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Improvement in keeping quality of pomegranate fruits during storage

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ABSTRACT

Pomegranate (*Punica granatum* L.) is an important fruit crop of arid and semi-arid regions of the world. Due to its exquisite fruit quality, enriched nutritional values and enormous medicinal usage, it has great demand in domestic and export market. Among the different varieties of pomegranate grown in India, Bhagwa has become the predominant commercial cultivar. The fruits of Bhagwa have bold red arils (edible portion), soft seeds, thick rind which is dark red with attractive shininess. However, loss of surface moisture leads to shrinkage and fading of gloss (brightness) which makes the fruits to become unattractive and fetch poor price apart from reducing its keeping quality. Lac formulations developed at ICAR-IINRG, Namkum, Ranchi are natural edible coatings that enhance the shelf life/keeping quality of fruits by acting as barrier for moisture exchange from fruit surface. With the objective of improving the keeping quality, fruits of pomegranate cv. Bhagwa were dipped in lac formulations. The outcome of the study revealed that lac formulation SH 2 was found to be superior compared to others. Lac formulation SH 2 when applied at 100% concentration was found most effective in improving the keeping quality of pomegranate fruits by 6.0 days under ambient conditions over the untreated control (16.7 days) by reducing the physiological loss in weight, enhancing the brightness (gloss), and increasing the brix acid ratio of the fruits.

Key words : Brix acid ratio, keeping quality, pomegranate, storage

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important fruit crop of arid and semi-arid regions of the world (Jalikop and Kumar, 2000; Pal *et al.,* 2014). It is a perennial shrub of 'Lythraceae' family (sub-family : punicoideae) with somatic chromosome number, 2n=2x=16 (Nath and Randhawa, 1959; Smith, 1976). During 2012-13, it is cultivated over 1.13 lakh ha with an annual production of 7.45 lakh tonnes and productivity of 6.6 t/ha in India (NHB, 2013). There are about 25 pomegranate cultivars which are commercially cultivated in different regions of India (Jadhav and Sharma, 2007). Among them, Bhagwa (also known as Kesar, Shendari, Ashtagandha, Mastani, Jai Maharashtra, Red Diana) has become the predominant commercial variety (Waskar *et al.,* 2003) with immense potential for export market occupying the largest area under cultivation. The fruits of pomegranate are botanically known as 'balusta' (modified berry) and the edible portion of pomegranate fruits is known as 'arils' (Babu *et al.,* 2011). The red colour of arils is due to anthocyanins having novel qualities of functional foods, often called as 'super fruits'. It contains no cholesterol or saturated fats and is a good source of vitamins, minerals and soluble and insoluble dietary fibre aiding in smooth digestion and bowel movements (Ladaniya, 2014). Arils provide 12% of daily value of vitamin C and 16% of daily value of vitamin-K (Pal and Babu, 2014). It is a 'non-climacteric fruit' which gets ripen in the plant itself and hence the fruits are harvested only after attaining maturity in the plant.

The fruits of Bhagwa have bold red arils (juicy sacs encasing the seeds–edible portion), soft seeds, thick rind which is dark red with attractive shininess. However, the glossiness of the fruits is lost during storage besides increased physiological loss in weight (PLW), shrinkage, etc. This ultimately brings down the

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shelf life of pomegranate fruits. Several edible coatings including waxes and oils, polysaccharides, chitosan, protein, etc. have been reported to enhance the shelf life of fruits (Mahavar *et al.,* 2012). Lac is a type of natural resin and its application paves the way for improvement of cosmetic appearance of fruits as it acts as 'gloss enhancers'. It has the property of forming films on a wide variety of surfaces with low molecular weight (Sarkar and Kumar, 2003). Hence, an experiment was conducted to improve the keeping quality of pomegranate fruits.

MATERIALS AND METHODS

The investigations were carried out at ICAR-NRC on Pomegranate, Solapur during the period 2011 and 2012. The mature fruits of pomegranate cultivar Bhagwa were harvested from the orchard during the morning time and shifted to laboratory. The fruits were sorted out and fruits of uniform size (about 300 g) were selected for the experiment. The flavourless aqueous, lac formulations developed by ICAR-Indian Institute of Natural Resins and Gums, Ranchi having FDA clearance for use as food additives with property to dry rapidly after application were used. The fruits were cleaned with a muslin cloth and they were dipped with these formulations. Three different formulations viz., SH 1, SH 2 and SH 3 in aqueous state were used for surface coating each at 50% and 100% concentrations. After coating, the fruits were dried under a fan at ambient condition. There were seven treatments including an untreated control. Each treatment was replicated thrice with 10 fruits/replication. The fruits were packed in corrugated fibre board (CFB) boxes with ventilation holes and kept at ambient conditions. Paper shredding was used as cushioning material at the bottom of the CFB boxes. Observations were recorded periodically at an interval of four days for different quantitative parameters and qualitative traits viz., weight loss due to physiological processes (PLW), shrivelling loss (%), glossiness score to assess the brightness loss, decay loss (%), total soluble solids (°Brix), titrable acidity (%), Brix acid ratio and shelf life (days). For working out PLW, initial and final fruit weight was taken at four days interval in an electronic balance and calculated as follows :

$$PLW\ (\%) = (IW-FW)/IW \times 100$$

Where,

PLW–Physiological loss in weight (%)
IW–Initial weight of fruit (g)
FW–Final weight of fruit (g)

Shrivelling of the fruits was determined based on visual observations i. e. the proportion of surface area showing shrinkage over the period of storage by visual method. Glossiness of fruits was estimated by visual method and scores were allotted based on the extent of shining (brightness) of rind. A score of 0-10 was assigned to the pomegranate fruits for assessing glossiness or brightness of fruits. Decay loss was worked out by counting the spoiled fruits (fruits having spoilage symptoms, rotting/decay) and the healthy (without spoilage) fruits and expressed as percentage.

Decay loss (%)=(No. of fruits with spoilage/total no. of fruits) x 100

Total soluble solids (TSS) content of the fruits was determined using a digital refractometer ('Atago'make, Japan) and expressed as °Brix. The titrable acidity was worked out by titrating the juice against 0.1N sodium hydroxide solution using phenolphthalein indicator and expressed as 'percentage' of citric acid (Ranganna, 1986). TSS/acid ratio was calculated by dividing the total soluble solids (TSS) content with titrable acidity. Shelf-life of the fruits was determined on the basis of duration to which the fruits retain the glossiness. The data were statistically analyzed as per the standard procedure (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Weight Loss

During storage, the pomegranate fruits witnessed a weight loss due to moisture loss and respiration. The physiological loss in weight (PLW) was found to increase throughout the storage period from 4 to 32 days after storage (Table 1). The PLW of pomegranate fruits ranged from 6.21 to 39.24% during the storage period. During storage period, the mean PLW was lowest (6.21%) on four days after storage and highest (39.24%) on 32 days after storage.

In general, PLW was higher in control

Table 1. The physiological loss in weight of pomegranate fruits during storage

Treatment	Physiological loss in weight (%)							
	4 DAS	8 DAS	12 DAS	16 DAS	20 DAS	24 DAS	28 DAS	32 DAS
Control	7.00	12.00	17.33	22.33	29.00	34.00	39.33	44.00
SH 1-50%	6.67	11.33	16.00	20.00	26.50	32.33	37.00	41.66
SH 1-100%	6.33	11.00	15.66	19.66	26.00	31.00	35.50	40.00
SH 2-50%	6.00	10.67	15.00	19.00	24.50	29.33	34.00	37.50
SH 2-100%	5.50	10.33	14.67	18.00	24.00	29.00	33.00	36.00
SH 3-50%	6.00	10.67	15.66	19.66	25.00	30.00	34.00	38.00
SH 3-100%	6.00	10.67	15.33	19.33	24.50	29.66	33.50	37.50
Mean	6.21	10.95	15.66	19.71	25.64	30.76	35.19	39.24
C. D. (P=0.05)	0.60	0.90	1.10	1.30	1.60	1.90	2.04	2.12

compared to the fruits dipped with lac formulations. Among the different lac formulations, SH 2 was found to be more effective followed by SH 3 and SH 1. On 32 DAS, the PLW was lowest (36.00%) in SH 2-100% which was followed by SH 2-50% and SH 3-100% (37.50%), whereas PLW was highest in control (44.00%). This clearly reveals the significant effect of SH 2-100% formulation in reducing the PLW during the storage period with 25.82°C mean temperature and 39.76% mean relative humidity. The check in PLW might be due to the property of lac based formulations in acting as barrier for exchange of moisture, etc. This is in corroboration with the findings of Babu *et al.* (2012) in pomegranate.

Shrivelling Loss

In general, the rind surface of freshly harvested pomegranate fruits is smooth without any shrivelling symptoms or shrinkage. But due to respiration and associated physiological processes, the moisture is lost from the fruits which paves the way for shrivelling of rind surface. The shrivelling (shrinkage) loss of pomegranate fruits dipped with lac formulations was found to increase with the progress of storage period (Fig. 1). The mean shrinkage loss ranged from 5.87 to 15.76% during the storage period. The shrinkage loss was the least (5.87%) on eight days after storage, whereas it was highest (15.76%) on 32 DAS. Among the different

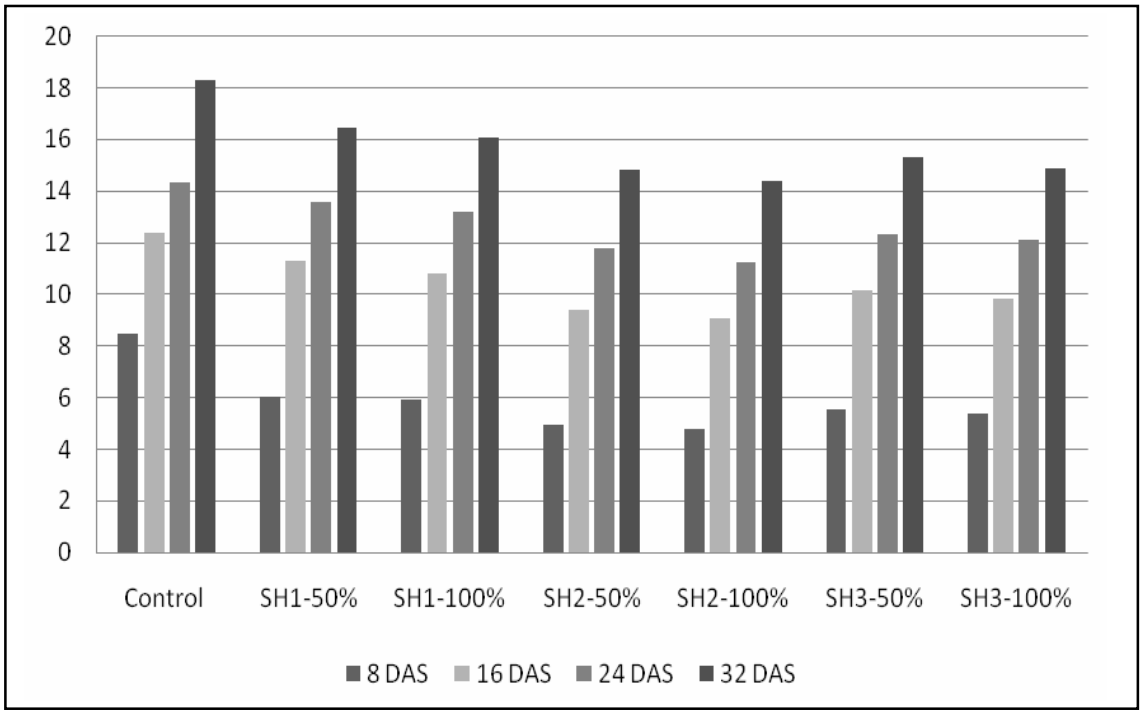

Fig.1. Shrivelling loss (%) of pomegranate fruits during storage.

formulations, the lowest (14.38%) shrivelling was recorded by SH 2-100%, whereas untreated control registered the highest shrivelling (15.76%). The reduction in shrivelling/ shrinkage might be attributed to the optimized gaseous and water vapour exchange between the lenticels of the fruits and the atmosphere due to surface coating of formulations. Similar results were reported by Bai *et al.* (2002) who studied the effect of coating materials in apple.

Brightness Loss

The fruits of pomegranate cv. Bhagwa have an attractive red colour rind besides appealing brightness/gloss on the rind surface that lures the customers. The brightness (Table 2) of pomegranate fruits dipped with lac formulations ranged from 1.00 to 8.71. The brightness/glossiness was highest on 0 DAS (8.71), whereas it was the least on 20 DAS (1.00). The glossiness index was good up to 8 DAS, whereas it was moderate on 12 DAS and poor on 16 DAS. But beyond 16 days, the glossiness of fruits was almost lost in control as well as some of the lac formulations. On 16 DAS (Fig. 2), highest index for glossiness was recorded by SH 2-100% (2.50), whereas it was the least in control (0.50). The property of coating materials to enhance the gloss and lustrous nature of fruits has been well documented in previous studies (Hagenmair and Baker, 1994; Hagenmair, 2002).

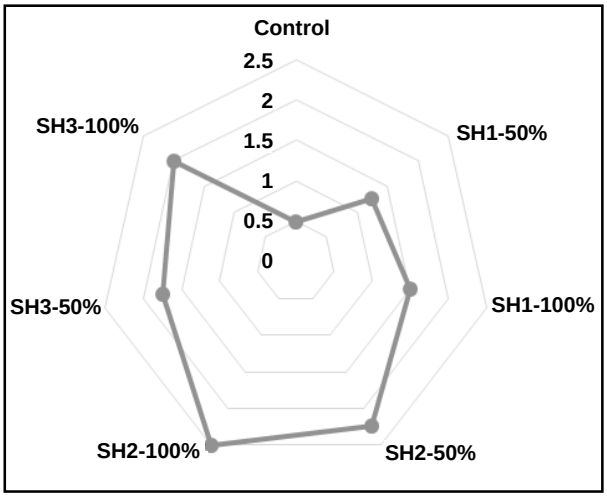

Fig. 2. Brightness (Glossiness) of pomegranate fruits on 16 days after storage.

Rotting Loss and Keeping Quality

The rotting/decay loss (Table 3) was determined by counting the fruits showing rotting and discarding them. There was no decay loss on 4 DAS from any of the treatments. The decay of fruits was noticed from 8 DAS onwards. The decay loss was found to range from 3.81 to 22.38%. The decay loss was lowest (3.81%) on 8 DAS, whereas it was highest (22.38%) on 32 DAS. On 32 DAS, the decay loss was found to vary from 16.67 to 26.67%. The decay loss was the lowest in SH 2-100% (16.67%) followed by SH 2-50% (20.00%). This is in conformity with the findings in citrus fruits

Table 2. The brightness (glossiness) score of pomegranate fruits during storage

Treatment	Brightness/glossiness* score					
	0 DAS	4 DAS	8 DAS	12 DAS	16 DAS	20 DAS
Control	6.00	4.50	3.00	1.50	0.50	0.25
SH 1-50%	9.00	6.75	4.75	3.00	1.25	0.50
SH 1-100%	9.00	7.00	5.00	3.25	1.50	0.75
SH 2-50%	9.00	7.50	5.75	4.00	2.25	1.50
SH 2-100%	9.50	8.00	6.00	4.25	2.50	1.75
SH 3-50%	9.00	7.25	5.25	3.50	1.75	1.00
SH 3-100%	9.50	7.50	5.50	3.75	2.00	1.25
Mean	8.71	6.93	5.38	3.32	1.68	1.00
C. D. (P=0.05)	0.82	0.79	0.75	0.69	0.63	0.38

*Score out of maximum value 10.

(McGuire and Dimitroglou, 1999; McGuire and Hagenmair, 2001).

The shelf-life (Fig. 3) of pomegranate fruits treated with lac based formulations ranged from 16.7 to 23.3 days. The shelf-life was highest (23.3 days) in SH 2-100% followed by SH 2-50% (22.7 days). The shelf-life was lowest in control (16.7 days). This might be attributed to the optimized gaseous and water vapour exchange between lenticels of the fruits and the atmosphere that delayed shrivelling. This is in corroboration with the findings of

Table 3. Rotting (decay) loss of pomegranate fruits during storage

Treatment	Rotting loss (%)						
	8 DAS	12 DAS	16 DAS	20 DAS	24 DAS	28 DAS	32 DAS
Control	6.66	8.00	10.00	15.00	20.00	23.33	26.67
SH 1-50%	3.33	6.67	10.00	13.33	16.67	21.33	23.33
SH 1-100%	3.33	6.67	10.00	15.00	20.00	21.67	25.00
SH 2-50%	3.33	6.33	10.00	13.33	16.67	16.67	20.00
SH 2-100%	3.33	5.00	6.67	10.00	13.33	15.00	16.67
SH 3-50%	3.33	5.33	6.67	12.00	16.67	20.00	23.33
SH 3-100%	3.33	6.66	10.00	13.33	16.67	18.33	20.00
Mean	3.81	6.38	9.05	13.14	17.14	19.48	22.38
C. D. (P=0.05)	0.30	0.38	0.45	0.69	0.90	1.45	1.92

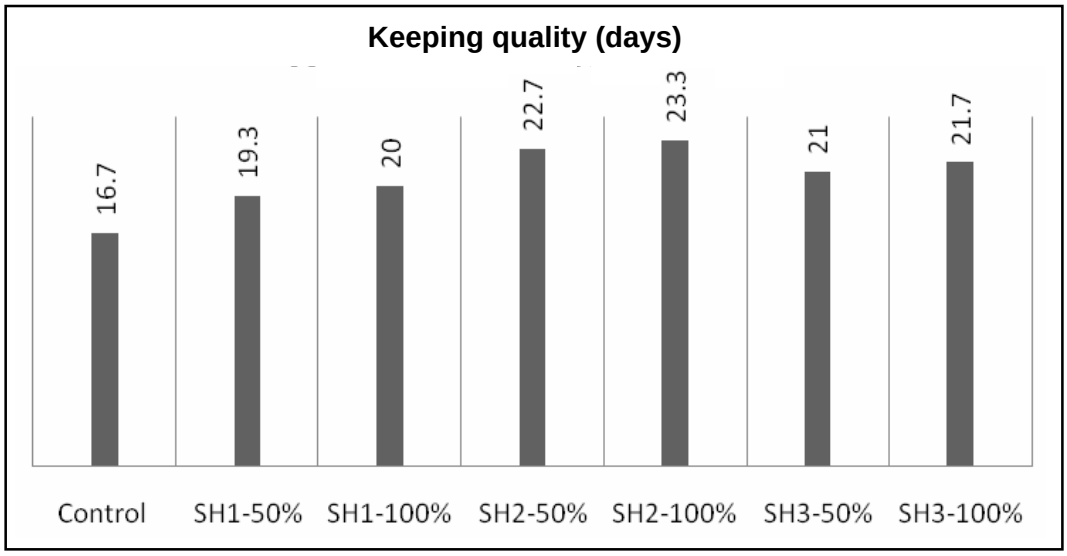

Fig. 3. Keeping quality (shelf life) of pomegranate fruits.

earlier reports in mango (Diaz-Sobac *et al.,* 1996) that surface coating extends the shelf-life of fruits.

Brix Acid Ratio

On the day of storage (0 DAS), quality traits viz., total soluble solids (TSS) content, titrable acidity (TA) and brix acid ratio (BAR) were observed to be 15.4°B, 0.51% and 30.20 in all the treatments and control. The TSS and brix acid ratio revealed slight increase with the advancement of storage period probably due to moisture loss from the fruits (Table 4). On 8 DAS, the TSS ranged from 15.5°B to 15.9°B and the acidity ranged from 0.50 to 0.51%. The brix acid ratio was lowest in control (30.39), whereas it was highest in SH 2-100% (31.80). Likewise, the brix acid ratio had a similar increasing trend throughout the period of storage i. e. (32 DAS). On 32 DAS (Table 5), the TSS was found to range from 16.0 to 17.0°B with highest TSS (17.0°B) recorded from SH 2-100%. The acidity was lowest (0.40%) in SH 2-100% and highest in control (0.44%). Brix acid ratio was found to be highest in SH 2-100% (42.50) followed by SH 2-50% (41.21), whereas it was lowest in control (36.36). Similar results were reported by Hagenmair and Shaw (2002).

Thus, it is concluded that surface coating of fruits of pomegranate cv. Bhagwa with lac formulation SH 2-100% enhanced the keeping quality of pomegranate by six days over the control by significantly reducing the PLW and shrivelling besides improving the glossiness of fruits. Among different lac formulations, SH 2 was found to be most effective for maintaining the post-harvest quality of the fruits of pomegranate cv. Bhagwa compared to SH 3 and SH 1.

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Table 4. Brix acid ratio (BAR) of pomegranate fruits during storage (4-16 DAS)

Treatment	4 DAS			8 DAS			12 DAS			16 DAS		
	TSS (°B)	TA (%)	BAR	TSS (°B)	TA (%)	BAR	TSS (°B)	TA (%)	BAR	TSS (°B)	TA (%)	BAR
Control	15.50	0.51	30.39	15.50	0.50	31.00	15.60	0.49	31.84	15.70	0.48	32.70
SH 1-50%	15.60	0.50	31.20	15.80	0.50	31.60	15.70	0.49	32.04	15.90	0.48	33.12
SH 1-100%	15.70	0.50	31.40	15.80	0.50	31.60	15.80	0.49	32.24	15.90	0.48	33.12
SH 2-50%	15.80	0.50	31.60	16.10	0.48	33.54	16.20	0.47	34.47	16.30	0.46	35.43
SH 2-100%	15.90	0.50	31.80	16.20	0.48	33.75	16.30	0.47	34.68	16.40	0.46	35.65
SH 3-50%	15.70	0.50	31.40	15.90	0.49	32.44	15.90	0.48	33.13	16.00	0.47	34.04
SH 3-100%	15.80	0.50	31.60	16.00	0.48	33.33	16.00	0.48	33.33	16.10	0.47	34.25
C. D. (P=0.05)	0.18	NS	0.54	0.30	NS	0.96	0.32	NS	1.08	0.32	NS	1.20

NS : Not Significant.

Table 5. Variation in brix acid ratio of pomegranate fruits during storage (20-32 DAS)

Treatment	20 DAS			24 DAS			28 DAS			32 DAS		
	TSS (°B)	TA (%)	BAR	TSS (°B)	TA (%)	BAR	TSS (°B)	TA (%)	BAR	TSS (°B)	TA (%)	BAR
Control	15.80	0.47	33.62	15.90	0.46	34.56	15.90	0.45	35.33	16.00	0.44	36.36
SH 1-50%	16.00	0.46	34.78	16.20	0.45	36.00	16.30	0.44	37.04	16.50	0.43	38.37
SH 1-100%	16.10	0.46	35.00	16.20	0.44	36.82	16.40	0.43	38.13	16.60	0.42	39.52
SH 2-50%	16.40	0.45	36.00	16.60	0.43	38.60	16.70	0.42	39.76	16.90	0.41	41.21
SH 2-100%	16.50	0.44	37.50	16.70	0.42	39.76	16.90	0.41	41.21	17.00	0.40	42.50
SH 3-50%	16.10	0.46	35.00	16.40	0.44	37.27	16.50	0.43	38.37	16.60	0.42	39.52
SH 3-100%	16.20	0.45	36.00	16.50	0.43	38.37	16.60	0.42	39.52	16.70	0.41	40.73
C. D. (P=0.05)	0.34	NS	1.24	0.36	NS	1.28	0.38	NS	1.30	0.40	NS	1.32

NS : Not Significant.

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