

Exploring the storage potential of groundnut var.TMV (Gn) 13 under Modified Atmospheric Storage conditions

ABSTRACT

The lab experiment was conducted to assess the storage potential of groundnut (*Arachis hypogaea* L.) variety TMV (Gn) 13 under modified atmospheric storage conditions during 2022 at Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. The groundnut pods and kernels were subjected into different storage conditions viz., kernels pods stored in gunny bag, kernels stored in gunny bag, kernels stored in polythene bag, kernels stored with N₂ gas and kernels stored in vacuum conditions. The results revealed that pod storage recorded the maximum germination percentage(73%), root length(14.5cm), shoot length(14.3cm), dry matter production (3.47 g 10 seedlings⁻¹) and vigour (2136). Similarly, enzymes viz., dehydrogenase, peroxidase, alpha amylase and catalase activity were also maximum in pod storage and nitrogen storage conditions with minimum harmful effect of pest and fungus incidence. Present study, it is concluded that groundnut kernels stored under modified atmospheric storage i.e. nitrogen gas storage can maintain the seed longevity by minimizing the deterioration process in groundnut equally as that of pod storage. Further, it will help to minimize the expenditure towards transport and storage.

Key words: Modified atmospheric storage, Groundnut kernel, Seed storability

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a leguminous plant that is widely cultivated in the tropics and subtropics and it is valued for its high-oil content and edible seeds. It is the fourth most important source of edible oil and a third most important source of vegetable protein in the World. Globally, groundnut covers 327 lakh hectares with the production of 539 lakh tonnes with the productivity of 1648 kg per hectare (FAOSTAT, 2021). Groundnut is valued as a rich source of energy contributed by oil (48–50%) and protein (25–28%) in the kernels and 100 g of kernels provide 567 kcal of energy and 8.5 g of dietary fiber (Murali and Janila, 2017). Additionally, groundnuts are a rich source of minerals, vitamins (Vitamin E, Thiamine, Pantothenic acid, Vitamin B6, Folate, and Niacin) and antioxidants and health improving bioactive compounds such as

resveratrol, tocopherol, arginine, p-coumaric acid, polyphenols, flavonoids, isoflavones, etc. The consumption of groundnut and its products can reduce risk of inflammation, diabetes, cancer, Alzheimer's and gallstone disease. As they are highly nutritious, groundnut and its products can be promoted as nutritional foods to fight energy, protein, and micronutrient malnutrition among the poor people. Due to high nutrient contents of groundnuts, they have been used to combat the malnutrition in developing countries and also reduce the cardiovascular heart disease and gall stone (Bonkuand Yu., 2020).

Seed of improved varieties is a costly input; more so in the case of groundnut, where the non-availability of improved variety seeds is a major constraint in most of the groundnut-growing countries. The private sector has shown little interest in the groundnut seed enterprise due to the low seed multiplication ratio, bulky nature of the produce, quick loss of seed viability, high cost of transportation, low-profit margin, and the self-pollinated nature of the crop. Quick loss in viability period of groundnut leads to create more seed demand and it indirectly affects the seed multiplication chain. Therefore, availability of good quality seeds at right time with affordable price is a great task to the public sector seed services.

The major problem accompanied with groundnut is poor storage because of its possession of polyunsaturated fatty acids which will get break down when there is high temperature and thus results in lipid peroxidation. The seeds produced in one season are not fully consumed in the same season for farm and home, because of its voluminous quantity of production. So the major part of the produce is going for storage to utilize in the next upcoming months either as seed source or food source. The most common method of storage of groundnut was pod storage because of its ability to protect the kernel by limiting the lipid peroxidation. There are numerous techniques such as seed treatment, mid-storage correction to sustain the seed quality during storage. In all these techniques practical difficulties are more. Modified Atmospheric Storage (MAS) is one of the novel approaches to protect groundnut kernel with its quality for a longer period compared to kernel under ambient storage. In MAS, the kernels are stored in the atmospheric condition including higher amount of (N_2), (CO_2) and reduced (O_2). In this modified storage condition, the environment that surrounds the seeds is only altered and does not treated with any material, so it does not pose any health hazard to human, animal and not phytotoxic to the seeds. Seed stored in MAS will reduce the insect population by reducing the temperature that will increase during the respiration of seeds. Riudavetset *et al.*, (2018) reported that modified atmospheric packaging of maize seed with (90% CO_2 , 5% O_2 and 5% N_2) effectively reduce the *Sitophilus zeamais* population by inhibiting all the life stages of insects thereby it control the proliferation of aflatoxin produced during storage of maize seeds.

Keeping all these points in view, the present investigations were undertaken to explore the storage potential of groundnut variety TMV 13 under modified atmospheric storage conditions.

2. MATERIALS AND METHODS

The laboratory experiments were conducted with groundnut variety TMV (Gn) 13 in the laboratory of Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore during the year 2022 and packaging of the groundnut kernels was done in the Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore with the Modified Atmosphere Packaging (MAP) Unit. The groundnut TMV (Gn) 13 is a red kernel variety released from Oilseeds Research Station, Tindivanam during 2013 and it is widely cultivated in Villupuram, Thiruvannamalai and Coimbatore districts of Tamil Nadu. The kernels were dried to 6.3 per cent moisture content and then subjected into following storage conditions.

Treatment details

M₁- Pod stored in gunny bag under ambient condition

M₂- Kernel stored in gunny bag under ambient condition

M₃- Kernel in polythene bag without any treatment under ambient condition

M₄- Kernel stored with N₂ storage under ambient condition

M₅- Kernel stored in vacuum storage under ambient condition

The seed quality parameters viz., seed moisture content ((ISTA, 2010). seed germination (ISTA, 2013), root length, shoot length, dry matter production, vigour index (Abdul-Baki and Anderson, 1973), insect infestation, storage fungus infection, alpha amylase((Paul *et al.*, 1970), catalase (Aebi 1984), peroxidase (Malik and Sing, 1980), and dehydrogenase value (Kittock and law, 1968) enzyme activities were analyzed at monthly intervals up to six months of the storage period (P₀, P₁, P₂, P₃, P₄, P₅ and P₆). The data were analyzed by Factorial Completely Randomized Design (FCRD) with three replications as suggested by Panse and Sukhatme (1985).

Table 1 Influence of modified atmospheric storage on seed moisture content, seed germination, root length and shoot length of groundnut variety TMV 13

Period of storage (P)	Seed moisture content (%)						Germination (%)						Root length (cm)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean
P ₀	6.3	6.3	6.3	6.3	6.3	6.3	94	94	94	94	94	94	15.2	15.2	15.2	15.2	15.2	15.2
P ₁	6.3	6.4	6.3	6.3	6.3	6.3	90	86	88	90	87	88	15.2	15.0	15.1	15.1	15.0	15.0
P ₂	6.4	6.6	6.4	6.4	6.4	6.4	80	71	74	73	74	74	14.8	14.1	14.7	14.8	14.9	14.7

P₃	6.5	7.2	6.5	6.5	6.5	6.6	75	54	62	72	61	65	14.6	13.9	14.5	14.1	14.7	14.4
P₄	6.7	7.4	6.7	6.6	6.7	6.8	66	50	54	61	52	57	14.3	13.6	12.5	13.9	13.8	13.7
P₅	6.8	7.6	6.8	6.7	6.8	6.9	54	42	58	53	50	51	14.0	13.5	11.7	13.8	12.9	13.2
P₆	7.0	8.0	7.6	7.4	7.3	7.4	55	40	46	50	45	47	13.8	12.7	11.5	13.3	12.2	12.7
Mean	6.5	7.0	6.7	6.6	6.6		73	62	67	70	66		14.6	14.0	13.6	14.3	14.1	
	P		M		PXM		P		M		PXM		P		M		PXM	
SED	0.068		0.057		0.151		0.608		0.514		1.360		0.124		0.105		0.277	
CD(0.05)	0.135		0.114		0.302		1.212		1.025		2.711		0.247		0.209		0.553	

Table 2 Influence of modified atmospheric storage on shoot length, dry matter production and vigour index of groundnut variety TMV 13

Period of storage (P)	Shoot length (cm)						Dry mater production (g seedlings ⁻¹⁰)						Vigour index					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean
P₀	14.7	14.7	14.7	14.7	14.7	14.7	3.74	3.74	3.74	3.74	3.74	3.74	2810	2810	2810	2810	2810	2810
P₁	14.6	14.0	14.3	14.6	14.3	14.4	3.68	3.56	3.60	3.66	3.61	3.62	2691	2494	2587	2587	2549	2582
P₂	14.5	13.9	14.1	14.4	14.3	14.2	3.56	3.43	3.50	3.53	3.52	3.50	2344	1988	2131	2132	2160	2151
P₃	14.4	12.8	13.7	14.3	14.0	13.8	3.45	3.33	3.40	3.42	3.40	3.40	2175	1414	1748	2044	1750	1826
P₄	14.4	12.1	13.4	14.1	13.6	13.5	3.36	3.30	3.32	3.34	3.32	3.32	1894	1285	1397	1708	1425	1542
P₅	14.2	11.9	13.1	14.0	13.0	13.2	3.27	3.13	3.21	3.25	3.27	3.22	1523	1066	1473	1473	1295	1366
P₆	13.7	11.6	12.8	13.2	12.8	12.8	3.24	3.11	3.10	3.21	3.20	3.17	1512	968	1118	1325	1125	1210
Mean	14.3	13.0	13.7	14.1	13.8		3.47	3.37	3.41	3.45	3.43		2136	1717	1895	2011	1873	
	P		M		PXM		P		M		PXM		P		M		PXM	
SED	0.138		0.116		0.308		0.032		0.027		0.071		0.032		0.027		0.072	
CD(0.05)	0.275		0.232		0.615		0.064		0.054		0.143		0.064		0.054		0.143	

Table 3 Influence of modified atmospheric storage on insect infestation, storage fungus infection and alpha amylase activity of groundnut variety TMV 13

Period of storage (P)	Insect infestation (%)						Storage fungus infection (%)						Alpha amylase activity (mg maltose min ⁻¹)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean
P ₀	0.0	0.0	0.0	0.0	0.0	0.0	4	4	4	4	4	4	14.01	14.01	14.01	14.01	14.01	14.01
P ₁	0.0	0.0	0.0	0.0	0.0	0.0	8	16	8	8	8	10	13.96	13.64	13.73	13.86	13.81	13.80
P ₂	0.0	0.0	0.0	0.0	0.0	0.0	12	24	20	16	16	18	13.84	13.52	13.67	13.79	13.71	13.70
P ₃	0.0	0.0	0.0	0.0	0.0	0.0	16	28	24	20	24	22	13.74	13.44	13.60	13.70	13.63	13.62
P ₄	0.0	0.0	0.0	0.0	0.0	0.0	20	36	32	24	28	28	13.68	13.38	13.51	13.62	13.59	13.55
P ₅	0.0	4.0	0.0	0.0	0.0	0.8	24	40	36	32	32	33	13.15	13.09	13.13	13.27	13.23	13.17
P ₆	4.0	4.0	4.0	4.0	4.0	4.0	32	44	40	36	36	38	12.94	12.79	12.82	12.83	12.86	12.84
Mean	0.6	1.1	0.6	0.6	0.6		17	27	23	20	21		13.60	13.41	13.49	13.58	13.54	
	P		M		PXM		P		M		PXM		P		M		PXM	
SED	0.017		0.015		0.039		0.209		0.176		0.466		0.132		0.111		0.295	
CD(0.05)	0.034		0.029		0.077		0.416		0.352		0.930		0.263		0.223		0.589	

Table 4 Influence of modified atmospheric storage on dehydrogenase, catalase and peroxidase enzyme activities of groundnut variety TMV 13

Period of storage (P)	Dehydrogenase activity (OD value)						Catalase activity ($\mu\text{molH}_2\text{O}_2 \text{ min}^{-1}\text{g}^{-1} \text{ protein}$)						Peroxidase activity ($\text{U mg}^{-1} \text{ protein min}^{-1}$)					
	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean	M ₁	M ₂	M ₃	M ₄	M ₅	Mean
P ₀	1.00	1.00	1.00	1.00	1.00	1.00	1.363	1.363	1.363	1.363	1.363	1.363	1.63	1.63	1.63	1.63	1.63	1.63
P ₁	0.92	0.72	0.82	0.85	0.83	0.83	1.358	1.327	1.338	1.345	1.342	1.342	1.56	1.40	1.50	1.55	1.54	1.51
P ₂	0.81	0.66	0.71	0.74	0.73	0.73	1.343	1.290	1.317	1.339	1.333	1.324	1.36	1.25	1.28	1.35	1.32	1.31
P ₃	0.73	0.59	0.62	0.69	0.68	0.67	1.310	1.231	1.309	1.324	1.215	1.278	1.27	1.11	1.15	1.21	1.18	1.18
P ₄	0.54	0.41	0.46	0.50	0.48	0.48	1.285	1.150	1.211	1.215	1.203	1.212	1.11	1.01	1.04	1.08	1.06	1.06
P ₅	0.47	0.33	0.35	0.41	0.38	0.39	1.131	0.956	0.978	0.982	0.988	1.007	1.09	0.90	0.93	0.97	0.95	0.97
P ₆	0.38	0.20	0.26	0.32	0.27	0.29	0.985	0.879	0.934	0.947	0.932	0.935	0.98	0.79	0.86	0.89	0.87	0.88
Mean	0.72	0.56	0.60	0.64	0.62		1.253	1.170	1.207	1.220	1.196		1.29	1.16	1.20	1.24	1.22	
	P		M		PXM		P		M		PXM		P		M		PXM	
SED	0.005		0.004		0.011		0.011		0.009		0.024		0.012		0.010		0.026	
CD(0.05)	0.010		0.009		0.023		0.022		0.018		0.487		0.023		0.020		0.053	

3. RESULTS

The results of this experiment revealed that the modified atmospheric storage condition, period of storage and their interactions showed significant effect with all the seed quality attributes.

Among the storage conditions, the maximum seed moisture content was recorded in kernel stored in gunny bags under ambient storage (M_2) while, the minimum was observed in nitrogen and vacuum storage (M_4 & M_5). The moisture content was slowly increased from 6.3 to 7.4 % as the advancement of storage period from P_0 to P_6 . On the contrary, the highest germination percentage of 94 per cent at initial period of storage (P_0) was slowly decreased to 47 per cent at the end of the storage period (P_6). With respect to modified storage conditions, pod stored in gunny bag under ambient condition (M_1) recorded the maximum mean germination (73 %) and it was followed by kernel storage under nitrogen storage (M_4) (70 %) while, kernel storage at ambient condition (M_2) recorded the minimum mean germination percent (66 per cent). The maximum root and shoot length of 14.6 and 14.3 cm were observed in pod stored in gunny bag under ambient storage (M_1) while, the minimum length of 13.6 and 13.0 cm were observed in kernel stored in gunny bag (M_2), respectively. The decline trend in seedling length was observed as the advancement of storage period. The similar trend was observed in dry matter production and vigour index (**Table 1 & 2**).

On the six month of storage period, there is no storage pest incidence was observed up to four months of storage (P_4) and then it was slowly increased to 0.4 (P_5) to 8 per cent (P_6). Similarly, the minimum pest incidence and fungus infection of 0.6 and 17 per cent were observed in pod stored in gunny bag while, they were maximum in kernel stored in gunny bag (1.1 and 27 %), respectively (**Table 3**).

The enzymes *viz.*, alpha amylase, dehydrogenase, catalase and peroxidase also have positive correlation with seed quality and initially they were maximum of 14.01 mg maltose min^{-1} , 1.00 OD value, 1.363 $\mu\text{molH}_2\text{O}_2 \text{ min}^{-1}\text{g}^{-1}$ protein and 1.63 U mg^{-1} protein min^{-1} while, it was minimum of 12.84 mg maltose min^{-1} , 0.29 OD value, 0.935 $\mu\text{molH}_2\text{O}_2 \text{ min}^{-1}\text{g}^{-1}$ protein and 0.88U mg^{-1} protein min^{-1} , respectively. Similarly, the maximum enzyme activity was observed in pod stored in gunny bag and nitrogen storage, which was followed by vacuum storage (**Table 4**).

4. DISCUSSION

Seed deterioration or ageing is a universal physiological phenomenon which leads to loss of viability. The rate of seed deterioration is vary with the crop species and it is triggered by unfavourable storage conditions (Harrington, 1960 and Agrawal, 1980). Obviously, the seed deterioration rate is faster in oilseed crops and which is due to auto oxidation fatty acids i.e. more lipid peroxidation. In order to overcome or manipulate the deleterious effect of storage environment, MAS is a novel approach for storing groundnut kernels for longer period.

In the present study, it was evidenced that seed stored as such as a pod in gunny bag recorded good storability in terms of germination (**Plate 1**), seedling length, dry matter production, vigour index and enzyme activities and it was equally on par with the kernel stored under nitrogen storage. It clearly indicated that kernel storage also possible to maintain the storability in groundnut when kernels are stored under nitrogen which is followed by vacuum storage.

The reason for the long term maintenance of seed quality in pod storage is due to the microclimate that prevails inside the pod. When the groundnut stored as pod it occupy more space than stored as kernel. The problem associated with kernel is auto-oxidation, peroxidation more prone to insect attack loss of natural antioxidant and rancidity which will affect the seeds standard and also make it unfit for human consumption. The seeds are naturally provided with both enzymatic and non enzymatic antioxidant which will protect the seeds under the adverse situation of lipid peroxidation. The seed coat with deeper color contain more polyphenol content and high flavonoid content and thus have the stronger antioxidant ability (Kuang *et al.* 2017). Vakeswaran *et al.*, (2017) suggested that the seeds stored with pod in the modified atmospheric packaging of 40% CO₂ given higher vigour and viability even after the 12 month of storage. Copeland (1985) highlighted the consequences of deteriorative changes in seed which include membranodegradation, accumulation of toxic metabolites, decreased enzymatic activity, lipid auto-oxidation, and failure of repair mechanisms, genetic degradation, and reduced yield, finally loss of germination or death. In kernel storage, the kernels are exposed to environment and this environment oxygen promote the auto-oxidation and lipid peroxidation in groundnut which results in the production free radical, hydrogen peroxide which damage cell structure and ultimately leads to poor seed viability. The similar result were also reported by Guillaumin (1928), Rathi *et al.*, (2000), Bera *et al.*, (2004), and Bera *et al.*, (2008).



Kernel stored in gunny bag	Pod stored in gunny bag	Kernel stored in nitrogen gas
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Plate 1. Comparative assessment seed and seedling quality of groundnut under modified atmospheric storage

5. CONCLUSION

Of the outset, it is concluded that groundnut kernels stored under modified atmospheric storage i.e., nitrogen gas storage can maintain the seed longevity by minimizing the deterioration process in groundnut equally as that of pod storage. Further, it will help to minimize the expenditure towards transport and storage.

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