EFFECT OF PRETREATMENTS AND PACKAGING ON SHELF-LIFE OF PEELED GARLIC CLOVES

M. Dronachari, K.Venkatachalapathy and K.S.Rajashekarappa

Department of Agricultural Engineering University of Agricultural Sciences, Bangalore - 560 065, India.

ABSTRACT

A study on minimally processed garlic was carried out to study the effect of different packages on the keeping quality during refrigerated storage. Peeled garlic cloves pretreated with $CaCl_2$, gingelly oil and untreated garlic samples packed in LDPE and HDPE with 0.3% ventilation and without ventilation were stored at 10°C and 60-70% RH. A respiration rate of untreated garlic cloves was higher than pretreated garlic cloves. Colour values L*and a* values showed a decreasing trend, while b* showed an increasing trend. The firmness of garlic cloves decreased at a steady rate with the increase in duration of the refrigerated storage. The sprouting ratio and rooting score were higher in ventilated packages than unventilated packages. At the end of storage ascorbic acid content, pyruvic acid (pungency), oleoresin, protein decreased as storaged days increased, total soluble solids also increases as storage days increases. The shelf life of peeled garlic cloves pretreated with gingelly oil was enhanced from 18 to 42 days in the HDPE package without ventilation.

Key words: Peeled garlic, Minimal processing, Garlic cloves, Pretreatment, Packaging, Storage, Shelf-life.

INTRODUCTION

Garlic (*Allium sativum L.*) is the second most widely cultivated vegetable and allium used next to onion. It is being grown throughout the plains of India and used by large segment of population in various forms. Garlic pickle, powder, paste, flavour and flakes are a few value added products. Peeled garlic cloves are a convenient minimally processed vegetable and volumes have increased in retail and food service markets (Cantwell and Suslow, 2002).

Surface discolouration, moisture loss, and microbial spoilage contribute to loss of shelf life and quality in peeled cloves (Kang and Lee, 1999). Other important causes of quality loss are sprouting and rooting which occur because of high humidity conditions in plastic packaging and because of storage at higher than recommended 0-2°C (Cantwell and Suslow, 2002). Modified atmosphere containing high $C0_2$ (15-25%) concentrations reduce sprout development but are less effective

in controlling adventitious rooting under higher humidity conditions (Kang and Lee, 1999).

The major objective of this investigation was to study pretreatments and packaging of minimally processed peeled garlic cloves for short-term preservation and to study the changes of gas composition, colour, texture, sprouting ratio and rooting score during storage.

MATERIAL AND METHODS

The investigation was carried out on uniform sized, white colour garlic bulbs procured from the vegetable market, Bangalore. A study on minimally processed peeled garlic clove was undertaken to evaluate the effect of packaging material [LDPE and HDPE bags of 200 gauge measuring $15 \times 10 \text{ cm}^2$] with ventilation (0.3%) and without ventilation and pretreated individually with calcium chloride(2%), gingelly oil and untreated samples on the shelf-life under refrigerated storage (10°C) and 60-70% RH.

E-mail:-dron0321@gmail.com,

A modified atmosphere was created naturally in the sealed packing. The measurement of the O_2 uptake and CO_2 production in the headspace of the packages with an $O_2 - CO_2$ analyzer (PBI Dansensor A/S Check Mate Denmark-9900). The headspace gas composition was recorded daily and expressed as per cent O_2 and per cent CO_2 directly from the instrument screen. The firmness of peeled garlic cloves was evaluated by performing a puncture test on the cloves using a Texture Analyzer (Stable Micro Systems, UK) with a 50 kg load cell, equipped with a rounded 2 mm diameter. Steel Probe. The colour measurements were made using the colorimeter CR-200b (Minolta Chroma Instrument, Osaka, Japan).

The biochemical parameters were monitored at the end of shelf life of peeled garlic cloves under refrigerated condition as per procedure given by Ranganna (1986). For estimation of oleoresin by using solvent extraction method and pyruvic acid (pungency) content using DNPH method was estimated by the spectrophotometric measurement. The sprouting ratio and rooting score were measured by visual observation, while sensory evaluation was carried out to differentiate between the colour, aroma, texture and overall acceptability of minimally processed peeled garlic cloves treated with different packages. The5-point 'Hedonic scale' was employed (Amerine *etal.*, 1965).

RESULTS AND DISCUSSION

The gas composition was virtually same for all the treatments on 0th day of storage. In CaCl₂ pretreated 200 gauge LDPE and HDPE package (Table 1.1 and Table 1.2), 200 gauge LDPE packing showed maximum CO₂ content (3.6 per cent) than 200 gauge HDPE packing (2.1 per cent). In case of gingelly oil pretreated, samples T_8 showed higher CO_2 (6.73 per cent) than T_{10} (4.9 per cent), respectively. In case of untreated garlic T_{12} showed maximum CO_2 (1.83 per cent) than T_{14} (1.80 per cent) respectively. The change in temperature affected the rate of respiration and the equilibrium conditions within the package (Kader et al., 1989). Hence storing under refrigerated condition helped to enhance the shelf life of garlic.

The research results indicated that colour values L*and a* values showed a decreasing trend, while b* showed an increasing trend during

refrigerated condition. Colour of the garlic was found to be white. The effect of different pretreatments and packages on colour variation of peeled garlic was studied which is shown in Fig.1.1, 1.2, and 1.3. The treatment T_5 (82.2) and T_{14} (83.2) showed the maximum values of L* coordinates which were closely related to fresh cloves (83.9). The CaCl₂ pretreatment found to gave excellent white colour to the garlic.

During modified atmosphere storage of peeled garlic, the changes in penetrating force in cloves by using texture analyser were also compared as shown in Fig 1.4, 1.5, and 1.6. The peak force was observed to be 735.0, 736.0 and 663.0 g for CaCl₂ pretreatment (T_5), gingelly oil pretreatment (T_{10}) and untreated samples (T_{14}) respectively. Modified atmosphere packaging significantly slow down the softening of peeled garlic during storage which was considered to be the minimum for commercial acceptability. Hence (T_5) CaCl₂ and (T_{10}) gingelly oil pretreatment helped in maintaining the texture.

The sprouting ratio and rooting score of peeled garlic storage showed that minimum of 0.624 and 1.0 mm in CaCl₂ pretreatment (T_5), 0.6 and 1.0 mm in gingelly oil pretreated sample (T_{10}) and 0.9 and 1.0 mm in untreated samples (T_{14}) stored at refrigerated temperature as shown in Table 1.3. Hence, the pretreatments have been found to retard sprouting and rooting. Mechanical injuries in minimally processed products speed up the deterioration rate of fresh produce by disrupting membranes and increasing enzymatic activity which causes undesirable reactions to occur (Abdul Rahman et al., 2006). This may cause rooting, sprouting and browning which can render to reduction in shelf life and loss of quality of minimally processed peeled garlic.

Bio-chemical analysis

At the end of the storage studies, the biochemical properties such as total soluble solids, titrable acidity, ascorbic acid content, protein, oleoresin and pyruvic acid (pungency) were evaluated to see the best treatment that enhanced the shelf-life of peeled garlic cloves retaining its quality. Ascorbic acid content, pyruvic acid, oleoresin, protein decreased as storage days increased, total soluble solids also increased as storage days increased. The initial values of fresh and control of different pretreatments and packages on quality parameters of stored peeled garlic cloves are presented in Tables 1.4.

i) Ascorbic acid

The ascorbic acid content of peeled garlic cloves during storage was maximum (11.03 mg/100 g) in CaCl₂ pretreatment (T_5), followed by 8.29 mg/100 g in gingelly oil pretreatment (T_{10}) and 8.06 mg/100 g in untreated sample (T_{14}).

ii) Pyruvic acid content

The pyruvic acid content (pungency) of peeled garlic during storage showed a maximum value of 121.3 mg/100 g in CaCl₂ pretreatment (T_5), followed by 124.1 mg/100 g in gingelly oil pretreatment (T_{10}) and 96.70 mg/ 100 g in untreated treatment (T_{14}) at the end of shelf life.

iii) Protein estimation

Protein content in fresh peeled garlic cloves was 6.30 per cent. The protein content of peeled garlic during storage showed a maximum value of 5.58 per cent in $CaCl_2$ pretreatment (T_5), followed by 5.68 per cent in gingelly oil pretreatment (T_{10}) and 5.05 per cent in untreated samples (T_{14}) at the end of shelf life.

iv) Titrable acidity

In refrigerated storage conditions, titrable acidity of peeled garlic cloves was found to be slightly decreased with irrespective of packages and pretreatments.

v) Total soluble solids (TSS)

It was noticed that in case of fresh garlic peeled cloves, the extent of TSS was 32.1° Brix, and for control, it was 52° Brix. It was observed that TSS of peeled garlic increased as storage duration increased.

vi) Oleoresin

Garlic oleoresin is a dark viscous liquid, having 12 times the flavor of that of fresh garlic cloves. It is observed that the Oleoresin content decreased with significantly among various treatments. The fresh peeled garlic showed 1.94 per cent oleoresin while in control garlic cloves, it was 0.26 per cent.

CONCLUSION

Among treated samples, gingelly + HDPE package without ventilation was found to be best treatment with regard to all sensory and quality parameters. The final finding is that gingelly oil treatment with HDPE packing not only helps in maintaining good quality but also enhanced the shelf life to 42 days. In CaCl₂

Table 1.1: Gas composition (per cent O₂) in LDPE and HDPE bags peeled garlic stored under refrigerated condition.

Treatments				Day				
	6 th	12^{th}	18^{th}	24 th	30 th	36 th	42 nd	
T_1	-	-	-	-	-	-	-	
T ₂	-	-	-	-	-	-	-	
T ₃	19.4	18.4	17.2	14.2	14.4	-	-	
T ₄	-	-	-	-	-	-	-	
T_5	19.6	18.6	16.2	15.7	15.9	-	-	
T ₆	-	-	-	-	-	-	-	
T ₇	-	-	-	-	-	-	-	
T ₈	20.1	19.3	19.6	19.7	16.7	14.2	14.4	
T ₉	-	-	-	-	-	-	-	
T_{10}	20.2	19.7	19.6	18.8	16.9	15.1	15.4	
T ₁₁	-	-	-	-	-	-	-	
T ₁₂	19.3	17.5	17.4	-	-	-	-	
T ₁₃	-	-	-	-	-	-	-	
T ₁₄	18.9	17.6	17.4	-	-	-	-	
Mean	8.39	7.93	7.67	4.88	4.56	2.09	2.12	
F-test	*	*	*	*	*	*	*	
SE	0.14	0.27	0.19	0.05	0.22	0.02	0.03	
CD	0.41	0.56	0.56	0.14	0.65	0.078	0.10	

Treatment	Day						
	6 th	12^{th}	18^{th}	24 th	30 th	36 th	42 th
T_1	-	-	-	-	-	-	-
T_2	-	-	-	-	-	-	-
T ₃	0.73	1.33	2.30	3.30	3.60	-	-
T_4	-	-	-	-	-	-	-
T_5	0.40	1.33	1.80	1.93	1.86	-	-
T_6	-	-	-	-	-	-	-
T ₇	-	-	-	-	-	-	-
T ₈	0.23	0.53	0.90	1.20	4.50	6.63	6.73
T ₉	-	-	-	-	-	-	-
T ₁₀	0.23	0.66	0.50	1.10	3.20	4.46	4.93
T ₁₁	-	-	-	-	-	-	-
T ₁₂	0.63	1.63	1.83	-	-	-	-
T ₁₃	-	-	-	-	-	-	-
T ₁₄	0.70	1.80	1.80	-	-	-	-
Mean	0.21	0.52	0.65	0.54	0.94	0.79	0.83
F-test	*	*	*	*	*	*	*
SE	0.068	0.083	0.065	0.052	0.18	0.081	0.051
CD	0.198	0.241	0.189	0.149	0.52	0.234	0.147

Table 1.2: Gas Composition (per cent CO₂) in LDPE and HDPE bags peeled garlic stored under refrigerated condition.

Table 1.3 : Effect of different pretreatments on sprouting ratio and rooting of peeled garlic in LDPE and HDPE packages during refrigerated storage condition

Treatment	18 th day		30 th	day	42 th (42 th day	
	Sprouting	Rooting	Sprouting	Rooting	Sprouting	Rooting	
	Ratio	(mm)	Ratio	(mm)	ratio	(mm)	
T_1	-	-	2.83	2.0	-	-	
T_2	-	-	2.45	3.81	-	-	
T ₃	-	-	1.66	2.21	-	-	
T_4	-	-	1.18	3.66	-	-	
T ₅	-	-	0.62	1.00	-	-	
T ₆	-	-	-	-	1.22	1.00	
T ₇	-	-	-	-	1.71	3.20	
T ₈	-	-	-	-	1.20	2.00	
T ₉	-	-	-	-	1.61	3.00	
T ₁₀	-	-	-	-	0.60	1.00	
T ₁₁	2.80	3.47	-	-	-	-	
T ₁₂	1.57	2.75	-	-	-	-	
T ₁₃	2.22	2.70	-	-	-	-	
T ₁₄	0.90	1.00	-	-	-	-	
Control	2.92	1.16	-	-	-	-	
Mean	0.694	0.738	0.582	0.845	0.442	0.667	
F-test	*	*	*	*	*	*	
SE	0.225	0.133	0.033	0.272	0.029	0.149	
CD	0.642	0.380	0.092	0.786	0.086	0.430	



Fig 1.1: Effect of CaCl₂ pretreatment on the colour of Peeled garlic cloves stored at 10°C



Fig 1.3: Effect of Untreated peeled garlic cloves on the colour, stored at 10° C.



Fig 1.5: Effect of gingelly oil pretreatments on Fig 1.6: Effect of Untreated peeled garlic cloves on the texture of peeled garlic cloves stored 10°C.



Fig 1.2: Effect of gingelly oil pretreatment on the colour of Peeled garlic cloves stored at 10°C



Fig 1.4: Effect of CaCl₂ pretreatments on the texture of peeled garlic cloves stored at 10°C.



texture stored at 10° C.

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Treatment	TSS (⁰ Brix)	Ascorbic acid (mg/100 g)	Titratable acidity (%)	Oleoresin (%)	Protein (%)	Pyruvic acid (mg/100 g)
T_1	51.0	5.70	0.315	0.47	2.70	70.35
T_2	43.4	8.70	0.393	0.60	3.57	98.41
T_3	41.0	9.87	0.246	1.01	5.25	110.1
T_4°	40.8	9.05	0.393	0.71	4.25	98.83
T_5	38.6	11.03	0.295	1.13	5.58	121.3
T ₆	48.0	3.52	0.424	0.42	2.52	80.75
T_7	42.9	4.71	0.344	0.73	4.28	86.03
T ₈	39.0	7.05	0.321	1.22	4.55	115.0
T ₉	42.2	5.88	0.420	0.84	3.83	98.81
T ₁₀	37.9	8.29	0.333	1.32	5.68	124.1
T ₁₁	43.4	6.47	0.322	0.44	3.07	79.25
T ₁₂	41.0	7.58	0.274	0.62	4.37	92.53
T ₁₃	40.8	7.30	0.367	0.43	3.83	86.06
T ₁₄	38.0	8.06	0.318	1.09	5.05	96.70
Control	51.0	5.71	0.393	0.26	2.63	75.35
Fresh	32	13	0.6	1.94	6.30	145.3
Mean	41.93	7.62	0.36	0.82	4.21	98.67
F-test	*	*	*	*	*	*
SE	0.312	0.029	0.001	0.007	0.056	0.938
CD	0.901	0.085	0.005	0.022	0.164	2.70

Table 1.4 : Effect of different pretreatments on bio-chemical properties of peeled garlic in LDPE and HDPE packages, during refrigerated storage condition

pretreated samples, CaCl₂ + HDPE package untreated sample + HDPE packing without without ventilation was found to be better with ventilation was found to be better with regard regard to all the sensory and quality parameters to all the sensory and quality parameters studied. It had a shelf life of 30 days. In studied. It had a shelf life of 18 days.

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