**STUDIES ON ENHANCEMENT OF SHELF LIFE IN CUSTARD APPLE**

**ABSTRACT**

The experiment was laid in a Randomized Block Design with two replications. The experiments framed with sixteen treatments viz., T1- Calcium chloride (0.5%), T2- Calcium chloride (1%), T3- Calcium chloride (1.5 %), T4- Calcium nitrate (4%), T5- Calcium nitrate (6%), T6- Calcium nitrate (8%), T7- Wax emulsion (6%), T8- Wax emulsion (8%), T9- Wax emulsion (10%), T10- GA3 Emulsion – 100 ppm, T11- GA3 Emulsion – 200 ppm, T12- GA3 Emulsion – 300 ppm, T13- Sago emulsion – 10 %, T14- Sago emulsion – 20 %, T15- Sago emulsion – 30 % and T16- Control. The varieties APK (Ca)1, Rayadurg, Balanagar and Mammoth were used as experimental materials with all normal cultural practices followed for aonla cultivation during 2022-2023. The post harvest physiological parameters such as., Specific gravity, physiological loss in weight (%), TSS (°Brix) and acidity (pH) and percentage in decay loss were recorded after treatments. Among the treatments the fruits stored at room temperature without any treatment registered higher PLW (2.04, 3.01 and 4.07%) on 2nd, 4th and 6th day of storage and least physiological loss in weight was observed in wax emulsion 10% (0.39, 0.78, 1.26 and 1.60% at on 2nd, 4th, 6th day and 8th day of storage). Among the treatments the fruits stored at room temperature without any treatment (control) registered higher decay loss (14.86%) on 6th day of storage and the least was observed in wax emulsion treatments. Among the different pretreatments on the 4th day of storage, fruits without any treatment (control) recorded higher TSS (21.73%) but on 6th day total sugar decreased to 20.72%. Wax treated fruits did not ripen even after on 8th day of storage. On the 6th day of storage fruits treated with Calcium chloride (1.5 %) recorded higher TSS (21.68%). On the 4th day of storage, fruits without any treatment (control) recorded lower acidity (0.27%). On the 6th day of storage fruits without any treatment (control) recorded lower acidity (0.28%) but fruits started to decay and the fruits treated with Calcium chloride (1.5 %) recorded lower acidity (0.25%). Fruits treated with Calcium chloride (1.5 %) showed longer shelf life of 5.98 days while shorter shelf life of 4.65 days was noticed in control.

*Key words*: *Post harvest Physiology – Shelf life – Custard apple varieties*

**Introduction**

Custard apple (*Annona squamosa* L.) is a climacteric fruit, semi deciduous, exotic subtropical fruit, highly perishable in nature and consumed in many countries throughout the world. Hence, it is mostly utilized or preferred for fresh market. Due to its climacteric nature, it ripens fast and spoiled easily (Manica, 1994). It belongs to the family Annonaceae, is believed to be introduced in India from tropical South America (Beerh, 1972), and is widely distributed throughout the tropical and sub-tropical regions. It has several synonymous such as Sithaphal, Sharifa, Sugar apple, Sweet sop etc. and more than 70 species come under the genus Annona of which only six of them produces edible fruits. Custard apple is the rich source of nutrients but it has short storage life and having a great demand in the market. In India, custard apple is grown on marginal lands and hilly rocks with minimum inputs (Rajput, 1985). It is grown in Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharastra, and Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal states. Besides India, it is common in China, Philippines and Cuba and has a commercial importance in Egypt and Central Africa. The plants are hardy and drought resistant and can thrive well on marginal and neglected soils (Rajput, 1985). Custard apple is a climacteric fruit and starts ripening soon after detachment from the tree (Wills *et al.,* 2001). It is highly perishable fruit with short shelf life of 1 to 2 days after ripening. The steady increase in area under custard apple has enhanced the fruit flow into the markets which most of the time leads to glut in the markets (Jalikop, 2006). The lack of information on the physiological studies to enhance the shelf life of the custard apple fruit after harvest. Therefore, it is necessary to investigate the effect of emulsions and chemicals to enhance shelf life of custard apple and conserve the quality of produce.

**Materials and Method**

The experiment was laid in a Randomized Block Design with two replications. The experiments framed with sixteen treatments viz., T1- Calcium chloride (0.5%), T2- Calcium chloride (1%), T3- Calcium chloride (1.5 %), T4- Calcium nitrate (4%), T5- Calcium nitrate (6%), T6- Calcium nitrate (8%), T7- Wax emulsion (6%), T8- Wax emulsion (8%), T9- Wax emulsion (10%), T10- GA3 Emulsion – 100 ppm, T11- GA3 Emulsion – 200 ppm, T12- GA3 Emulsion – 300 ppm, T13- Sago emulsion – 10 %, T14- Sago emulsion – 20 %, T15- Sago emulsion – 30 % and T16- Control. The APK 1 variety was chosen for this experiment. All normal cultural practices were followed for custard apple cultivation during 2023-2024. The post harvest physiological studies like., physiological loss in weight (PLW %), TSS (°Brix), Specific gravity, total sugar (%), acidity (pH) and Shelf life (Days)were measured during this experiment.

**Results and Discussion**

The result on physiological loss in weight was recorded after pretreatments in custard apple fruits. Among the sixteen treatments the fruits stored at room temperature without any treatment (Control) had higher PLW (10.44, 11.48, 13.47 and 14.71%) on 2nd, 4th, 6th and 8th day of storage. However, the least physiological loss in weight was observed in wax emulsion 10% (3.11, 2.33, 2.70 and 2.58% at on 2nd, 4th, 6th day and 8th day of storage). This may have been resulted from restricted availability of oxygen and CO2 accumulation and consequently reduction in respiration leading to less moisture loss (Heining, 1975). Wax Coatings make good oxygen and lipid barrier at low to intermediate RH because the polymers can effectively make hydrogen bonds (Sihag *et al*., 2005).

The effects of pretreatments on TSS of custard apple during storage were recorded on 4th, 6th and 8th day of storage. Among the different pretreatments on the 8th day of storage, fruits treated with Wax emulsion (6%) recorded higher TSS (25.13, 26.64, 27.89 and 26.59% on 2nd, 4th, 6th day and 8th day of storage). However, the fruits treated with GA3 Emulsion – 100 ppm recorded lowest TSS of about 18.55, 19.64, 20.90 and 21.81%on 2nd, 4th, 6th day and 8th day of storage. The lowest values with respect to PLW and TSS might be due to low rate of respiration and transpiration caused by wax coating. The findings are supported by Bojappa and Venkatesh Reddy (1990) in sapota; Jakhar and Singh (2008) in aonla.

The data on specific gravity of custard apple during storage were recorded in different pretreatments. Among the treatments, the least specific gravity was recorded in fruits treated with wax emulsion at the concentration of 10% (1.07) on 4th day of storage, which was followed by fruits treated with Wax emulsion at the concentration of 8% (1.07), whereas the highest specific gravity was recorded in control fruits (1.12). According to Asnath Prerna Minz et al., (2023) who stated that, the application of Paraffin wax emulsion (10%) + polythene wrap + KMnO4 (0.1%) recorded the total sugar per cent of custard apple fruit had an increasing trend up to 6 days of storage and thereafter declined on 8th days of storage period. Increase in total sugar might be due to partial hydrolysis of complex carbohydrate.

The data on total sugar content gradually increased from 2nd day of storage to 8th day of storage period. Comparing the sixteen treatments the fruits treated with Calcium chloride (0.5%) registered higher sugar content (19.33%) than the other treatments. However, the treatment GA3 Emulsion – 100 ppm had least sugar content of about 15.26 % on 8th day of storage period.

On the 4thand 8th day of storage, fruits without any treatment (control) recorded lower acidity value of 0.29 % and 0.24% but fruits and the fruits treated with Wax emulsion (10%) recorded higher acidity 0.42 and 0.38 % on the 4thand 8th day of storage. Fruits treated with Wax emulsion (10%) showed longer shelf life of 9.35 days while shorter shelf life of 5.72 days was noticed in control. The lowest rotted fruits in the above treatment might be due to inhibition of sporulation and spore germination of rot causing fungus by wax coating treatment (Jakhar and Singh, 2008). Presence of thin coating of wax emulsion over the surface of the fruit leading to reduction in oxygen concentration. As a result, the respiration of fruits may be minimized due to which the degeneration of colour and softening of fruit tissues reduced. These results are in conformity with the findings of Haribabu *et al.* (1990) and Singh *et al.* (2006) in custard apple and Sharma *et al* (2006) in kinnow mandarin fruits.

**Table 1. Effect of different treatments on PLW (%), TSS (B0) and specific gravity in fruits of   
 custard apple.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Storage period (Days)** | | | | **Storage period (Days)** | | | | **Specific**  **Gravity** |
| **PLW (%)** | | | | **TSS (%)** | | | |
| 2 | 4 | 6 | 8 | 2 | 4 | 6 | 8 | **4th day** |
| Calcium chloride (0.5%) | 8.19 | 9.30 | 10.53 | 12.68 | 20.51 | 21.79 | 22.57 | 23.53 | 1.10 |
| Calcium chloride (1%) | 8.30 | 10.46 | 11.30 | 11.50 | 18.56 | 21.68 | 21.74 | 22.72 | 1.09 |
| Calcium chloride (1.5 %) | 8.25 | 9.41 | 11.32 | 12.59 | 21.50 | 22.57 | 23.53 | 24.83 | 1.08 |
| Calcium nitrate (4%) | 9.16 | 9.56 | 10.63 | 11.43 | 22.67 | 22.55 | 24.65 | 25.62 | 1.10 |
| Calcium nitrate (6%) | 7.47 | 9.54 | 9.58 | 11.60 | 23.77 | 24.73 | 25.55 | 26.84 | 1.09 |
| Calcium nitrate (8%) | 9.38 | 10.34 | 11.57 | 12.46 | 20.52 | 21.79 | 22.72 | 23.96 | 1.08 |
| Wax emulsion (6%) | 3.37 | 3.38 | 3.86 | 3.31 | 24.05 | 24.55 | 25.89 | 26.52 | 1.08 |
| Wax emulsion (8%) | 3.17 | 2.74 | 2.58 | 3.09 | 25.13 | 26.64 | 27.90 | 26.60 | 1.07 |
| Wax emulsion (10%) | 3.11 | 2.33 | 2.70 | 2.58 | 20.49 | 22.55 | 23.98 | 25.91 | 1.07 |
| GA3 Emulsion – 100 ppm | 8.39 | 9.26 | 10.31 | 10.75 | 18.55 | 19.64 | 20.90 | 21.81 | 1.09 |
| GA3 Emulsion – 200 ppm | 9.52 | 10.53 | 12.77 | 13.59 | 21.75 | 23.56 | 24.77 | 25.60 | 1.09 |
| GA3 Emulsion – 300 ppm | 7.55 | 8.54 | 9.79 | 9.95 | 22.81 | 23.96 | 24.73 | 26.59 | 1.09 |
| Sago emulsion – 10 % | 6.66 | 7.55 | 8.83 | 9.05 | 23.81 | 25.11 | 25.61 | 26.88 | 1.08 |
| Sago emulsion – 20 % | 5.19 | 6.43 | 7.96 | 8.61 | 20.72 | 22.70 | 25.86 | 24.58 | 1.08 |
| Sago emulsion – 30 % | 4.76 | 5.22 | 6.57 | 6.49 | 20.51 | 21.79 | 23.00 | 23.59 | 1.08 |
| Control | 10.44 | 11.48 | 13.47 | 14.71 | 21.68 | 23.53 | 24.73 | 25.93 | 1.12 |
| **SEd** | **0.131** | **0.183** | **0.196** | **0.250** | **0.484** | **0.438** | **0.503** | **0.557** | **0.025** |
| **CD (P=0.05)** | **0.267** | **0.375** | **0.400** | **0.510** | **0.989** | **0.895** | **1.028** | **1.137** | **0.051** |

**Table 2. Effect of different treatments on total sugar (%), acidity (%) and shelf life in fruits of custard apple**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Storage period (Days)** | | | | **Storage period (Days)** | | | | **Shelf life (Days)** |
| **Total sugar (%)** | | | | **Acidity (%)** | | | |
| 2 | 4 | 6 | 8 | 2 | 4 | 6 | 8 |
| Calcium chloride (0.5%) | 14.25 | 15.26 | 17.30 | 19.33 | 0.33 | 0.31 | 0.28 | 0.27 | 7.43 |
| Calcium chloride (1%) | 16.28 | 17.30 | 18.32 | 18.32 | 0.27 | 0.25 | 0.25 | 0.24 | 6.66 |
| Calcium chloride (1.5 %) | 14.25 | 15.26 | 16.28 | 18.32 | 0.31 | 0.29 | 0.28 | 0.27 | 6.99 |
| Calcium nitrate (4%) | 14.25 | 15.26 | 16.28 | 17.30 | 0.35 | 0.31 | 0.29 | 0.28 | 7.65 |
| Calcium nitrate (6%) | 14.25 | 15.26 | 17.30 | 18.32 | 0.32 | 0.30 | 0.29 | 0.29 | 7.61 |
| Calcium nitrate (8%) | 16.28 | 17.30 | 18.32 | 19.29 | 0.33 | 0.31 | 0.29 | 0.28 | 7.58 |
| Wax emulsion (6%) | 14.25 | 15.26 | 16.28 | 17.30 | 0.38 | 0.37 | 0.35 | 0.32 | 9.00 |
| Wax emulsion (8%) | 13.23 | 14.25 | 15.26 | 16.28 | 0.40 | 0.38 | 0.36 | 0.34 | 9.10 |
| Wax emulsion (10%) | 14.25 | 15.26 | 16.28 | 17.30 | 0.44 | 0.42 | 0.40 | 0.38 | 9.35 |
| GA3 Emulsion – 100 ppm | 13.23 | 14.25 | 14.25 | 15.26 | 0.31 | 0.31 | 0.29 | 0.27 | 6.47 |
| GA3 Emulsion – 200 ppm | 15.26 | 15.26 | 16.28 | 16.28 | 0.29 | 0.28 | 0.27 | 0.25 | 6.92 |
| GA3 Emulsion – 300 ppm | 12.21 | 13.23 | 14.25 | 16.32 | 0.27 | 0.27 | 0.24 | 0.23 | 7.43 |
| Sago emulsion – 10 % | 16.28 | 17.30 | 17.30 | 18.32 | 0.31 | 0.29 | 0.25 | 0.23 | 6.92 |
| Sago emulsion – 20 % | 13.23 | 17.30 | 18.32 | 18.32 | 0.38 | 0.37 | 0.35 | 0.32 | 6.68 |
| Sago emulsion – 30 % | 15.26 | 16.28 | 16.28 | 17.30 | 0.37 | 0.35 | 0.33 | 0.31 | 7.23 |
| Control | 10.18 | 12.21 | 13.23 | 14.25 | 0.30 | 0.29 | 0.27 | 0.24 | 5.72 |
| **SEd** | **0.282** | **0.269** | **0.280** | **0.315** | **0.007** | **0.006** | **0.007** | **0.006** | **0.176** |
| **CD(P=0.05)** | **0.576** | **0.549** | **0.572** | **0.644** | **0.014** | **0.013** | **0.014** | **0.012** | **0.360** |

**Conclusion:**

The result on physiological loss in weight was recorded after pretreatments in custard apple fruits. Among the sixteen treatments the fruits stored at room temperature without any treatment (Control) had higher PLW (10.44, 11.48, 13.47 and 14.71%) on 2nd, 4th, 6th and 8th day of storage. However, the least physiological loss in weight was observed in wax emulsion 10% (3.11, 2.33, 2.70 and 2.58% at on 2nd, 4th, 6th day and 8th day of storage).The effect of pretreatments on TSS of custard apple during storage were recorded on 4th, 6th and 8th day of storage. Among the different pretreatments on the 8th day of storage, fruits treated with Wax emulsion (6%) recorded higher TSS (25.13, 26.64, 27.89 and 26.59% on 2nd, 4th, 6th day and 8th day of storage). However, the fruits treated with GA3 Emulsion – 100 ppm recorded lowest TSS of about 18.55, 19.64, 20.90 and 21.81% on 2nd, 4th, 6th day and 8th day of storage. The data on specific gravity of custard apple during storage were recorded in different pretreatments. Among the treatments, the least specific gravity was recorded in fruits treated with wax emulsion at the concentration of 10% (1.065) on 4th day of storage, which was followed by fruits treated with Wax emulsion at the concentration of 8% (1.073), whereas the highest specific gravity was recorded in control fruits (1.115).The data on total sugar content gradually increased from 2nd day of storage to 8th day of storage period. Comparing the sixteen treatments the fruits treated with Calcium chloride (0.5%) registered higher sugar content (19.33%) than the other treatments. However, the treatment GA3 Emulsion – 100 ppm had least sugar content of about 15.26 % on 8th day of storage period.On the 4thand 8th day of storage, fruits without any treatment (control) recorded lower acidity value of 0.29 % and 0.24% but fruits and the fruits treated with Wax emulsion (10%) recorded higher acidity 0.42 and 0.38 % on the 4thand 8th day of storage. Fruits treated with Wax emulsion (10%) showed longer shelf life of 9.35 days while shorter shelf life of 5.72 days was noticed in control.

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