperature recorded significantly higher values of copper content (14.55 and 14.37 ppm) as compared to aluminium bags (11.83 and 11.30 ppm) followed by cloth bags (11.57 and 11.00 ppm), respectively. It is clear from the results that the vacuum packed seeds maintained higher copper content compared to aluminium bags followed by cloth bags during storage period. It is significantly difference in copper content, was not observed in vacuum packed seeds stored either under cold storage or room temperature; while cloth bag seeds and the aluminium bag seeds differed significantly to each other from 10 to 18 months of storage.

Iron content (Fe, ppm)

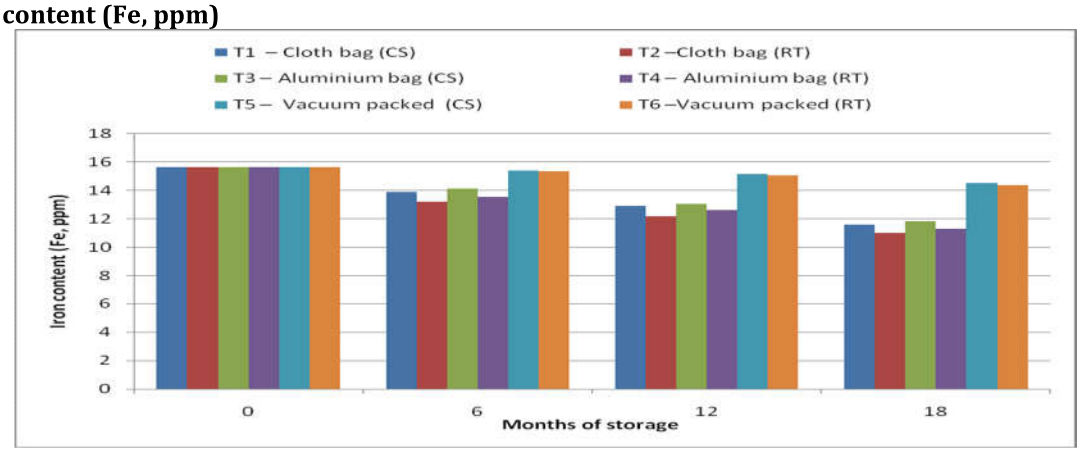

Fig. 2. Influence of packaging and storage conditions on iron content (Fe, ppm) at different time intervals of storage in onion seeds

The data related to the iron content (ppm) of onion seeds differed significantly between treatments recorded with progress in storage period (Fig.,2). The iron content in cloth bags as well as aluminium packed seeds was when reduced to great extent from the initial stage to upto 18 months of storage when stored under room temperature. At ten months of storage, significantly higher iron content (42.43 ppm) was recorded in vacuum packed seeds stored under cold storage and it was onpar with those stored under room temperature (42.35 ppm). Significantly lower iron content (38.47 ppm) was observed in aluminium bag seeds stored under room temperature followed by cloth bag seeds (38.60 ppm) stored at room temperature. The similar trend was continued at all the stages of storage even upto 18 months. Similar way to At the end of storage i.e., 18 months, vacuum packed seeds stored under cold storage recorded significantly higher iron content (41.78 ppm) over all other treatments, followed by vacuum packed seeds stored under room temperature (41.43 ppm). The lower iron content (33.27 ppm) was recorded seed stored in aluminium bags followed by cloth bags (33.70 ppm).

Zinc content (Zn, ppm)

Zinc content (ppm) of onion seeds differed significantly between the treatments and reduced from 4 months onwards until upto 18 months of storage in cloth bag seeds (Fig.3). The decline in zinc content of vacuum packed seeds was much slower than in aluminium packed seeds at all the stages of storage. Significantly lower zinc content (34.81 and 35.50 ppm) was recorded in cloth bag seeds kept under room temperature and cold storage, respectively at 10 months of storage While significant higher values (37.48

and 37.30 ppm) were recorded in vacuum packed seeds stored under cold storage and room temperature followed by aluminium packed seeds (35.15 and 34.30 ppm), respectively. A similar trend was continued at all the stages of storage upto 18 months

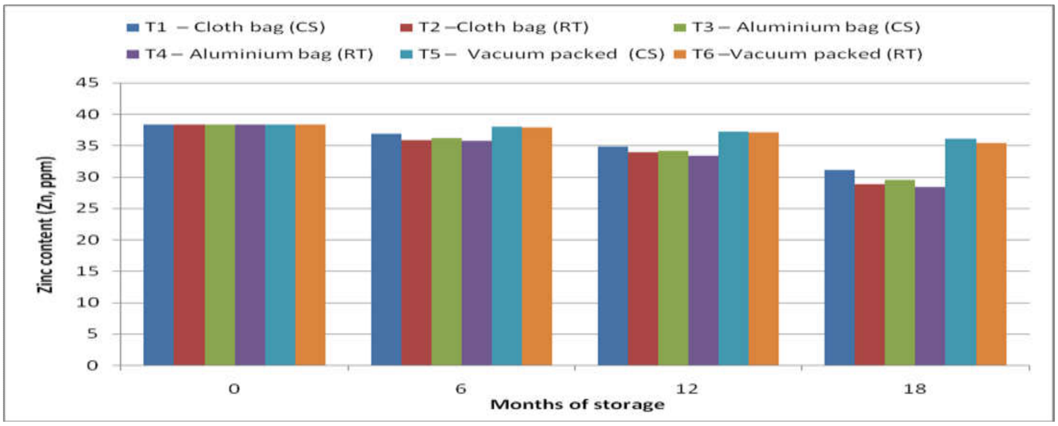

Fig. 3. Influence of packaging and storage conditions on zinc content (Zn, ppm) at different time intervals of storage in onion seeds

Manganese content (Mn, ppm)

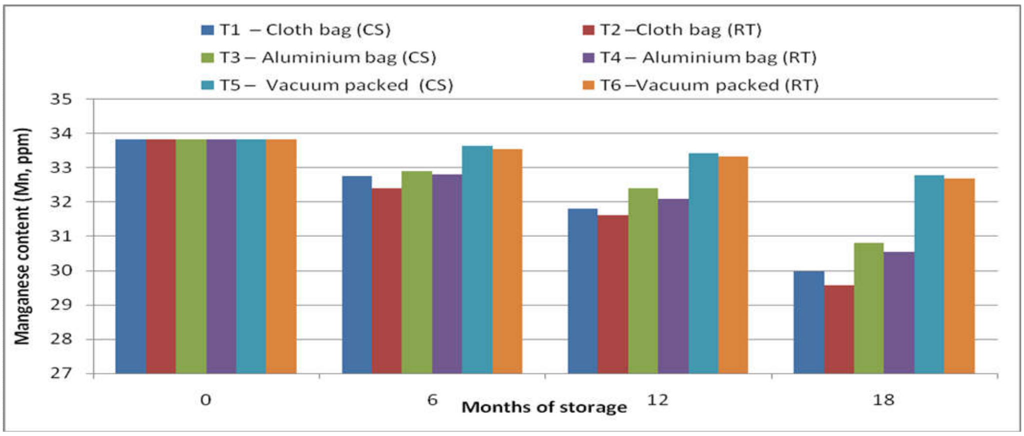

Fig. 4. Influence of packaging and storage conditions on manganese content (Mn, ppm) at different time intervals of storage in onion seeds

The data on manganese content (ppm) of onion seeds as influenced by different packaging materials and storage condition significantly differences among the treatment during storage (Fig. 4). Significantly higher values of manganese content (28.78 ppm) were recorded for vacuum packed seeds stored under cold storage, but were onpar with those stored under room temperature (28.75 ppm) at 10 months of storage. Significant lower values (26.54 ppm) were observed in aluminium bag seeds at room temperature, but it was on par with cloth bag seeds (26.70 ppm). Same trend was at all the stages of storage even upto 18 months. The vacuum packed seeds could maintain higher manganese content throughout the storage period. The values of manganese content in vacuum packed seeds did not differ significantly within the treatments upto 18 months of storage.

It is clear from the above results for all the mineral's content that the seeds stored in cloth bags under cold storage were onpar with the aluminium bags stored under cold storage similarly the cloth bags stored at room temperature was also onpar with aluminium bags stored at room temperature. The vacuum packed seeds could maintain higher mineral's content values throughout the storage period. The vacuum packed seeds could maintain higher manganese content values throughout the storage period. Mineral elements like zinc, copper, iron and manganese are very crucial for plant growth and human health, and play a key role in various physiological and biochemical processes. Results pertaining to mineral contents during study including copper, iron, zinc and manganese of soybean seeds showed gradual decrease with an advancement of storage period at all the stages of storage. Among the containers, the decrease in mineral content was very less in vacuum packed bags compared to aluminium, and cloth bags throughout the storage period under both ambient and cold storage. Variation in the mineral contents between the packaging materials could be attributed to redistribution of mineral elements in seeds and possible microbial contamination [9]. In the aluminium bags mineral content values were higher than cloth bags, but it was lower than vacuum packed bags. Same results were obtained by [18] in groundnut, [19] in melon seeds, [15] in cocoyam chips, [32], [40] in chilli and [56] in green beans.

Higher reduction of iron content in aluminium and cloth bags may be attributed to its sensitivity to temperature. [26] reported that copper, iron, zinc and manganese contents in both conventional and vacuum packed bags were affected significantly and decreased with an increased storage period of 10 months. At 18 months of storage, vacuum packed bags recorded significantly higher values of copper, iron, zinc and manganese compared to aluminium, while significantly lower values were found in cloth bags stored under both ambient and cold storage. Similarly, [5] also reported a decrease in Zn, Cu and Fe of cocoyam and white yam stored for six months. Higher mineral contents during cold storage compared to ambient storage could be attributed due to lower internal physiological and biochemical processes in the seed there by prolonging the shelf life of seeds during storage. Higher micronutrients in vacuum packed bags compared to cloth bags, may be due to decrease in ash content [26]. Similar findings were also reported in shelled melon seeds [20], in millet seeds [19], in cocoyam chips.

α-amylase activity (mg maltose released/min)

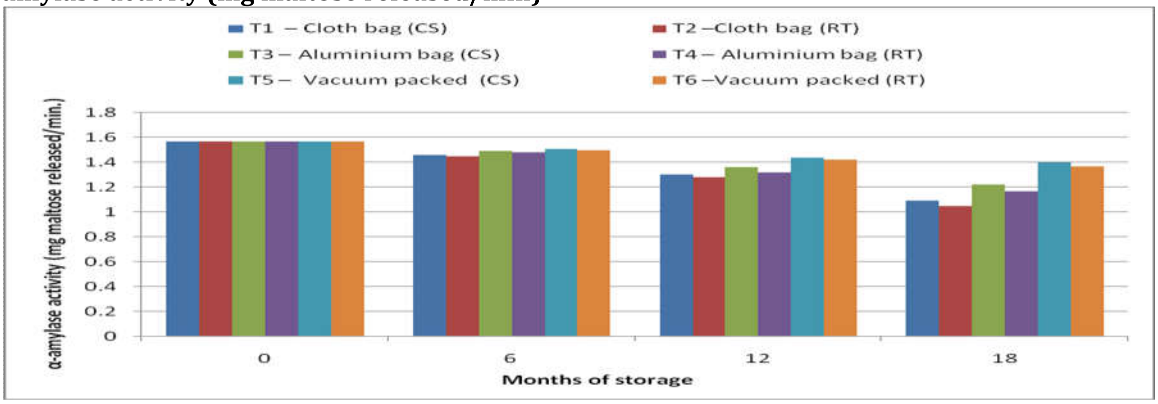

Fig. 5. Influence of packaging and storage conditions on α-amylase activity (mg maltose released/min) at different time intervals of storage in onion seeds

α-amylase activity (mg maltose released/min) of onion seeds differed significantly between treatments and there was a gradual decline with progress in storage period (Fig., 5). The reduction was greater in cloth bag as well as aluminium packed seeds from the initial stage upto 18 months of storage stored under room temperature. At 18 months of storage, the vacuum packed seeds recorded significantly higher values of α-amylase activity (1.40 and 1.37 mg maltose released/min), kept at cold storage and room temperature, respectively compared to aluminium bags (1.22 and 1.17 mg maltose released/min) followed by cloth bags (1.09 and 1.05 mg maltose released/min), respectively throughout the storage period. It is clear from the results that the vacuum packed seeds could maintain higher α-amylase activity as compared to aluminium bags followed by cloth bags, throughout the storage period. From the results, it is clear that the vacuum packed seeds could maintain higher α-amylase activity values over aluminium bags followed by cloth bags at all the stages of storage. Similar observations were also reported in wheat seeds [10] and in naturally aged gram, chickpea and wheat seeds [2], and in mustard [52].

Lipase activity (meq. free fatty acid /min/g)

Lipase activity (meq. free fatty acid /min/g) of onion seeds differed significantly between treatments and there was gradual decline with an advancement in storage period (Fig.,6). The reduction was greater in cloth bag as well as aluminium packed seeds from the early stage to upto 18 months of storage, stored under room temperature. At the end of storage periods i.e., 18 months vacuum packed seeds recorded significantly higher lipase activity (3.61and 3.58 meq. free fatty acid /min/g) kept under cold storage and room temperature compared to aluminium bags (3.45 and 3.32 meq. free fatty acid /min/g) and cloth bags (3.30 and 3.18 meq. free fatty acid /min/g), respectively. It is clear from the results that the vacuum packed seeds showed higher lipase activity compared to aluminium bags followed by cloth bags throughout the storage period. It is also clear from the results that no significant differences, were found between vacuum packed treatments, either stored under cold storage or room temperature; while the lipase activity values for cloth bags and the aluminium bags differed significantly with each other throughout the storage period. Our results are in good agreement with results of [14] and [11], [28] in wheat and [16] in cucurbitaceous seeds.

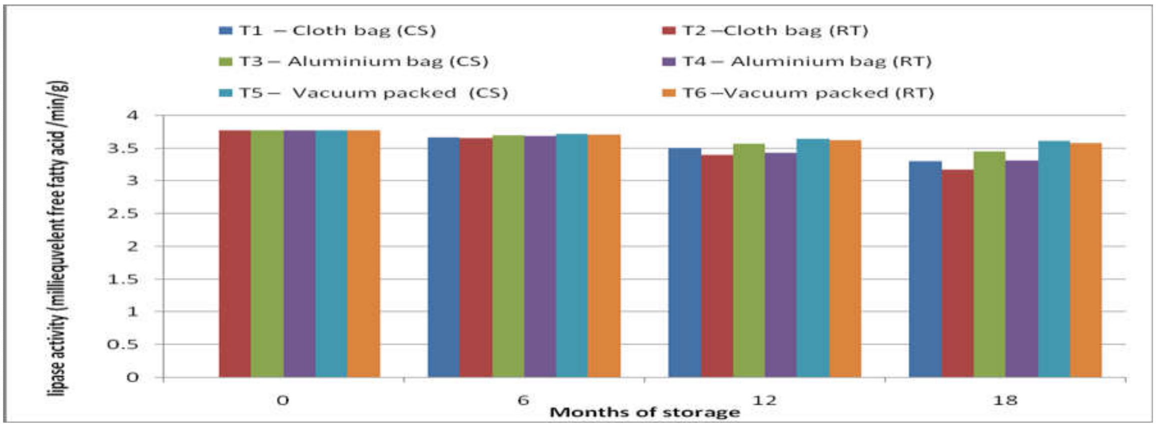

Fig. 6. Influence of packaging and storage conditions on lipase activity (milliequvelent free fatty acid /min/g) at different time intervals of storage in onion seeds

Protease activity (mg amino acid released /min/ml)

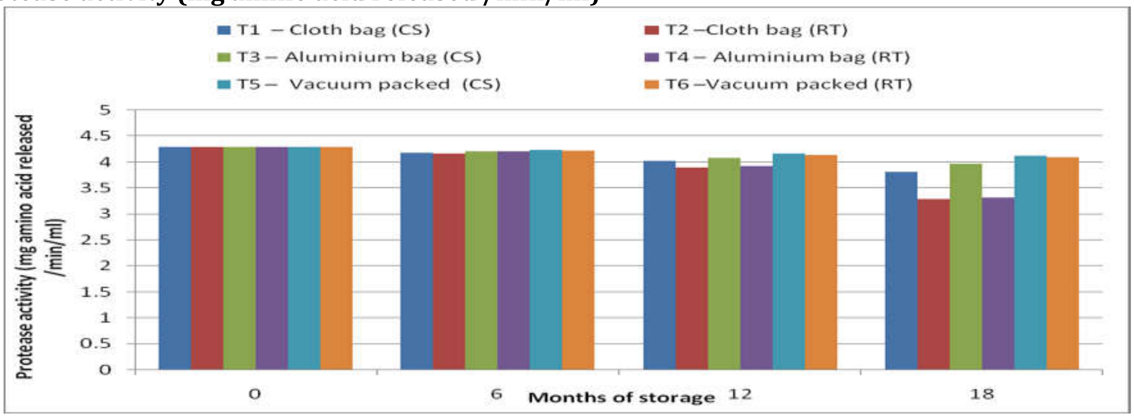

Fig. 7. Influence of packaging and storage conditions on protease activity (mg amino acid released /min/ml) at different time intervals of storage in onion seeds

Protease activity (mg amino acid released /min/ml) of onion seeds differed significantly between treatments during storage period (Fig.,7). The decline in protease activity of vacuum packed seeds was very minimum and a slow decline with an advancement in storage period. While, cloth bags as well as aluminium bag seeds was found to reduce great from the initial stage to 18 months of storage under room temperature. At the end of storage periods, the vacuum packed seeds recorded significantly higher protease activity (4.12 and 4.09 mg amino acid released /min/ml) kept at cold storage and room temperature, respectively compared to aluminium bags (3.96 and 3.31 mg amino acid released /min/ml) and cloth bags (3.81 and 3.29 mg amino acid released /min/ml). It is clear from the results that the vacuum packed seeds could maintain higher values of protease activity compared to aluminium bags followed by cloth bags throughout the storage period. It is also clear from the results that within the treatments, there was no significant difference in vacuum packed seeds stored under either cold storage or room temperature; while the cloth bags and the aluminium bags differed significantly with each other throughout the storage period. Similar results were observed by [10] in wheat, [53] in radish, [39] in sunflower. Same results of lipase activity were also observed in germinated seeds of castor bean [37] ,[50] in bajara & sorghum and the African bean [17].

Loss of viability of seeds has been correlated to enzymatic activity. [1] reported that the activity of respiratory and associated enzymes *viz.,*peroxidase, glutamic acid oxidase and catalase, activity of hydrolytic enzymes *viz., α-amylase, lipase,* proteases, phytases and phosphatases is associated with the degradation of organelles membranes, nucleoproteins, etc. In crop seeds, the development of amylase activity constitutes an important event in germination. During germination of seeds, a massive breakdown of the reserve substances begin with the help of amylolytic, proteolytic and lipolytic enzymes and the products are transported to the growing seedlings for their development. The remaining small amounts of protein represents enzymes concerned with metabolic processes during seed development and germination [30]. Among the storage conditions, ambient storage recorded higher enzyme activities compared to cold storage. This may be due to higher temperature and higher metabolic activity under ambient storage. These findings are in agreement with those of [55], [24] in castor, [31]in bush bean, and [51] in wheat, [22] in sorghum and [34] in quinoa, [27] in oat seeds, [21] and [48] in mungbean.

CONCLUSIONS

Seed physiological and biochemical parameters deterioration is an inexorable and an irreversible process. The quality and viability of onion seeds are subjected to variations during storage conditions and it has been found that the life span of seeds depends on moisture content of the seeds, relative humidity, temperature, light and oxygen content under which the seeds are stored. It has been found in the present study that it is possible to extend the shelf life of onion seeds up to 18 months without deterioration in seed biochemical parameters *viz.,* enzyme activity such as α-amylase, lipase and protease and seed physiological parameters such as mineral content (Cu, Mn, Zn and Mn), moisture content and electrical conductivity by storing them under vacuum packaging. Since seed is an important input in agriculture which determines not only the production but also the productivity, it is essential to maintain the seed quality as well as seed vigor for better crop yield potential.

REFERENCES

1. Abdul-Baki, A.A. and Anderson, J. D., (1973), Vigour determination in soybean by multiple criteria. *Crop Sci.,* 13 : 630-633
2. Agrawal, S.C. and Kharlukhi, R.K., (1987), Fungal pathogens detected on soybean seeds grown in different localities*. Seed Res.*, 17 (2): 208-210.
3. Anonymous, (2013), Area, production and productivity of crops. *Http : //Www. Rkmp. Co. In/crops-Stats/Statewise-Statistics/Karnataka.*
4. Anonymous, (2014), Area, production and productivity of crops. *Http : //Www. Rkmp. Co. In/crops-Stats/Statewise-Statistics/ Karnataka*
5. Alinnor, I.J. and Akalezi C.O., (2010), Proximate and mineral composition of *Discorea rotundata* (White yam) and *Colocasia esculentus* (white cocoyam). *Pakistan J. Nutrition,* 9 (10): 998 – 1001.
6. Asha, A. M., (2012), Effect of plant products and containers on storage potential of maize cv. Arjun. *M. Sc. (Agri) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka.
7. Balasubramanyam, N., Baldevaraj and Indiramma, A. R., (1983), Packaging and storage quality of roasted and salted, spiced peanuts in flexible packages. *Perfectpac*., 23(1): 5-11.
8. Bernfeld, P., (1955), *Amylase α and β. Methods in enzymology* 1. S. P. Colswick and N. O. K., (Eds). Academic Press Inc, New-York, pp. 149-154
9. Bognar, A., Bohling, H. and Fort, H., (1990), Nutrient retention in chilled foods. In : Gormley T. R. (Ed) *Chilled foods. Elsevier Applied Sci.,* London, pp. 305–336.
10. Chauhan, D. S., Deswal, D. P., Dahiyaand, O. S. and Punia, R. C., (2011), Changes in storage enzymes activities in natural and accelerated aged seed of wheat (*Triticum aestivum*). *Indian J. Agric. Sci.,* 81 (11) : 1037–1040.
11. Chaitanya, K. S., Keshavkant, S. and Naithani, S. C., (2000), Changes in total protein and protease activity in dehydrating recalcitrant sal (*Shorea robusta*) seeds. *Silva Fennica,* 34 (1) : 71–77.
12. Deepa, G. T., Chetti, M. B., Mahadev, C., Khetagoudar and Gopal M. A., (2011), Influence of vacuum packaging on seed quality and mineral contents in chilli (*Capsicum annuum* L.). *J Food Sci Tech.,* DOI 10.1007/s13197-011-0241-3.
13. Delouche, J. C., Mathews, R. K. Dougherty, G. M. and Boyd, A. H., (1973), Storage of seeds in tropical regions. *Seed Sci. Technol.,* 1 : 671-700.
14. Dhaliwal, Y. S., Sekhon, K. S. and Nagi, H. P. S., (1991), Enzymatic activities and pheological properties of stored rice. *Cereal Chem.,* 68 : 18–21.
15. Echendu, A. O., Obizoba, I. C., Ngwu, E. K. and Anyika, J. U., (2009), Chemical composition of groundbean based cocoyam, yam and plantain pottage dishes and roasted groundbean. *Pakistan J. Nutr.,* 8 (11) : 1786–1790.
16. Eze, S.O., and Chilaka, F. C., (2010), Lipolytic activities in some species of germinating cucubitaceae: *Cucumeropsis manii naud, Colocynthis vulgaris* L. and *Cucubita moschata schrad. World J. Agric. Sci.,* 6 (6): 700-706.
17. Enujiugha V.N., Thani F.A., Sanni T.M., and Abigor R.D., 2004, Lipase activity in dormant seeds of the African oil bean (*Pentaclethra macrophylla* Benth). *Food Chem.*, 88: 405-410.
18. Fagbohun, E. D. and Faleye, O.S., (2012), The nutritional and mycoflora changes during storage of groundnut (*Arachis hypogea*). *Intl. J. Agron. Agric. Res.,* 2(6) : 15-22.
19. Fagbohun, E. D. and Lawal, O. U., (2011), Effect of storage on nutrient composition and mycobiota of sundried soyabean. In : *African J. Food Sci.,* 5(8) : 473-477.
20. Fagbohun, E. D. and Lawal, O. U., (2011), Effect of storage on nutrient composition and mycobiota of sundried soyabean. In : *African J. Food Sci.,* 5(8) : 473-477.
21. Ghavidel, R.A. and Davoodi, M.G., (2011), Evaluation of changes in phytase, α-amylase and protease activities of some legume seeds during germination. *International Conference on Bioscience, Biochemistry and Bioinformatics IPCBEE* 5 (2011) *IACSIT Press, Singapore*
22. Govind, K.G. and Tumkur K.V., (1970), Acid protease from germinated sorghum. *Eur. J. Biochem.* 17 : 4-12.

23. Gurmithsingh and Harisingh, (1992), Maintenance of germinability of soybean (*Glycine max L.*) seeds. *Seed Res.*, 20 : 49-50.
24. Huang, A.H.C., Wimer, I.T., and Y. Lin, (1983), Lipase in the lipid bodies of corn scutella during seedling growth. *Plant Physiol*., 7: 460-466.
25. Jayaraman, J., (1981), *Laboratory Manual in Biochemistry*, Wiley Eastern Ltd. New Delhi, India, pp. 122-123.
26. Kayisoglu, S. and Demirci, M., 2006, Effect of storage time and condition on mineral contents of grape pekmez produced by vacuum and classical methods. *J. Tekirdag Agril Faculty,* 3(1) : 1–7
27. Liukkonen, K.H., Montfoort, A., and Laakso, S.V., 1992, Water–Induced lipid changes in oat processing. *J. Agric. Food Chem.,* 40 (1): 126-130.
28. Mohamed, G. M., (2011), Study on stability of wheat germ oil and lipase activity of wheat germ during periodical storage. *Agric. Biol. J. North America*, 2(1): 163-168.
29. Monira, U. S., Amin, M. H. A., Marin, M. and Mamun, M. A. A. 2012, Effect of containers on seed quality of storage soybean seed. *Bangladesh Res. Publ. J.,* 7(4) : 421-427
30. Millerd, A. and Thomson, J., (1975), Storage pro-teins of legume seeds : Proteins of legume seeds : Potential for change. *CSIRO Div. of Plant Industry Genetics Report.* 3 : 58-60.
31. Mostarin, T., Saha, S. R. and K. Khatun, (2012), Seed quality of bush bean as influenced by different storage containers and conditions. *J. Expt. Biosci.* 3(1): 83-88.
32. Mata, M.C., Mara, M.C.A., and Diez-Marque, C., (2003), Extending shelf-life and nutritive value of green beans (*Phaseolusvulgaris* L.), by controlled atmosphere storage. *Micronutrients Food Chem.*, 80: 317–322
33. Malekar, P. K., Mian, I. H., Bhuiyan, R. K., Akanda, A. M. and Reza, M. M., 2008, Effect of storage containers and time on seed quality of wheat. *Bangladesh J. Agric. Res.*, 33(3) : 469-477
34. Neg, S.C. and Anderson A., (2005), Lipid oxidation in Quinoa (*Chenopodium quinoa*) as determinate through accelerated aging. *J. Environmental, Agric. Food Chem.*. 4 (4): 1010-1020.
35. Nataraj, K., Balakrishna, P., Ramegowda, Roopa, A.R. and Chandrashekar, U. S., (2011), Influence of storage containers and seed treatment chemicals on quality of new sunflower (*Helianthus annus*) hybrids during storage. *National Seed Congress,* January, 29-31, pp-267-280.
36. Narayanaswamy, S., (1993), Effect of provenance, pre-sowing treatment and storage on seed yield and quality in groundnut. *Ph.D. Thesis,* Univ. Agric. Sci., Bangalore
37. Ory, R.L., Angelo A.J. and Altschul A.M., 1962, The acid lipase of the castor bean properties and substrate specificity. *J. Lipid Res.,* 3: 99-105.
38. Padma, V. and Reddy, M.B., (2002), Storage of brinjal seed under ambient conditions at two moisture levels. *J. Res. ANGRAU*, 30 (2): 6-10.
39. Pallavi, M., Sudheer, S. K., Dangi, K. S and Reddy, A. V., (2003), Effect of seed ageing on physiological, biochemical and yield attributes in sunflower (*Helianthus annus* L.) cv. Morden. *Seed Res.,* 31(2) : 161–168.
40. Perring, M. A., and Pearson, K., (1987), Redistribution of minerals in apple fruit during storage, the effect of storage atmosphere on calcium concentration. *J. Sci. Food Agric.,* 40: 37–42.
41. Panse, V. G. and Sukhatme, P. V., (1967), *Statistical Methods for Agricultural Workers,* Indian Council of Agricultural Research, New Delhi, pp. 167-174.
42. Presley, J. T., (1958), Relationship of protoplast permeability of cotton seed viability and predisposition of seedling disease. *Pl. Dis. Rep.,* 42 : 582.
43. Poulle, M. and Jones, B. L., (1988), A proteinases from germinated barley I. Purification and some physical properties of a 30-kD cystein-endoproteinase from green malt. *Pl. Physiol.,* 88 : 1454-1460.
44. Raikar, S. D., Vyakarnahal, B. S., Biradar, D. P., Deshpande, V. K. and Janagoudar, B. S., (2011), Effect of seed source, containers and seed treatment with chemical and biopesticide on storability of scented rice Cv. Mugad sugandha *Karnataka J. Agric. Sci.,* 24 (4) : 448-454.
45. Remya, J., (2007), Influence of vacuum packaging and long terms storage on quality in chilli. Powder, *M. Sc. (Agri) Thesis*, Univ. Agric. Sci., Dharwad, Karnataka (India).
46. Ravi Hunje, Vyakarnahal, B. S. and Channappagoudar, B. B., (2007), Influence of containers on storability of chilli seed. *Karnataka J. Agric. Sci.,* 20(3) : 55-58..
47. Roshny, T. A., (2007), Influence of vacuum packaging and long term storage on quality in whole chilli. *M. Sc. (Agri) Thesis*, Univ. of Agric. Sci., Dharwad, Karnataka (India).
48. Rahman, M. M. K. and Rahman, G. M. M., (2007), Effect of container and length of storage on germination and seed-borne associated with mungbean seed. *Bangladesh J. Plant Path.,* 13(1-2) : 13-16.
49. Rajendraprasad, S., Ujjnaiah, U.S., Sathyanarayana Reddy, A. and Jagadish, G.V., (1998), Effect of genotypes of groundnut kernels and containers on seed quality during storage. *Seed Tech. News*, 28 (4):35.
50. Rao, N. K. and Sastry, D. S. R., (2002), Vacuum storage and seed survival in pearl millet and sorghum. *Intl. Sorghum and Millets Newslett.,* 43 : 20-22.
51. Rehman, Z. U. and Shah, W. H., (1999), Biochemical changes in wheat during storage at three temperatures. *Pla. Human Nutr.,* 54 : 109-117.
52. Sana, N. K., Sarkar, B. C., Azad, M. A. K., Huque, M. E., Shaha, R. K., (2009), Enzyme activities and mobilization of nutrients in brassica (*brassica* spp.) and wheat (*Triticum aestivum* L.) seeds during germination. *J. Bio-Sci.,* 17 : 101-106.
53. Scialabba, A., Bellani, L. M. and Dell'Aquila, A., (2002), Effects of ageing on peroxidase activity and localization in radish (*Raphanus sativus* L.) seeds. *European J. Histoche.,* 46(4) : 351–358.

54. Shanmugavel, S., Anuradha Varier and Malavika Dadlani, (1995), Physiological attributes associated with seed ageing in soybean (*Glycine max* (L.) Merrill) cultivars. *Seed Res*., 23(2): 61-66
55. Sopanen, T. and Lauriere, C., (1989), Release and activity of bound-amylase in a germinating barley grain. *Plant Physiology,* 134: 678-684.
56. Zagory, D., and Kader, A.A., (1989), Quality maintenance in fresh fruits and vegetables by controlled atmospheres. *In J. J. Jen (Ed.), Quality factors of fruits and vegetables. Chemistry and Technology. Los Angeles: American Chemical Society,* pp.23-26.

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