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Effect of post-harvest treatments on quality of custard apple CV. Local under ambient temperature

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Abstract
The experiment was conducted at Post Graduate Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat during October, 2013 to study effect of post-harvest treatments on quality of custard apple cv. Local under ambient temperature. Freshly harvested uniform sized custard apple fruits were washed, cleaned and treated with different levels of $CaCl_2$ (1.0, 1.5 and 2.0 %) and Sago (5, 10 and 15 %) and covered with and without wrapping materials (Newspaper and Banana leaves) and stored at ambient temperature. The experiment was framed in Completely Randomized Design and repeated three times with nineteen treatments. The result revealed that application of sago (10%) + Newspaper wrapping improved the chemical constituents *i.e.* TSS (27.06 º Brix), reducing and total sugars *i.e.* 26.16 %, 31.80 %, respectively while, acidity content (0.22%) was minimum in fruits treated with sago (5 %) + Newspaper wrapping.

Keywords: Custard apple, $CaCl_2$, Sago, Newspaper, Banana leaves

Introduction
Custard apple (*Annona squamosa* L.) belongs to family Annonaceae, is one of the finest fruit gifted to India by tropical America. It is a common cultivated crop in India, China, Philippines and Cuba. Now it is widely distributed in the tropics and warmer sub-tropics. The fruit has commercial importance in Egypt and Central Africa. In India, it is successfully cultivated in Andhra Pradesh, Tamil Nadu, Orissa, Maharashtra, Assam, Uttar Pradesh, Bihar and Rajasthan and Gujarat. In Gujarat contributes 6,176 ha area with 63,626 MT production during the year 2016-17 (Anon., 2017) [1].

Crop is known to various names like sitaphal, sugar apple, sweet sop and sarifa. Custard apple popular in the Deccan plateau is one of the most important fruit due to its nutritional and medicinal values. The fruits contain sugars, minerals and vitamins which are known to serve as blood tonic (Rao, 1974) [6]. An 'ancorin' is extracted from custard apple seed/pulp, which has insecticidal properties and therefore used as botanical insecticide. Due to the presence of 'annonaine', the leave, stem and other portions of the plant are also bitter and the plant is not attacked by goats or cattle (Katyal *et al.*, 1963) [4].

Fruit coatings *viz*., sago, waxol, arrowroot and isabgol are one such alternative as they not only improve external appearance, but also modify the internal atmosphere of fruits (Saftner, 1999) [7].

The fast fruit softening (firmness loss) is the main characteristic reducing the fruit's quality and commercialization. Hence this study has been under taken.

Materials and methods
The present investigation on "Effect of post-harvest treatments on quality of custard apple cv. Local under ambient temperature" was carried out during October, 2013 at PG laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat).

Freshly harvested uniform sized 10 fruits for each treatment were washed, cleaned and treated with different levels of $CaCl_2$ (1.0, 1.5 and 2.0%) and Sago (5, 10 and 15%) and covered with and without wrapping materials (Newspaper and Banana leaves) and stored at ambient temperature. The experiment was framed in Completely Randomized Design and repeated three times with nineteen treatments as per below.

T_1 : $CaCl_2$ (1.0%) dip for 3 minutes
T_2 : $CaCl_2$ (1.0%) dip for 3 minutes + Newspaper wrapping
T_3 : $CaCl_2$ (1.0%) dip for 3 minutes + Banana leaves wrapping
T_4 : $CaCl_2$ (1.5%) dip for 3 minutes
T_5 : $CaCl_2$ (1.5%) dip for 3 minutes + Newspaper wrapping
T_6 : $CaCl_2$ (1.5%) dip for 3 minutes + Banana leaves wrapping

T_7 : $CaCl_2$ (2.0%) dip for 3 minutes
T_8 : $CaCl_2$ (2.0%) dip for 3 minutes + Newspaper wrapping
T_9 : $CaCl_2$ (2.0%) dip for 3 minutes + Banana leaves wrapping
T_{10} : Sago (Tapioca powder) (5%) dip for 3 minutes
T_{11}: Sago (Tapioca powder) (5%) dip for 3 minutes + Newspaper wrapping
T_{12} : Sago (Tapioca powder) (5%) dip for 3 minutes + Banana leaves wrapping
T_{13} : Sago (Tapioca powder) (10%) dip for 3 minutes
T_{14}: Sago (Tapioca powder) (10%) dip for 3 minutes + Newspaper wrapping
T_{15} : Sago (Tapioca powder) (10%) dip for 3 minutes + Banana leaves wrapping
T_{16} : Sago (Tapioca powder) (15%) dip for 3 minutes
T_{17} : Sago (Tapioca powder) (15%) dip for 3 minutes + Newspaper wrapping
T_{18}: Sago (Tapioca powder) (15%) dip for 3 minutes + Banana leaves wrapping
T_{19} : Control (Fruits are kept without application of chemicals and wrapping materials)
The fruits were subjected to various qualitative analyses on the time of ripening in storage period.

Results and discussion
The experimental results revealed that application of sago (10%) + Newspaper wrapping improved the chemical constituents *i.e.* TSS (27.06 ^{o}Brix), reducing (26.16%) and total sugars (31.80 %) but acidity content (0.22%) was minimum in fruits treated with sago (5 %) + Newspaper wrapping.
The data pertaining to total soluble solids of custard apple fruits under influence of calcium chloride and sago along with different covering materials are presented in Table 1. Significantly higher TSS (27.06 ^{o}Brix) was recorded with T_{14} Sago (10%) + NW, which remained at par with T_{10}, T_{11} and T_{13} *i.e.* (26.10, 26.76, 26.02 ^{o}Brix), while, lower TSS (23.34 ^{o}Brix) was recorded in control (T_{19}). The increase in TSS might be due to conversion of reserved starch and other polysaccharides to soluble form of sugar with the advancement of storage period and also increased in total soluble solids. In newspaper wrapped fruits might be due to slow conversion of insoluble sugars into soluble forms and least utilization of organic acids in respiration Gohlani and Bisen (2012) [2].
Similarly, higher accumulation of total sugar (31.80%) was recorded with T_{14} Sago (10%) + NW as compared to the rest of the treatments and it remained at par with T_{11} *i.e.* 30.43%. However, lower accumulation of total sugar (22.20%) was recorded with T_9-$CaCl_2$ (2.0%) + BLW. The total sugar was significantly found higher with the different post-harvest treatments of sago and calcium chloride during ripening in custard apple fruit. The increased in total sugar might be due to partial hydrolysis of complex carbohydrates and might be due to conversion of starch and pectin into simple sugar.
Similarly, significant effect on the accumulation of reducing sugar (26.16 %) was recorded with T_{14} Sago (10 %) + NW as compared to the rest of the treatments followed by T_{11} (24.58 %) and T_{15} (24.70 %). Whereas, lower accumulation of total sugar (16.15 %), was recorded with T_4 $CaCl_2$ (1.5 %). Sugar was correlated with the decreased in non-reducing sugar and also, the increased in reducing sugar in newspaper wrapped fruits might be due to increased rate of starch degradation by amylase activity.
The data revealed that post-harvest treatments showed significant effect on non-reducing sugar of custard apple fruits at the time of ripening. Significantly the highest non-reducing sugar (7.26 %) was recorded in fruits which were treated with $CaCl_2$ (1.5 %) as compared to the rest of the treatments, and remained at par with T_6 $CaCl_2$ (1.5 %) + BLW *i.e.* (7.02 %). While, the lowest non-reducing sugar 4.27%, was recorded with T_{17} Sago (15 %) + NW. The increased in the non-reducing sugar might be due to the hydrolysis of starch and conversion in the pectin substances from water insoluble to water soluble fractions. The results are in accordance with the findings of Kumar *et al.* (2012) [5] in guava fruit.
The data (Table 1) revealed that calcium chloride and sago along with and without covering materials showed significant effect on acidity of custard apple fruits at the time of ripening. Significantly the lowest acidity (0.22%) was recorded in fruits treated with sago (5%) + NW, which was at par with T_8 and T_{14} *i.e.* 0.24% and 0.23%, respectively as compared to the rest of the treatments. Decrease in acidity could be explained with the fact that organic acid might be utilized rapidly in respiration or conversion of acid into sugar from pre-climacteric to post-climacteric stage while higher acidity content might be due to anaerobic respiration and higher evapotranspiration rate (Jholgiker and Reddy 2007) [3].
Whereas moisture content of custard apple fruits under the influence of post- harvest treatments at ripped stage was not significantly changed. However, numerically highest moisture content (68.14%) was recorded in fruits treated with sago (10%) and wrapped in newspaper as compared to the rest of the treatments.
The pulp to peel ratio of custard apple fruits under influence of different post-harvest treatments at ripped stage was also found non-significant difference. However, numerically the highest in pulp to peel ratio (1.27) was recorded in fruits treated with $CaCl_2$ (1.0 %) and wrapped in banana leaves.
The data given in Table 1 revealed that during storage period, all the post-harvest treatments were found non-significant effect on organoleptic evaluation.

Table 1: Effect of post-harvest treatments on biochemical parameters of custard apple fruit under ambient temperature

Treatments	TSS (^{o}brix) at ripening stage	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Acidity (%)	Moisture content (%)	Pulp to peel ratio	Organoleptic score (out of 9)			
								Colour	Flavour	Taste	Overall
T_1 -$CaCl_2$ (1.0%)	25.02	25.70	20.21	5.49	0.27	65.00	1.13	6.43	7.00	6.90	6.67
T_2 - $CaCl_2$ (1.0%) + NW	25.21	26.36	21.04	5.32	0.26	65.55	1.20	6.07	7.00	7.07	6.73
T_3 - $CaCl_2$ (1.0%) + BLW	24.13	25.36	20.03	5.32	0.26	66.04	1.27	5.68	7.00	6.80	6.53
T_4 - $CaCl_2$ (1.5%)	24.63	23.41	16.15	7.26	0.28	66.00	1.13	5.82	6.00	6.73	6.63

T_5 - $CaCl_2$ (1.5%) + NW	25.00	23.40	16.93	6.47	0.27	66.11	1.17	6.67	6.70	6.87	6.59
T_6 - $CaCl_2$ (1.5%) + BLW	24.96	23.29	16.26	7.02	0.25	65.33	1.18	6.18	6.30	7.03	6.75
T_7 - $CaCl_2$ (2.0%)	25.13	22.43	18.15	4.28	0.25	66.33	1.21	5.77	6.00	6.90	6.74
T_8 - $CaCl_2$ (2.0%) + NW	24.97	23.26	18.80	4.46	0.24	66.41	1.22	5.10	6.20	7.07	6.83
T_9 - $CaCl_2$ (2.0%) + BLW	25.00	22.20	18.33	3.87	0.25	66.78	1.24	6.41	6.00	6.60	6.71
T_{10} - Sago (5%)	26.10	28.51	23.34	5.17	0.26	67.15	1.22	6.37	5.70	6.87	6.81
T_{11} - Sago (5%) + NW	26.76	30.43	24.58	5.84	0.22	67.33	1.17	6.31	7.00	7.03	7.27
T_{12} - Sago (5%) + BLW	25.27	29.32	23.33	5.98	0.25	66.82	1.19	6.18	7.00	7.00	7.21
T_{13} - Sago (10%)	26.02	30.10	24.52	5.58	0.29	66.00	1.21	7.04	7.30	6.93	6.89
T_{14} - Sago (10%) + NW	27.06	31.80	26.16	5.63	0.23	68.14	1.25	7.14	7.00	7.00	7.00
T_{15} - Sago (10%) + BLW	25.13	30.16	24.70	5.46	0.30	65.66	1.23	6.31	7.00	6.80	6.80
T_{16} - Sago (15%)	25.12	27.16	22.16	5.00	0.29	64.33	1.24	5.57	7.30	6.87	6.71
T_{17} - Sago (15%) + NW	24.97	27.35	23.07	4.27	0.28	65.04	1.20	5.31	5.7	7.20	7.13
T_{18} - Sago (15%) + BLW	24.40	28.22	22.43	5.79	0.28	66.33	1.19	6.07	5.00	6.13	6.20
T_{19} - Control	23.34	27.81	23.48	4.33	0.30	63.30	0.98	5.00	4.00	6.40	5.91
S.Em. ±	0.594	0.54	0.41	0.18	0.01	2.41	0.06	0.42	0.63	0.18	0.24
C.D. (0.05 %)	1.713	1.55	1.17	0.53	0.02	NS	NS	NS	NS	NS	NS
C.V. %	4.116	3.52	3.32	5.90	4.13	6.34	8.17	11.9	17.26	4.63	6.18

Conclusion

From the present study it can be concluded that application of sago (10%) + Newspaper wrapping improved the chemical constituents *i.e.* TSS (27.06 ^{o}Brix), reducing and total sugars *i.e.* 26.16%, 31.80% but acidity content (0.22%), was minimum in fruits treated with sago (5%) + Newspaper wrapping.

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