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Effect of surface coating with lac based formulations on postharvest quality of pomegranate (*Punica grantum* L.) fruits

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ABSTRACT: *Pomegranate (Punica grantum L.) is an important fruit crop of arid and semiarid regions of the world. Bhagwa is the predominant commercial cultivar of pomegranate with exquisite fruit quality and enormous demand both in domestic and export market. The fruits 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 which makes the fruits to become unattractive and fetch poor price apart from reducing its shelf-life. Lac based formulations developed at ICAR-IINRG, Namkum, Ranchi are natural edible coatings that enhance the shelf life of fruits by acting as barrier for moisture exchange from fruit surface. The present study was aimed at comparative evaluation of the efficacy of three different lac based formulations at two concentrations for retaining the post harvest quality of pomegranate cv. Bhagwa. Lac based formulation SH2 when applied as 100% concentration was found effective in increasing the shelf life of pomegranate fruits by 6.0 days over the control under ambient conditions.*

Key words: *Pomegranate, post-harvest, surface coating, lac formulations*

INTRODUCTION

Pomegranate (*Punica granatum* L.) is an important fruit crop of arid and semiarid regions of the world (Prasad and Bankar, 2003; 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 tonnes/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'. 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 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 kind 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 study the effect of lac

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formulations on the post harvest quality of pomegranate fruits.

MATERIALS AND METHODS

The experiment was conducted at ICAR-NRC on Pomegranate, Solapur during 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 300g) were selected for the experiment. Lac based flavourless aqueous formulations developed by ICAR-Indian Institute of Natural Resins and Gums, Namkum, 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 surface coated with lac based 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 at an interval of four days for different quantitative parameters and qualitative traits viz., Physiological Loss in Weight (%), shrinkage (%), glossiness, decay loss (%), total soluble solids (°B), titrable acidity (%), TSS/acid ratio and shelf life. For working out PLW, fruit weight was taken in an electronic balance and calculated as follows.

PLW (%) = (IW-FW) / IW x100

PLW - Physiological loss in weight (%)

IW - Initial weight of fruit (g)

FW - Final weight of fruit (g)

Shrinkage of the fruits was determined based on visual observations ie., the proportion of surface area showing shrinkage over the period of storage by visual method. Glossiness of the 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 glossiness. Decay loss was worked out by counting the spoiled fruits (fruits having spoilage, rotting / decay) and the healthy (without spoilage) fruits and expressing as percentage.

Decay Loss (%) = (No. of fruits with spoilage/ total no. of fruits) x100

Total Soluble Solids (TSS) content of the fruits was determined using a digital refractometer ('Atago' make, Japan) and expressed as ÚBrix (ÚB). 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

Physiological Loss in Weight (PLW)

The physiological loss in weight (PLW) was found to increase throughout the storage period from 8 to 32 days after storage (Fig. 1). The PLW of pomegranate fruits ranged from 10.95 to 39.24 per cent during the storage. During storage period, the mean PLW was lowest (10.95%) on 8 days after storage and highest (39.24%) on 32 days after storage.

In general, PLW was highest in control compared to the fruits surface coated with lac formulations. Among the different lac formulations, SH2 was found to be more effective followed by SH3 and SH1. On 32 DAS, the PLW was lowest (36.00%) in SH2-100% which was followed by SH2-50% & SH3-100% (37.50%) whereas PLW was highest in control (34.00%). This clearly reveals the significant effect of SH2-100% formulation in reducing the PLW during the storage period with 25.82 ÚC 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.

Shrinkage

The shrinkage loss of pomegranate fruits surface coated with lac formulations was found to increase with the progress of storage period (Fig. 2). The mean shrinkage loss ranged from 5.87 to 15.76%. The shrinkage loss was the least (5.87%) on 8 days after storage whereas it was highest (15.76%) on 32 days after storage. On 32 DAS, the shrinkage was least (14.38%) in SH2-100% whereas untreated control registered the highest shrinkage loss (15.76%). The reduction in 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. Similar results have been reported by Bai *et al.* (2002) who studied the effect of coating materials in apple.

Glossiness

The glossiness (Table 1) of pomegranate fruits surface coated with lac formulations ranged from 0.29 to 8.71. The glossiness was highest on 0 DAS (8.71) whereas it was the least on 24 DAS (0.29). The glossiness index was good upto 8 DAS whereas it was moderate-poor till 16 DAS. But, beyond 16 days, the glossiness of fruits was completely lost in control as well as some of the lac formulations. On 16 DAS (Fig. 3), highest index for glossiness was recorded by SH2-100% (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 have been well documented in previous studies (Hagenmair and Baker, 1994; Hagenmair, 2002).

Decay Loss and Shelf-life

The decay loss (Table 2) was determined by counting the fruits infected with rotting and discarding them. On 0 DAS, there was no decay loss from any of the treatments. The decay of fruits was noticed from 8 DAS onwards. The decay loss was found to range from 2.85% to 22.38%. The decay loss was lowest (2.85%) 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 the lowest in SH2-100% (16.67%) followed by SH2-50% (20.00%). This is in conformity with the findings in citrus fruits (McGuire and Dimitroglou,1999; McGuire and Hagenmair, 2001).

Table 1
Effect of lac based formulations on glossiness of pomegranate fruits

Treatment	*Glossiness**			
	0 DAS	*8 DAS*	*16 DAS*	*24 DAS*
Control	6.00	3.00	0.50	0.00
SH1-50%	9.00	4.75	1.25	0.00
SH1-100%	9.00	5.00	1.50	0.00
SH2-50%	9.00	5.75	2.25	0.50
SH2-100%	9.50	6.00	2.50	0.75
SH3-50%	9.00	5.25	1.75	0.25
SH3-100%	9.50	5.50	2.00	0.50
Mean	8.71	5.38	1.68	0.29
CD (5%)	0.62	0.75	0.63	0.12

*-Score out of maximum value 10

Table 2
Effect of lac based formulations on decay loss of pomegranate fruits

Treatment	*Decay loss (%)*			
	8 DAS	*16 DAS*	*24 DAS*	*32 DAS*
Control	6.66	10.00	20.00	26.67
SH1-50%	3.33	10.00	16.67	26.67
SH1-100%	3.33	10.00	20.00	23.33
SH2-50%	0.00	10.00	16.67	20.00
SH2-100%	0.00	6.67	13.33	16.67
SH3-50%	3.33	6.67	16.67	23.33
SH3-100%	3.33	10.0	16.67	20.00
Mean	2.85	9.05	17.14	22.38
CD (5%)	0.30	0.45	0.90	1.92

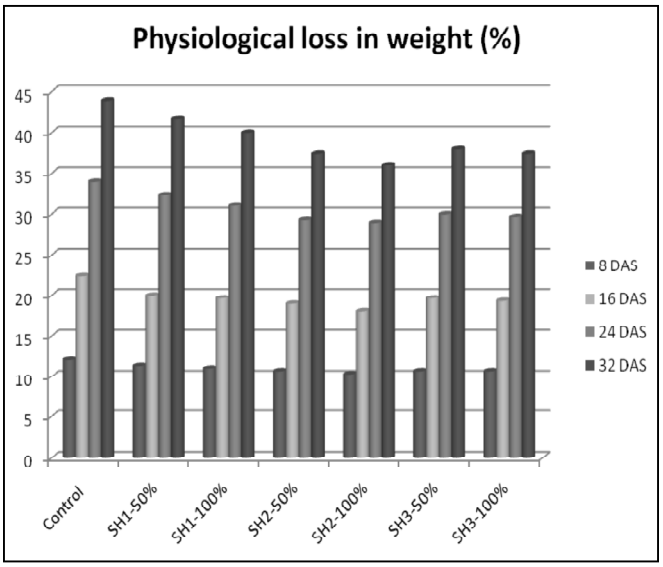

Figure 1: Physiological loss in weight (%) of pomegranate fruits treated with lac formulations

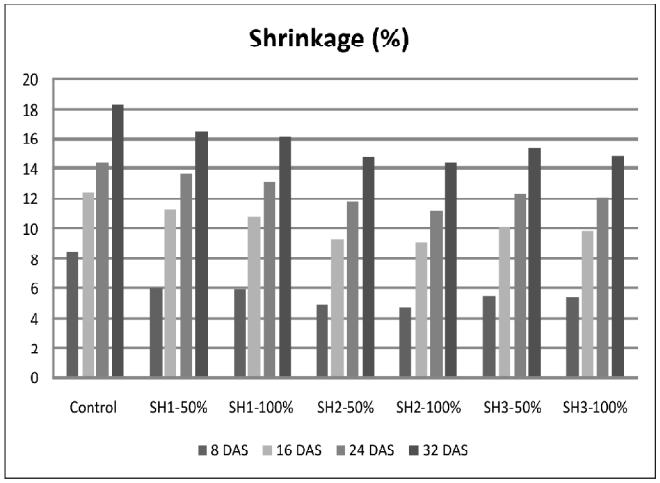

Figure 2: Shrinkage loss (%) of pomegranate fruits treated with lac formulations

The shelf-life (Fig. 4) 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 SH2-100% followed by SH2-50% (22.7days). 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 delays shriveling. This is in corroboration with the findings of earlier reports in pomegranate (Waskar and Kedkar, 1999**)** and mango **(**Diaz-Sobac *et al.*, 1996) that surface coating extends the shelf life of fruits.

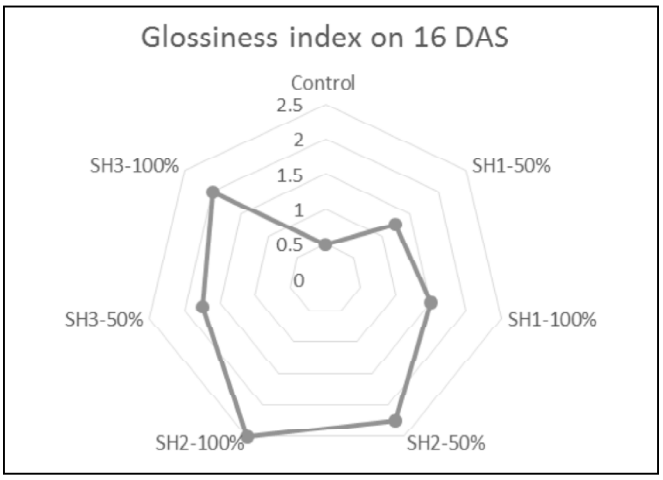

Figure 3: Glossiness of pomegranate fruits treated with lac formulations on 16 DAS

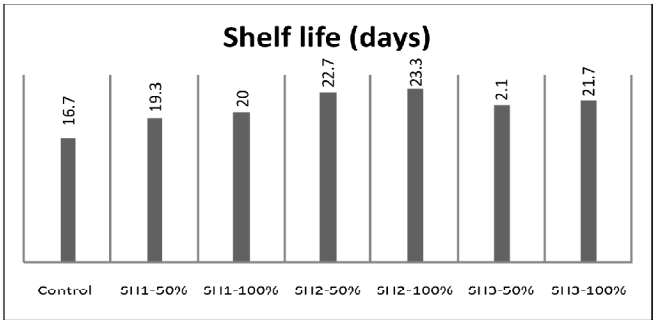

Figure 4: Shelf life of pomegranate fruits surface coated with lac formulations

Qualitative Traits

On the day of storage (0 DAS), quality traits viz., total soluble solids (TSS) content, titrable acidity and TSS/ acid ratio were observed to be 15.4ÚB, 0.51% and 30.20 in all the treatments and control. The TSS and TSS/ acid ratio revealed slight increase with the advancement of storage period probably due to moisture loss from the fruits (Table 3). On 8 DAS, the TSS ranged from 15.5°B to 16.2°B and the acidity ranged from 0.48 to 0.50%. The TSS/ acid ratio was lowest in Control (31.0) whereas it was highest in SH2-100% (33.54). Likewise, the TSS/acid ratio had an increasing trend on 16 DAS and 24 DAS also. On 32 DAS (Table 4), the TSS was found to range from 16.0 to 17.0°B with highest TSS (17.0°B) recorded from

Table 3
Effect of lac based formulations on the qualitative traits of pomegranate (upto 16 DAS)

Treatment	*8DAS*			*16DAS*		
	TSS (°B)	*Acidity (%)*	*TSS / acid ratio*	*TSS (°B)*	*Acidity (%)*	*TSS / acid ratio*
Control	15.5	0.50	31.00	15.7	0.48	32.70
SH1-50%	15.8	0.50	31.60	15.9	0.48	33.12
SH1-100%	15.8	0.50	31.60	15.9	0.48	33.12
SH2-50%	16.1	0.48	33.54	16.3	0.46	35.43
SH2-100%	16.2	0.48	33.75	16.4	0.46	35.65
SH3-50%	15.9	0.49	32.44	16.0	0.47	34.04
SH3-100%	16.0	0.48	33.33	16.1	0.47	34.25
CD (5%)	0.30	NS	0.96	0.32	NS	1.20

Table 4
Effect of lac formulations on the qualitative traits of pomegranate (upto 32 DAS)

Treatment	*24DAS*			*32DAS*		
	TSS (°B)	*Acidity (%)*	*TSS / acid ratio*	*TSS (°B)*	*Acidity (%)*	*TSS / acid ratio*
Control	15.9	0.46	34.56	16.0	0.44	36.36
SH1-50%	16.2	0.45	36.00	16.3	0.43	37.90
SH1-100%	16.2	0.45	36.00	16.4	0.43	38.13
SH2-50%	16.4	0.42	39.04	16.9	0.41	41.21
SH2-100%	16.5	0.42	39.28	17.0	0.40	42.50
SH3-50%	16.3	0.44	37.04	16.5	0.42	39.28
SH3-100%	16.4	0.43	38.13	16.6	0.42	39.52
CD (5%)	0.36	NS	1.32	0.40	NS	1.44

SH2-100%. TSS/acid ratio was found to be highest in SH2-100% (42.50) followed by SH2-50% (41.21) whereas it was lowest in control (36.36). Similar reports were reported by Hagenmair and Shaw (2002).

It is concluded that surface coating of fruits of pomegranate cv. Bhagwa with lac formulation SH2-100% enhanced the shelf-life of pomegranate by 6 days over the control by significantly reducing the PLW and shrinkage besides improving the glossiness of fruits. Among the 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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