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Himani Srivastava
Research Scholar, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India

Kirti Kumari
Subject Matter Specialist, KVK, Tehri Garhwal, UUHF Uttarakhand, India

Dhanajaya A Kulkarni
Assistant Professor, Shriram College of Agriculture Engineering, Paniv, Maharashtra, India

Correspondence
Himani Srivastava
Research Scholar, College of Technology and Engineering, MPUAT, Udaipur, Rajasthan, India

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Studies on the shelf life enhancement of green Bengal gram pods

Himani Srivastava, Kirti Kumari and Dhanajaya A Kulkarni

Abstract
Bengal gram (*Cicer arientimum* L.) is considered to be a good source of protein, carbohydrates and has a very important role in human diet in our country. Green chick peas are generally consumed as fresh, drsied, boiled and soaked *hara chana*. The shelf life of green Bengal gram kernels need to be extended by retarding their physiological metabolism which slow down the undesirable changes by application of proper storage condition. Looking in to the increasing demand of green Bengal gram kernels and its products, the present study was undertaken to study physical characterstics and shelf life enhancement of green Bengal gram pods. The average moisture content (wb) of green Bengal gram pod was found 71.1 percent. The mean values of the length, width, thickness and unit mass of the Bengal gram pod were found to be 20.14 mm, 10.24 mm, 8.54 mm and 0.39 g. The geometric mean diameter of green Bengal gram pods was found to be 11.96. Similarly sphericity of green Bengal gram pods and kernels was calculated as 0.59 and 0.79, respectively. The bulk density of green Bengal gram pods was found to be 410.03 kg/m^3, the true density 1127.70 kg/m$^{3.}$ The angle of repose of green Bengal gram pods was found to be 40.67°. The hardness of the green Bengal gram pod was found to be 1712.9 gf when placed horizontally and vertically. Preservation study of green Bengal gram pods shows that the maximum shelf life of pods with best possible quality was obtained with LDPE packaging material, deep freeze storage condition and vacuum packaging method. Analysis of variance clearly shown that the packaging material, storage condition and storage period had a significant effect over PLW, decay, Chroma, bacterial count and fungal count at 99 percent confidence level. The maximum shelf life of pods in vacuum packed LDPE samples was found to be 6 days for ambient temperature, 54 days for both refrigerated and deep freeze storage conditions, respectively.

Keywords: Bengal, gram, pods, enhancement, *Cicer arientimum* L.

1. Introduction
Bengal gram (*Cicer arientimum* L.) is a multipurpose pulse crop and has a very important role in human diet in our country. Chickpea is grown in over 50 countries across the Indian subcontinent, North Africa, the Middle East, southern Europe, the Americas and Australia. Chickpeas contribute the single largest share in India's export basket of pulses registering 63.73% and 70.92% share in the total pulses export during 2016-17 and 2017-18 respectively. India produces about 83.65 lakh tones of chickpea contributing area of 89.28 lakh hectare in 2016-17 (dpd.gov.in/) Major Bengal gram producing states are Madhya Pradesh, Rajasthan, Uttar Pradesh, and Maharashtra. Rajasthan is the second largest gram producing state in the country. Mostly *desi chana* is cultivated in Rajasthan as a rain fed (Barani) crop. Bengal gram considered to be a good source of protein (8.86%), 60-65% moisture content, 27-28 % carbohydrates and other nutrients like fats, sugars *etc.* (Chibbar *et al.* 2010) [7]. Green chickpeas have a more flavourful taste than boiled or processed. Green chickpeas are high in fibre, folate, vitamin A & C, phytonutrients and naturally low in fat, saturated fat, cholesterol, sodium, promoting a healthy heart. In today's world of population explosion, the importance of food preservation hardly needs any emphasis. Green Bengal gram leads to changes in its color, taste, texture within few days and considered unacceptable for the consumers. By improving shelf life of the product it can be made available during off season (Brewer *et al.*, 1995) [5]. Storage under controlled atmosphere/modified atmosphere is known to extend the shelf life of fresh vegetables by retarding their physiological metabolism (Kader *et al.*, 1989) [15].

The scope of present study is to investigate the effect of packaging methods (Vacuum and Normal Packaging) and materials at different storage condition for enhancement of shelf life of green Bengal gram (Boast 1993) [4].

2. Raw Materials

Green Bengal gram (*var. Pratap Chana*) was procured from farm of MPUAT and pods were detached manually from plant. Damaged and under matured pods, plant material were discarded and the remaining uniform size pods were taken for the experimental purpose. The storage study was conducted at Bio-processing laboratory of AICRP on Post-Harvest Technology, Department of Processing and Food Engineering, College of Technology and Engineering, MPUAT, Udaipur. Preservation study of green Bengal gram pods were undertaken to enhance the keeping quality.

3. Material and Methods

The sample size of 100 g green Bengal gram pods was selected for the storage study. Samples of green Bengal gram pods were prepared using LDPE and HDPE packaging material as described in Table 1, packed with hot sealing (YESH SEAL, India) and vacuum packaging. The packed samples were stored under ambient, refrigerated and deep freeze (-18°C) conditions.

Table 1: Input package parameters

S. No.	Parameter	LDPE	HDPE
1	Length of package, m	0.185	0.184
2	Breadth of package, m	0.130	0.126
3	Thickness of film, µm	40.00	40.00

3.1 Quality evaluation of stored samples

Quality evaluation of samples during storage study was performed every day for control (kernels) samples, at an interval of sixth day for pods and at an interval of third day in case of treated kernels on the basis of quality parameters *viz.*, physiological loss in weight (PLW), per cent decay, Chroma, microbial load and sensory evaluation using standard methods and techniques**.**

3.2 Physiological loss in weight (PLW)

The PLW was calculated by methods suggested by Ranganna (2005) [19].

$$\text{PLW}(\%) = \frac{(\text{Intitial Weight} - \text{Final Weight})}{\text{Initial Weight}} \times 100$$

3.3 Microbial analysis

The microbial analysis was mainly done for the bacterial and fungal count (Harrigan, 1998) [13]. The colony forming units per millilitre (CFU/g) was calculated for plates yielding 30-300 colonies. The count was then round off to two significant digits to avoid fictitious precision and accuracy.

$$\text{CFU/g} = \frac{\text{Colonies Counted}}{\text{Actual volume of sample in dish (g)}}$$

3.4 Colour measurement

Colour is important to consumer as a mean of identification, as a method of judging quality and for its basic aesthetic value. Hunter L-value, which denotes the degree of whiteness, was chosen to represent the colour value of sample (Anantheswaran *et al*., 1986) [2]. The measured a* and b* values were converted into Chroma values, as follows

$$C = \sqrt{(a^{*2} + b^{*2})}$$

3.5 Sensory evaluation

The products were served for the evaluation to a ten panellists at a time. The score sheet was provided with product and panellists were requested to mark the product according to their liking. The average scores of all the panelists were computed. The independent sample t test was applied to compare between modified atmosphere packed storage Bengal gram kernels for various organoleptic characteristics. All sensory tests were performed on basis of organoleptic properties such as taste, odour and appearance. The visual properties (color appearance of the pod/kernels *i.e*. the first impression the consumer gets about the brightness, the size and the absence of damage) were judged under daylight. Nine points were awarded as like extremely-9, like very much-8, like moderately-7, like slightly-6, neither like nor dislike-5, dislike slightly-4, dislike moderately-3, dislike very much-2, dislike extremely-1.

3.6 Statistical analysis

The influence of storage period &conditions, packaging materials & methods and pre-treatments on different quality parameters *viz.* PLW, decay, Chroma, bacterial count, fungal count and overall acceptability were studied using Analysis of Variance (ANOVA) subjected to statistical analysis with Completely Randomized Design (CRD) as suggested by Gomez and Gomez (1984). The critical difference value at 5% level of probability was used for their comparison.

4. Results and Discussion

4.1 Physiological loss in weight (PLW)

The effect of different storage conditions and packaging material under vacuum packaging on physiological loss in weight (PLW) during 60 days storage has been presented in Fig 1. The PLW was found to increase gradually with increase in storage period for all samples but the intensity of the increment was observed much higher in samples stored at ambient condition. PLW of samples stored at refrigerator condition were 19.82 and 14.32% for HDPE and LDPE samples up to 54th day of storage. For sample stored at deep freezer the increase in PLW was found to be 15.00 and 13.32% for HDPE and LDPE respectively for 60th day of storage. These findings are in agreement with Reddy *et al.* (2013) [20] for *rajgira* leaves; Etukudo *et al.* (2015) [9] for sweet corn and Sandhu and Singh (2000) [21], Baszczyk and Ysiak (2001) [3], Calvo *et al.* (2002) [6] and Tijskens and Vollebregt (2003) [22] for pear fruit. It can be seen from fig 2 that PLW of samples stored in ambient condition were within safe (< 25%) limit up to the 12th day of storage study. The maximum PLW of samples stored at ambient condition was found to be 20.15% up to 12th day of storage. Samples stored

in deep freezer were found acceptable up to 2 months storage. During storage, the maximum PLW was recorded to be 15.00% in deep freezer and 20.80% in refrigerator up to 2 months storage.

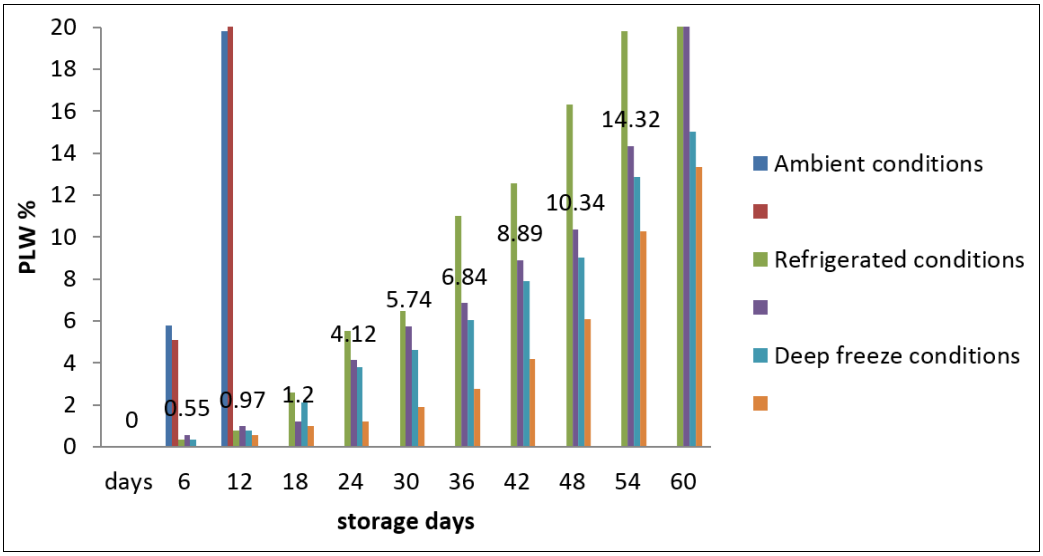

Fig 1: Physiological loss in weight (PLW) of Bengal gram pod stored in different condition.

4.2 Chroma

The Chroma for samples stored at refrigerator condition was 34.55 and 34.25 for HDPE and LDPE samples, respectively up to 54th day of storage from fig 3. For samples stored in deep freezer the increase in Chroma was found to be 26.63 and 25.12 for HDPE and LDPE, respectively, for 60th day of storage study from Fig. 2. These results are in agreement with Kim and Klieber (1997) [16] for paprika samples. The maximum chroma was found to be 25.78 and 34.65 for LDPE and HDPE samples, respectively. These results are in confirmation with Pilar *et al.* (2008) for straw berry and Eriksson *et al.* (2014) [8] for wheat flour. Similar observation was also reported by Weichmann (1986) [23] for control atmospheric storage of fresh fruits and vegetables and Zhou, Abe, and Iwata (1992) for pepper fruit.

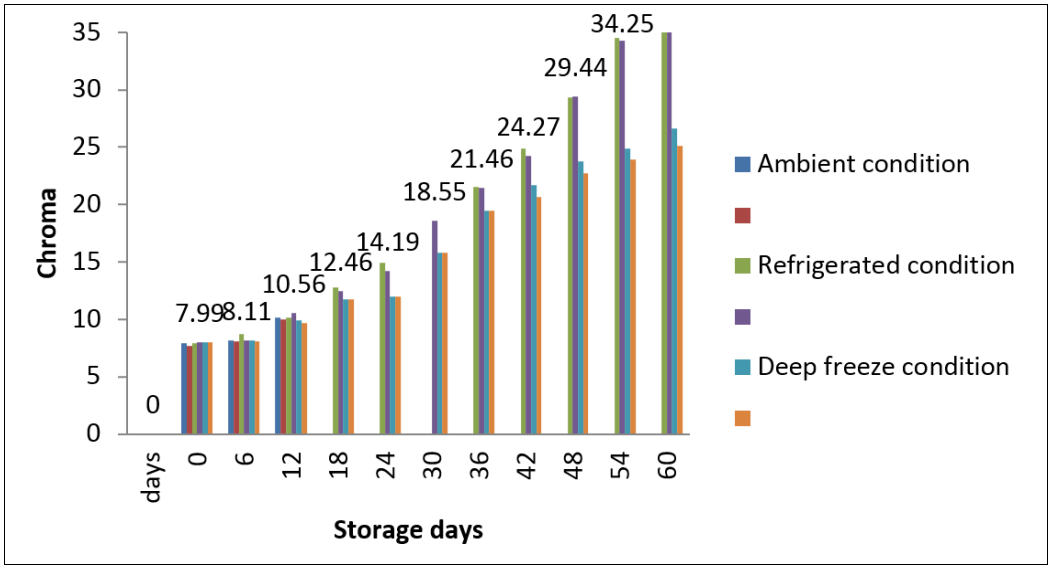

Fig 2: Chroma of Bengal gram pod stored in different temperature condition.

4.3 Microbial counts

The microbial counts reported in this study were well within the accepted „safe-to-consume" limits. The legal regulations on minimally processed fresh vegetables have been established at a maximum total limit for total plate count of 7.7 log10 CFU/g (Francis *et al*., 1999) [10].

4.4 Bacterial count

The bacterial count was found to increase gradually with increase in storage period. Bacterial count of all samples was found in acceptable limit (7 log cfu/g) and is similar result reported in ICMSF, 1986 for smoked fish. Bacterial count was acceptable up to 2 month for both refrigerator as well as deep freezer from fig. 3. These results are in agreement with Kim *et al.* (2001) [17] and Jiang *et al.* (2014) [14] who reported that bacterial multiplication was accelerated with the increase of the storage temperature. Gornik *et al.* (2011) [12] reported that temperature is the most crucial factor affecting microbial growth, microbial activity and spoilage potential during storage.

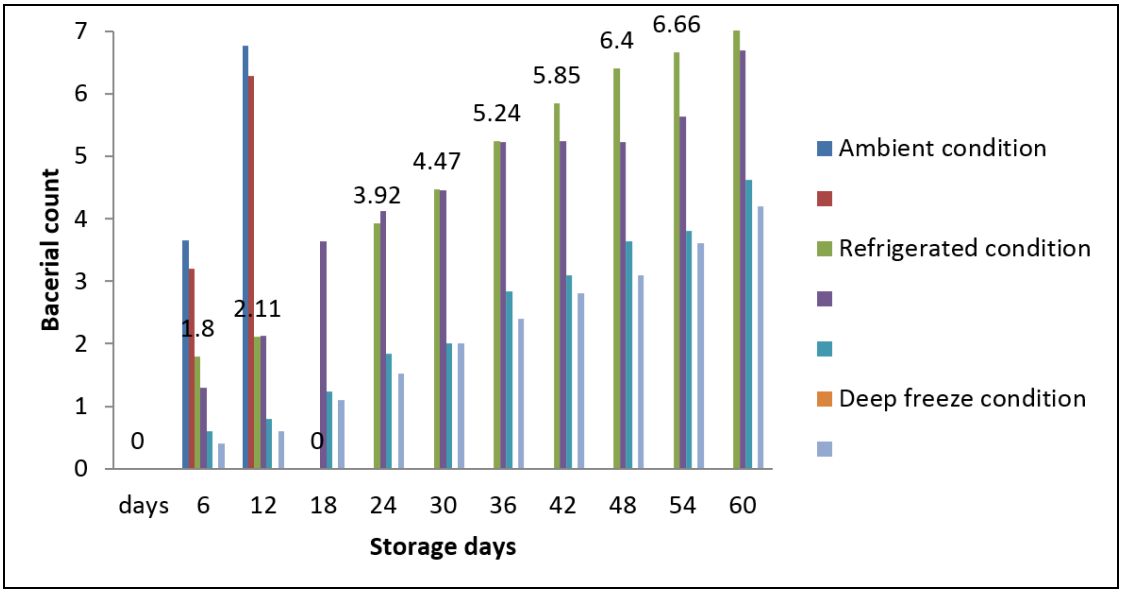

Fig 3: Bacterial count of Bengal gram pod stored in different temperature condition.

4.5 Fungal growth

The fungal count in samples stored at refrigerated condition was found to be 6.67 and 6.01 for the samples of HDPE and LDPE packaging materials up to 54th day of storage. For samples stored in deep freezer, the fungal count was found to be 5.67 and 5.01 for HDPE and LDPE, respectively for 60th day of storage study from fig. 4. The results are in agreement with the findings of Alabdulkarim *et al.* (2012) [1] for OGGTT dairy product who reported that product packed in LDPE was more acceptable for microbial load than HDPE during storage up to 40 days. The maximum fungal count was found to be 5.67 during 60 days of storage in deep freeze. Rachtanapun and Tangnonthaphat (2011) [18] also reported the similar results.

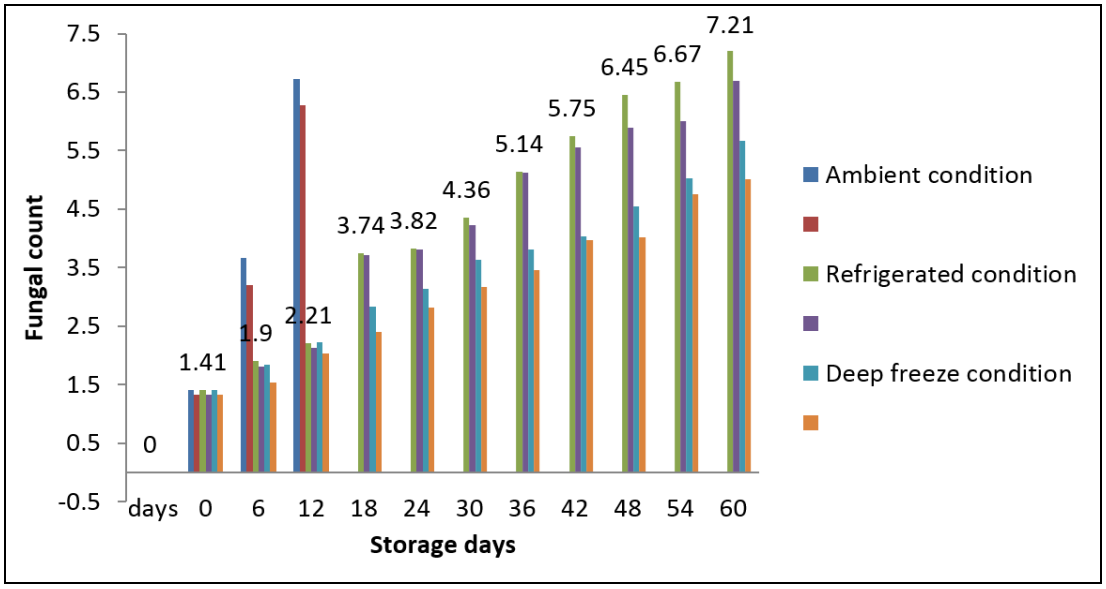

Fig 4: Fungal count of Bengal gram pod stored in different temperature condition.

4.6 Sensory evaluation

The overall acceptability scores were found to decrease gradually with increase in storage period for all samples but the intensity of the decrease was observed much higher for samples stored at ambient condition. The overall acceptability score of packed samples were same up to 6 days for both packaging material. During onwards storage after 6 days, the score of LDPE samples were higher than that of HDPE samples for all storage conditions. The samples stored in refrigerator as well as deer freezer were found to be acceptable (overall acceptability>>5) up to 48th day, however the overall acceptability score of deep freeze samples were higher than that of samples stored at refrigerator condition. The maximum OA score of 6.3 was found on 48th for LDPE samples for both refrigerated and deep freeze conditions from Fig. 5.

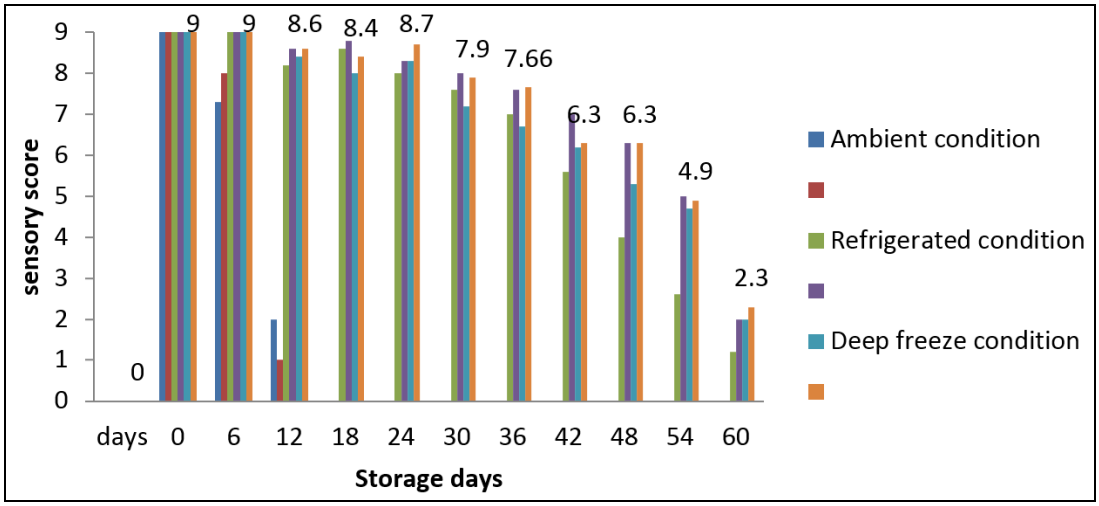

Fig 5: Sensory score of Bengal gram pod stored in different temperature condition.

4.7 Statistical analysis

The packaging material, storage condition and storage period had a significant effect over PLW, chroma, bacterial count, fungal count and OA at 99 per cent confidence level. Furthermore; that the interaction effect of all three variables namely (packaging material, storage condition and storage period) also had a significant effect over PLW, chroma, bacterial count, fungal count and OA at 99 per cent confidence level (Table 2 to 11). From table the best result can be obtained with LDPE packaging material, deep freeze storage condition and storage period of 6thday after which PLW increased gradually during increased storage period.

Table 2: CRD ANOVA of variables effect on Chroma for hot sealed GBG pods samples

S.N	Source	DF	SS	MS	F_{cal}	SE(m)	CD5%	CD1%
1.	Treat.	43	82386.412	1915.9631	6667.874**	0.309	0.870	1.153
2.	A	1	310.291	310.291	1079.866**	0.066	0.185	0.246
3.	B	1	10451.5	10451.5	36372.922**	0.066	0.185	0.246
4.	C	10	29514.3	2951.43	10271.464**	0.155	0.435	0.576
5.	AxB	1	85.2465	85.2465	296.672**	0.093	0.262	0.348
6.	AxC	10	10501.7	1050.17	3654.781**	0.219	0.615	0.815
7.	BxC	10	20599.7	2059.97	7169.058**	0.219	0.615	0.815
8.	AxBxC	10	10923.6	1092.36	3801.608**	0.309	0.870	1.153
9.	Error	88	25.2861	0.287342				

A-Packaging material, B- storage condition, C- storage periods *,** Significant at 5% and 1% respectively. GM = 15.748; CV = 3.40

Table 3: CRD ANOVA of variables effect on Chroma for vacuum packed GBG pods samples

S.N	Source	DF	SS	MS	F	SE(m)	CD5%	CD1%
1.	Treat.	43	97007.262	2255.9828	4450.199**	0.411	1.155	1.531
2.	A	1	1309.91	1309.91	2583.953**	0.088	0.246	0.326
3.	B	1	17593.5	17593.5	34705.249**	0.088	0.246	0.326
4.	C	10	47799.9	4779.99	9429.103**	0.206	0.578	0.765
5.	AxB	1	828.424	828.424	1634.166**	0.124	0.348	0.462
6.	AxC	10	1067.01	106.701	210.481**	0.291	0.817	1.083
7.	BxC	10	26334.7	2633.47	5194.828**	0.291	0.817	1.083
8.	AxBxC	10	2073.92	207.392	409.105**	0.411	1.155	1.531
9.	Error	88	44.6107	0.50694				

A-Packaging material, B- storage condition, C- storage periods *, ** Significant at 5% and 1% respectively. GM = 15.748; CV = 3.40

Table 4: CRD ANOVA analyzing variables effect on PLW of GBG pods for hot sealed samples

S.N	Source	DF	SS	MS	F_{cal}	SE (m)	CD5%	CD1%
1.	Treat.	43	4212.8698	97.973717	4773.147**	0.083	0.232	0.308
2.	A	1	3.86529	3.86529	188.311**	0.018	0.050	0.066
3.	B	1	15.0343	15.0343	732.449**	0.018	0.050	0.066
4.	C	10	2453.52	245.352	11953.207**	0.041	0.116	0.154
5.	AxB	1	4.20082	4.20082	204.658**	0.025	0.070	0.093
6.	AxC	10	409.969	40.9969	1997.312**	0.058	0.164	0.218
7.	BxC	10	1020.22	102.022	4970.355**	0.058	0.164	0.218
8.	AxBxC	10	306.066	30.6066	1491.114**	0.083	0.232	0.308
9.	Error	88	1.80629	0.020526				

A-Packaging material, B- storage condition, C- storage periods *, ** Significant at 5% and 1% respectively. GM = 6.749; CV = 2.12

Table 5: CRD ANOVA of variables effect on bacterial count for hot sealed GBG pods samples

S.N	Source	DF	SS	MS	F_{cal}	SE(m)	CD5%	CD1%
1.	Treat.	43	707.91198	16.463069	4234.543**	0.036	0.101	0.134
2.	A	1	0.565265	0.565265	145.395**	0.008	0.022	0.029
3.	B	1	27.3291	27.3291	7029.451**	0.008	0.022	0.029
4.	C	10	405.102	40.5102	10419.816**	0.018	0.051	0.067
5.	AxB	1	3.13421	3.13421	806.165**	0.011	0.031	0.040
6.	AxC	10	36.3606	3.63606	935.249**	0.025	0.072	0.095
7.	BxC	10	189.735	18.9735	4880.270**	0.025	0.072	0.095
8.	AxBxC	10	45.6855	4.56855	1175.099**	0.036	0.101	0.134
9.	Error	88	0.342127	0.0038878				

A-Packaging material, B- storage condition, C- storage periods *,** Significant at 5% and 1% respectively.GM = 3.097; CV = 2.01

Table 6: CRD ANOVA of variables effect on bacterial count for vacuum packed GBG pods

S.N	Source	DF	SS	MS	F_{cal}	SE(m)	CD5%	CD1%
1.	Treat.	43	529.99151	12.325384	1672.414**	0.050	0.139	0.185
2.	A	1	1.69275	1.69275	229.687**	0.011	0.030	0.039
3.	B	1	135.852	135.852	18433.521**	0.011	0.030	0.039
4.	C	10	365.645	36.5645	4961.388**	0.025	0.070	0.092
5.	AxB	1	0.284673	0.284673	38.627**	0.015	0.042	0.056
6.	AxC	10	2.91824	0.291824	39.597**	0.035	0.098	0.131
7.	BxC	10	21.9634	2.19634	298.019**	0.035	0.098	0.131
8.	AxBxC	10	1.63543	0.163543	22.191**	0.050	0.139	0.185
9.	Error	88	0.648544	0.00736982				

A-Packaging material, B- storage condition, C- storage periods *,** Significant at 5% and 1% respectively. GM = 15.748; CV = 3.40

Table 7: CRD ANOVA of variables effect on fungal count for hot sealed GBG pods samples

S.N	Source	DF	SS	MS	F_{cal}	SE(m)	CD5%	CD1%
1.	Treat.	43	707.91198	16.463069	4234.543**	0.036	0.101	0.134
2.	A	1	0.565265	0.565265	145.395**	0.008	0.022	0.029
3.	B	1	27.3291	27.3291	7029.451**	0.008	0.022	0.029
4.	C	10	405.102	40.5102	10419.816**	0.018	0.051	0.067
5.	AxB	1	3.13421	3.13421	806.165**	0.011	0.031	0.040
6.	AxC	10	36.3606	3.63606	935.249**	0.025	0.072	0.095
7.	BxC	10	189.735	18.9735	4880.270**	0.025	0.072	0.095
8.	AxBxC	10	45.6855	4.56855	1175.099**	0.036	0.101	0.134
9.	Error	88	0.342127	0.0038878				

A-Packaging material, B- storage condition, C- storage periods *, ** Significant at 5% and 1% respectively. GM = 3.097; CV = 2.01

Table 8: CRD ANOVA of variables effect on fungal count for vacuum packed GBG pods

S.N	Source	DF	SS	MS	F	SE(m)	CD5%	CD1%
1.	Treat.	43	359.36132	8.3572399	944.158**	0.054	0.153	0.202
2.	A	1	2.38146	2.38146	269.045**	0.012	0.033	0.043
3.	B	1	33.8778	33.8778	3827.334**	0.012	0.033	0.043
4.	C	10	307.307	30.7307	3471.795**	0.027	0.076	0.101
5.	AxB	1	0.146267	0.146267	16.524**	0.016	0.046	0.061
6.	AxC	10	1.01058	0.101058	11.417**	0.038	0.108	0.143
7.	BxC	10	14.1478	1.41478	159.835**	0.038	0.108	0.143
8.	AxBxC	10	0.490427	0.0490427	5.541**	0.054	0.153	0.202
9.	Error	88	0.778935	0.00885153				

A-Packaging material, B- storage condition, C- storage periods *, ** Significant at 5% and 1% respectively. GM = 3.761; CV = 1.81

Table 9: CRD ANOVA of variables effect on overall acceptability for hot sealed GBG pods

S.N	Source	DF	SS	MS	F	SE (m)	CD5%	CD1%
1.	Treat.	43	958.49033	22.290473	1832.140**	0.064	0.179	0.237
2.	A	1	8.83295	8.83295	726.014**	0.014	0.038	0.051
3.	B	1	10.8957	10.8957	895.558**	0.014	0.038	0.051
4.	C	10	882.625	88.2625	7254.640**	0.032	0.089	0.119
5.	AxB	1	7.43328	7.43328	610.970**	0.019	0.054	0.072
6.	AxC	10	15.4838	1.54838	127.268**	0.045	0.127	0.168
7.	BxC	10	22.9567	2.29567	188.690**	0.045	0.127	0.168
8.	AxBxC	10	10.2626	1.02626	84.352**	0.064	0.179	0.237
9.	Error	88	1.07064	0.0121664				

A-Packaging material, B- storage condition, C- storage periods *,** Significant at 5% and 1% respectively. GM = 6.136; CV = 1.80

Table 10: CRD ANOVA of variables effect on OA for vacuum packed GBG pods

S.N	Source	DF	SS	MS	F	SE(m)	CD5%	CD1%
1.	Treat.	43	642.18902	14.934628	590.312**	0.092	0.258	0.342
2.	A	1	11.6216	11.6216	459.361**	0.020	0.055	0.073
3.	B	1	0.814202	0.814202	32.183**	0.020	0.055	0.073
4.	C	10	609.575	60.9575	2409.433**	0.046	0.129	0.171
5.	AxB	1	1.40678	1.40678	55.605**	0.028	0.078	0.103
6.	AxC	10	7.84793	0.784793	31.020**	0.065	0.182	0.242
7.	BxC	10	5.74625	0.574625	22.713**	0.065	0.182	0.242
8.	AxBxC	10	5.17693	0.517693	20.463**	0.092	0.258	0.342
9.	Error	88	2.22636	0.0252995				

A- Packaging material, B- storage condition, C- storage periods *, ** Significant at 5% and 1% respectively. GM = 3.097; CV = 2.01

Table 11: CRD ANOVA of variables effect on PLW of vacuum packed GBG pods samples

S.N	Source	DF	SS	MS	F_{cal}	SE(m)	CD5%	CD1%
1.	Treat.	43	4801.2914	111.65794	2887.743**	0.114	0.319	0.423
2.	A	1	132.096	132.096	3416.320**	0.024	0.068	0.090
3.	B	1	303.673	303.673	7853.715**	0.024	0.068	0.090
4.	C	10	4061.62	406.162	10504.333**	0.057	0.160	0.211
5.	AxB	1	0.184128	0.184128	114.762**	0.034	0.196	0.127
6.	AxC	10	87.2283	8.72283	225.593**	0.080	0.226	0.299
7.	BxC	10	196.881	19.6881	509.182**	0.080	0.226	0.299
8.	AxBxC	10	19.606	1.9606	50.706**	0.114	0.319	0.423
9.	Error	88	3.40262	0.0386662				

A-Packaging material, B- Storage condition, C- Storage periods *, ** Significant at 5% and 1%, respectively. GM = 6.318; CV = 3.11

5. Conclusion

Preservation study of green Bengal gram pods was undertaken to establish the shelf life under different conditions. The sample size of 100 g was selected for green Bengal gram pods for conducting storage study. The maximum shelf life of pods in vacuum packed LDPE samples was found to be for deep freeze storage condition (PLW 13.32%, Chroma 25.12, bacterial count 4.20, fungal count 5.01 and overall acceptability 6) followed for refrigerated conditions (PLW 14.32 %, Chroma 34.55 bacterial count 5.22, fungal count 6.01 and overall acceptability 5.00) and 6 days for ambient condition (PLW 5.08, decay 37 %, Chroma 8.09, bacterial count 3.20, fungal count 3.20 and overall acceptability 8).

6. References

1. Alabdulkarim I, Garcia-Diaz L, Manas E, Saura-Calixto F. Analysis of oggtt dairy product: A method for foods and food products. Food Chem. 2012; 56:445-449.
2. Anantheswaran RC, Sastry SK, Beelman RB, Okereke A, Konanayakam M. Effect of processing on yield, colour and texture of canned mushrooms. Journal of Food Science. 1986; 51(5):1197-1200.
3. Baszczyk J, Ysiak G. Storage properties of Czech pear cultivars ‘Erica’ and ‘Dicolor’ J Fruit Ornam Plant Res. 2001; 9:71-76.
4. Boast MFG. Freezing operation. Food Technology and Nutrition. 1993; 8:2047-2060.
5. Brewer MS, Begum S, Bozeman A. Microwave and conventional blanching effects on chemical, sensory and color characteristics of frozen broccoli. Journal of Food Quality. 1995; 18(6):479-493.
6. Calvo G, Salvador ME, Sanchez E. Control of superficial scald in ‘Beurred’ 'Anjou' pears with low oxygen levels. Acta Horticulture. 2002; 596:879-882.
7. Chibbar RN, Ambigaipalan P, Hoover R. Molecular diversity in pulse seed starch and complex carbohydrates and its role in human nutrition and health. Cereal Chem. 2010; 87:342-352.
8. Eriksson M, Strid, Trip DI. Svinnreducerande åtgärder i butik - Effekter på kvantitet, ekonomi och klimatpåverkan [Waste reducing measures in supermarkets – Effects on quantity, 77 economy and greenhouse gas emissions], Report 6594, Swedish Environmental Protection Agency, Stockholm, 2014.
9. Etukudo OO, Babatola LA, Ojo OD, Fagbola O. Effects of mycorrhiza, organo-mineral and NKP fertilizer on the performance and post-harvest quality of sweetcorn. Journal of horticulture and foresty. 2015; 7(4):99-103.
10. Francis GA, Beirne OD. Effects of vegetable type and antimicrobial dipping on survival and growth of Listeria innocuaand E. coli. International Journal of Food Science and Technology. 1999; 37(6):711.
11. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 ed.). John wiley and sons, New York, 1984, 680.
12. Gornik SG, Albalat A, Macpherson H, Birkbeck H, Neil DM. The effect of temperature on the bacterial load and microbial composition in Norway lobster (Nephrops norvegicus) tail meat during storage. Journal of Applied Microbiology, 2011. ISSN 1364-5072.
13. Harrigan WF. Laboratory Methods in Food and Dairy Microbiology, Revised edn. Academic Press, London, New York San Francisco. Influence of Different Filling, Cooling, and Storage Conditions on the Growth of Alicyclobacillus acidoterrestris CRA7152 in Orange Juice Ana Cláudia N. F. Spinelli, Anderson S. Sant'Ana, Salatir Rodrigues-Junior, Pilar R. Massaguer, 1998. DOI: 10.1128/AEM.01400-09
14. Jiang T, Zheng X, Li J, Jing G, Cai L, Ying T. Integrated application of nitric oxide and modified atmosphere packaging o improve quality of retention of button mushroom (*Agaricus bisporus*). Food Chem. 2014; 126:1693-1699.
15. Kader AA, Zagory D, Kerbel EL. Modified Atmosphere Packaging of Fruits and Vegetables, Crit. Rev. Food Sci. Nutr. 1989; 28(1):1-30.
16. Kim KW, Kliebe SI. Antimicrobial activity against foodborne pathogens of chitosan biopolymer films of

different molecular weights. LWT – Food Sci. Technol. 1997; 44:565-569.
17. Kim SH, Field KG, Chang DS, Wei CI, An H. Identification of bacteria crucial to histamine accumulation in Pacific mackerel during storage. J Food Prot. 2001; 64:1556-1564
18. Rachtanapun P, Tangnonthaphat T. Effects of Packaging Types and Storage Temperatures on the Shelf Life of Fresh Rice Noodles under Vacuum Conditions. Chiang Mai J Sci. 2011; 38(4):579-589.
19. Ranganna S. Catalase & peroxidase test. In: Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. New Delhi: Tata McGraw Hill E. Handbook of analysis and quality control for fruit and vegetable products. Second ed. Tata McGraw Hill Publ. Co., New Delhi, India, 2005, 223-225.
20. Reddy Jb, Pushpa Bharati K, Ramachandra Naik, Bharati Chimmad V, Sunanda Itagi K, Suma Hasalkar. Effect of packaging materials on shelflife of minimally processed rajagira leaves (Amaranthus paniculatus). Karnataka J Agric. Sci. 2013; 26(2):285-287.
21. Sandhu SS, Singh AP. Effect of harvesting dates and individual seal packaging on the pear fruit cv. Le Conte during cold storage. Haryana. J Hortic Sci. 2000; 29:48-52.
22. Tijskens LMM, Vollebregt HM. Passive and semi-active modified atmosphere packaging of prickly pear cactus stems (*Opuntis* spp.) Acta Hortic. 2003; 604:665-668.
23. Weichmann J. The effect of controlled-atmosphere storage on the sensory and nutritional quality of fruits and vegetables. Hort. Rev. 1986; 8:101-127.
24. Zhou R, Wata I. Quality and internal characteristics of Huanghua pear (*Pyrus pyrifolia* Nakai, cv. Huanghua) treated with different kinds of coatings during storage. Postharvest Biol. Technol. 1992; 49:171-179.