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Effect of Edible Coating on Shelf Life and Physico-chemical Changes in Sapota (*Achras sapota* L.) cv Cricket Ball under Ambient Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A research experiment was conducted at Postharvest Laboratory, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experiment was conducted to study the effect of edible coating on Shelf life and Physico-chemical changes in Sapota (*Achras sapota* L.) under ambient condition. The experiment was conducted in Factorial Completely

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Randomized Design with three replications. There were two factors i.e., Aloevera Gel and cornstarch each having 4 concentrations i.e., Aloevera gel (0%, 25%. 50% and 75%) and cornstarch (0%, 1%, 2% and 3%). Various physical and chemical parameters were observed for each treatment. Physical parameters like Weight loss (86.00 g), Fruit length (5.28 cm), fruit diameter (5.00 cm), decay percent (0.00%) and surface color values of L*, a* and b*(36.16, 9.36 and 20.44) decreased minimum under Aloevera gel (75%) and cornstarch (2%). Similarly, chemical parameters like Acidity decreased maximum (0.039%), ascorbic acid decreased minimum (8.68 mg/100g), TSS increased maximum (31.50^{0}Brix), Total sugars increased maximum (21.60%), reducing sugar increased maximum (15.25%) and non-reducing increased maximum (6.35%) under Aloevera gel (75%) and cornstarch (2%). As regards the individual the Aloevera gel (75%) and cornstarch (2%) was found superior over other treatments.

Keywords: Alovera gel; corn starch; sapota; postharvest losses; microbiological activity.

1. INTRODUCTION

Postharvest losses are serious challenge faced by fruit growers and fruit industries because of rapid deterioration during transport, handling, and storage. In tropical countries like India, postharvest losses in sapota fruits are higher ranging from 25 to 30% (Salunkhe and Desai, 1984). These losses occur due to various factors, including a lack of insufficient storage facilities, improper handling during long-distance transportation, without pre-treatments, quick ripening, microbial deterioration etc. Therefore, it is urgent need to evolve any technology with the ability to reduce the postharvest losses. It will be benefited to the growers and consumers. Coating of edible substances in a thin film which help to keep the fruit fresh improve quality with respect to longevity and can be eaten safely. It also delays spoiling, hampered microbiological activity, and respiration rate, as well as extend the shelf life of products by limiting moisture loss and gas exchange. Edible coating is a cheaper and successful strategy that may be used at the agricultural level. The starch-based coating also found to be cost effective, bio-degradable edible coat. It is an excellent option for post-harvest packing as well as preservation for various fruits including sapota (Dey *et al*., 2014). Hence, these coating agents may be used for increasing shelf life of of fruit like sapota. However, there is a scarcity of research work in this field. Therefore, the present study was carried out to know the effect of various coating agents on shelf -life and physio-chemical changes occurs in sapota under ambient condition.

2. MATERIAL AND METHODS

An experiment was conducted at Department of Horticulture, College of Agriculture, JNKVV, Jabalpur, (M.P.) during the year 2022. The physiological matured color break stage fruits of cricket ball variety of sapota having uniformed size and shape free from injury and pathogenic infection were harvested and cleaned with moist cloth. The fruits were treated with four levels of each, Aloveragel (0%, 25%, 50% and 75%) and cornstarch (0%, 1%, 25% and 3%) and their combinations and were replicated thrice in Factorial CRD design. The treated fruits were stored in ambient conditions and analyses after 7 days for physical and chemical properties. The TSS were recorded with hand refractometer and results were expressed as ^{0}Brix. The percent acidity was analyzed by titrating the fruit juice pulp with N/10 NaOH using phenolphthalein as an indicator. The ascorbic acid content were determined by using 2,6 dichlorophenol indophenol dye (Ranganna,1997). The reducing sugar and total sugars were determined by standard methods (AOAC,1995).

3. RESULTS AND DISCUSSION

The data presented in Table 1 revealed thatthe during storage, an increase in surface colour development was observed in all treatments and minimum decrease of L* and b* values (up to 8.16% and 29.14%, respectively) whereas, minimum increase in a* value (63.56%) was recorded under fruit coated with 75% aloeveragel. Similarly in case of cornstarch, minimum decrease in colour values L* and b* (11.35% and 34.69%, respectively) were noted in fruits receiving cornstarch 2% coating and maximum decrease in colour L* and b* (14.86% and 39.19%, respectively) in control as compared to mean initial L* and b* values and minimum increase in a* value by 96.25% was recorded in fruits treated with 2 % cornstarch and maximum by 117% in control treatment as compared to mean initial a* value. As regards, the interaction effect minimum decrease in colour L* and b* (up to 7.19% and

27.80%,respectively) and minimum increase in color a value by 40.33% was recorded under aloeveragel gel 75% and 2% cornstarch while maximum decrease in L* and b* values (up to 23.00% and 49.59%, respectively) and maximum increase in a* value by 153.07% was observed under control after 7 days of storage in comparison to average initial L*, a* and b* values (38.96, 6.67 and 28.31).The colour of outer peel of sapota was shifting to reddish brown. However, this colour change towards red was more in control than that of treated ones and this edible coating could prevent the sapota fruit from becoming more reddish brown (Padmaja and Bosco, 2014; Hamman, 2008).

It is clear from the current experiment that weight loss and reduction in size throughout the 7-day storage period were considerably impacted by various post-harvest treatments and minimum losses in fruit weight (5.37%) and size (length 8.83% and diameter 7.79%) were recorded at 7th day of storage in comparison to average initial value when fruit coated with 75% aloeveragel. This result is in agreement with the behaviour of stand-alone formed films, the lowest physiological loss in weight was noted in the fruits coated with 75% aloeveragel whereas the highest PLW was noted in uncoated fruits. Aloevera gel, which is primarily composed of polysaccharides, was also highly effective as a moisture barrier without the addition of lipids (Ni *et al*., 2004). The concentration of cornstarch had significantly minimized the loss in fruit weight and size during initial to 7th day of storage period and the minimum loss in weight (9.55%) and size terms of length (15.10%) and diameter (13.68%) was recorded when fruits coated with cornstarch (2%) whereas, it was maximum under control. Fruits coated with cornstarch had less weight loss during storage as compared to fruits under control.The reduction in weight and size of fruit during storage period due to shrinking of fruits occurs due to transpiration process. Similarly, Olusola and Oluwaseun (2013). Observed that cornstarch coated cucumber showed a significant delay in weight loss compared to uncoated ones.In general, physiological loss in weight increases with the advancement of storage period. In the present investigation, the minimum physiological loss in fruit weight (4.11%), fruit length (6.01%) and diameter (6.68%) were noted at 7th day during storage under aloeveragel (75%) and cornstarch (2%) whereas these values were maximum under control in comparison to average initial value. The possible reason for minimized weight loss by chemical might be due to evaporation and transpiration processes. The reduction in weight loss was probably due to the effects of they creates a semi permeable barrier against oxygen, carbon dioxide, moisture and solute movement, thereby reducing respiration, water loss and oxidation reaction rates (Baldwin *et al*., 1999). The minimum fruit shrinking observed under fruit coated with aloeveragel and corn starch might be due to the anti-senescent action of coatings which had an inhibitory effect on ethylene biosynthesis and retard the activity of enzymes responsible for ripening, cell degradation was prevented which in turn facilitated reduced moisture loss and slow down the respiratory gas exchange, hence delay in senescence and lower the shrinkage percentage (Sudha *et al*., 2007).

The fruit decaying was significantly influenced by various postharvest treatments. The decay (%) was minimum (5.00%) under treatment aloeveragel (75%) at the 7th day of storage. Aloeveragel contains anthraquinone glycosides, glycol-proteins, gamma-lanoline acids and mucopolysaccharides that are mainly responsible for the antiviral, antibacterial as well as its antiviral antifungal activity which is the mechanism behind such positive effects of aloeveragel. The finding is in closely supported with Ahmed *et al*. (2009). In case of concentration of cornstarch minimum fruit decay (25.00%) was recorded under coating of cornstarch (2%) whereas, maximum fruit decay (43.33%) occurred under uncoated. Fruit decay loss is one of the salient observations in the quality of fruit and existence of decaying unfavourably affects the shelf-life of fruits.However, minimum decayed of fruits was recorded at 7th day of storage under cornstarch (2%) and aloeveragel (75%) than the others. The decayed of fruits were noted about 80.00% under control. The decay percent of sapota fruits was notably affected by different edible to result in coatings. It might be due to coating result in reduction in water losses and decay loss has been increased continuously with the advancement of storage period. Wang *et al.,* (2019) reported that the packaging materials could reduce water loss to a certain extent to avoid strawberry oxidation and reduce respiration, reducing the chance of fungal infection and decaying.

The significantly higher values of TSS (30.98$^{\circ 0}$B) was recorded under 75% aloeveragel whereas it

Table1. Effect of edible coating of aloeveragel on physical parameters after 7 days under ambient condition of sapota fruits

Treatment	Fruit				Fruit Surface colour		
	PLW (%)	Length (cm)	Diameter (cm)	Decay (%)	L* value	a* value	b* value
Aloevera gel							
Aloevera gel 0%	77.15	4.34	4.18	70.00	31.75	16.34	15.29
Aloevera gel 25%	79.68	4.58	4.42	43.33	33.82	14.5	17.19
Aloevera gel 50%	82.20	4.79	4.77	16.67	34.6	13.62	18.98
Aloevera gel 75%	86.02	5.16	4.97	5.00	35.78	10.91	20.06
Cornstarch							
Cornstarch 0%	80.43	4.61	4.49	43.33	33.17	14.54	17.21
Cornstarch 1%	81.18	4.66	4.55	36.67	33.79	14.08	17.69
Cornstarch 2%	82.23	4.81	4.65	25.00	34.54	13.09	18.49
Cornstarch 3%	81.80	4.79	4.63	30.00	34.46	13.66	18.13
For Alovera gel and Cornstarch							
SE(m)±	**0.03**	**0.02**	**0.01**	**4.41**	**0.03**	**0.08**	**0.03**
C.D. at 5% level	**0.11**	**0.06**	**0.03**	**14.11**	**0.10**	**0.24**	**0.11**
Interaction effect of Alovera gel and Cornstarch							
Aloevera gel 0 % + Cornstarch 0%	75.5	4.21	4.05	80.00	30.00	16.88	14.27
Aloevera gel 0 % + Cornstarch 1%	77.2	4.29	4.13	73.33	31.05	16.70	15.00
Aloevera gel 0 % + Cornstarch 2%	78.0	4.43	4.27	60.00	32.96	15.75	16.49
Aloevera gel 0 % + Cornstarch 3%	77.8	4.41	4.25	66.67	32.98	16.02	15.38
Aloevera gel 25 % + Cornstarch 0%	79.1	4.47	4.31	53.33	33.16	14.93	16.56
Aloevera gel 25 % + Cornstarch 1%	79.5	4.52	4.36	46.67	33.88	14.49	17.10
Aloevera gel 25 % + Cornstarch 2%	80.2	4.67	4.51	33.33	34.15	14.22	17.59
Aloevera gel 25 % + Cornstarch 3%	80.0	4.65	4.49	40.00	34.10	14.37	17.51
Aloevera gel 50 % + Cornstarch 0%	81.8	4.75	4.72	26.67	34.22	14.03	18.44
Aloevera gel 50 % + Cornstarch 1%	82.5	4.77	4.76	20.00	34.54	13.88	18.75
Aloevera gel 50 % + Cornstarch 2%	83.6	4.80	4.80	6.67	34.88	13.03	19.43
Aloevera gel 50 % + Cornstarch 3%	83.4	4.82	4.78	13.33	34.77	13.53	19.31
Aloevera gel 75 % + Cornstarch 0%	85.3	4.99	4.89	13.33	35.29	12.30	19.58
Aloevera gel 75 % + Cornstarch 1%	85.6	5.06	4.96	6.67	35.67	11.25	19.91
Aloevera gel 75 % + Cornstarch 2%	87.2	5.32	5.03	0.00	36.16	9.36	20.44
Aloevera gel 75 % + Cornstarch 3%	86.0	5.28	5.00	0.00	36.00	10.71	20.32
SE(m)±	**0.07**	**0.04**	**0.02**	**8.82**	**0.06**	**0.15**	**0.07**
C.D. at 5% level	**0.21**	**0.12**	**0.07**	**28.21**	**0.20**	**0.48**	**0.22**

Table 2. Effect of edible coating of Aloeveragel **on Bio-chemical Parameters after 7 days under ambient condition of Sapota Fruits**

Treatments	TSS (^{0} Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Total Sugar (%)	Reducing Sugar (%)	Non-reducing sugar (%)
Alovera gel						
Aloevera gel 0%	24.21	0.016 (60.98)	7.48 (47.73)	16.01	11.95	4.06
Aloevera gel 25%	26.98	0.022 (46.34)	7.98 (44.23)	17.46	13.07	4.40
Aloevera gel 50%	29.60	0.029 (29.27)	8.28 (42.14)	19.54	14.50	5.04
Aloevera gel 75%	30.98	0.029 (29.27)	8.53 (40.39)	21.16	14.98	6.18
Cornstarch						
Water alone	27.11	0.023 (43.90)	7.95 (44.44)	17.97	13.23	4.74
Cornstarch 1%	27.48	0.024 (41.46)	8.04 (43.82)	18.35	13.55	4.80
Cornstarch 2%	28.68	0.028 (31.71)	8.19 (42.77)	19.05	13.94	5.11
Cornstarch 3%	28.50	0.027 (34.15)	8.09 (43.47)	18.80	13.77	5.03
For aloeveragel **and Cornstarch**						
SE(m)±	**0.02**	**0.001**	**0.04**	**0.04**	**0.05**	**0.05**
C.D. at 5% level	**0.06**	**0.003**	**0.14**	**0.12**	**0.15**	**0.17**
Interaction effect of aloeveragel **and Cornstarch**						
Aloevera gel 0 % + Cornstarch 0%	23.50	0.014 (65.85)	7.32 (48.85)	15.25	**11.29**	3.96
Aloevera gel 0 % + Cornstarch 1%	24.10	0.015 (63.41)	7.48 (47.73)	16.06	12.06	4.00
Aloevera gel 0 % + Cornstarch 2%	24.70	0.018 (56.10)	7.63 (46.68)	16.52	12.35	4.17
Aloevera gel 0 % + Cornstarch 3%	24.50	0.017 (58.54)	7.50 (47.59)	16.21	12.10	4.11
Aloevera gel 25 % + Cornstarch 0%	25.40	0.020 (51.22)	7.86 (45.07)	16.85	12.56	4.29
Aloevera gel 25 % + Cornstarch 1%	25.70	0.021 (48.78)	7.91 (44.72)	17.12	12.79	4.33
Aloevera gel 25 % + Cornstarch 2%	28.50	0.025 (39.02)	8.10 (43.40)	18.07	13.56	4.51
Aloevera gel 25 % + Cornstarch 3%	28.30	0.024 (41.46)	8.03 (43.89)	17.81	13.36	4.45
Aloevera gel 50 % + Cornstarch 0%	29.10	0.027 (34.15)	8.19 (42.77)	19.02	14.37	4.65
Aloevera gel 50 % + Cornstarch 1%	29.40	0.028 (31.71)	8.26 (42.28)	19.22	14.43	4.79
Aloevera gel 50 % + Cornstarch 2%	30.00	0.032 (21.95)	8.35 (41.65)	20.00	14.61	5.39
Aloevera gel 50 % + Cornstarch 3%	29.90	0.031 (24.39)	8.30 (42.00)	19.90	14.58	5.32
Aloevera gel 75 % + Cornstarch 0%	30.40	0.034 (17.07)	8.41 (41.23)	20.75	14.70	6.05
Aloevera gel 75 % + Cornstarch 1%	30.70	0.035 (14.63)	8.49 (40.67)	21.00	14.92	6.08
Aloevera gel 75 % + Cornstarch 2%	31.50	0.039 (14.88)	8.68 (39.34)	21.60	15.25	6.35
Aloevera gel 75 % + Cornstarch 3%	31.30	0.038 (14.73)	8.53 (40.39)	21.28	15.05	6.23
SE(m)±	**0.03**	**0.002**	**0.09**	**0.09**	**0.10**	**0.10**
C.D. at 5% level	**0.11**	**0.008**	**0.28**	**0.27**	**0.31**	**0.33**

Figure in parenthesis indicated percentage reduction form initial values

was minimum (24.21^{0}B) under control at the 7th day of storage period. As the storage period progresses, fruits coated with aloeveragel (75%) recorded higher TSS value due to rapid breakdown of pectin and carbohydrates. This trend is in close agreement with Jholgikar and Reddy (2007). In the case of concentration of cornstarch, maximum increase in the value of TSS(28.68^{0}B)whereas, minimum under control (27.11^{0}B) were recorded as against the initialTSS value of 20.21^{o}Brix.Among the different combination of aloeveragel and cornstarch the maximum value of 31.50°B was noted when fruits coated with aloeveragel (75%) in combination of cornstarch (2%) whereas it was minimum (23.50 ^{0}B) under control at the last day of storage period. The rise in TSS is mainly due to hydrolysis of starch and sugars starts accumulating and mainly because of progressive boosting of free sugars and lowest TSS was recorded in coated fruits due to slow breakdown of carbohydrates and pectin under modified atmosphere which reduced respiration and transpiration rate in coated fruits (Yaman and Bayoindirli, 2002).

Acidity was significantly influenced by various post-harvest treatments in comparison to initial value of (0.041%) after 7th day of storage period and minimum decreased by 29.27% (0.029%) under fruit coated with aloeveragel 50 and 75 per cent), whereas maximum by 60.97% (0.016%) observed under control.In case of concentration of cornstarch, minimum decrease in acidity by 31.71%(0.028%) was observed when fruites treated with cornstarch2% whereas, maximum decrease in acidity by 43.90% (0.023%) under uncoated fruits with cornstarch.As regards the combine application of Alovera gel and corn starch significant effect on acidity was noted and minimum decreased by 14.63% with value of 0.035% was recorded under fruit coated with aloeveragel (75%) with cornstarch (1%). However, aloeveragel 75% with all levels of cornstarch were noted at par with each other's. the lower level of acidity in the control may be attributed due to its utilization in respiration compared to the coated fruits. The results are line with Damodaran *et al.,* (2001).

Data revealed that ascorbic acid reduced with the increase in storage period in all the treatments from the initial value of 14.31 mg/100g.The maximum value of ascorbic acid (8.53mg/100g) as well as minimum reduction in terms of percentage (40.39%) was recorded under fruit coated with Aloevera gel (75%). Similar trend was noted when fruit coated with cornstarch at the 7th day of storage period. The maximum value of ascorbic acid (8.19 mg/100g) as well as minimum reduction in terms of percentage (42.77%) was recorded under fruit coated with cornstarch (2%). The ascorbic acid content reduces continuously under all the treatments with the time period of storage. As regard the combined effect of aloeveragel and cornstarch had showed significant effect and maximum value ascorbic acid of 8.68mg/100g was noted with minimum reduction (39.34%) when fruit coated with aloeveragel (75%) in combination of 2% cornstarch. There was reduction in ascorbic acid in the uncoated fruits throughout period of ripening. There was significant increase in ascorbic acid content in coated fruits at the end of ripening as compare to control. This could be attributed to slower rate of oxidation of ascorbic acid in all the treatment Gautam and Chundawat (1989).

The data presented in Table 2, revealed that the all the treatment showed significant effect on percentage of total sugar, reducing sugar and non-reducing sugar and maximum value of 19.05,14.50 and 6.18 % was recorded at the end of 7th of storage period under coating of aloveragel (75%), respectively. As regard to coating of corn starch showed similar trend and maximum value of total sugar (19.05%), reducing sugar (13.94%) and non-reducing sugar (5.11 %)were noted when fruit coated with 2% cornstarch. Similarly, the fruit coated with aloeveragel and cornstarch had also showed significant effect and maximum value of total sugar (21.60%), reducing sugar (15.25%) and non-reducing sugar (6.35%) were recorded under cornstarch (2%) + aloeveragel (75%) along with cornstarch (2%) and this value was minimum under untreated fruits at the end of storage period. However, total sugar levels significantly increased during fruit storage in all treatments except control, as storage accelerated respiration and transpiration rates and inhibited the enzymatic activity that breaks down sugars. The subsequent decline may have resulted from the use of sugars for respiration, these findings are supported by the observations of Mohamed *et al*.(2013) in prickly pear. With the extension of storage time, polysaccharides hydrolyse into mono and disaccharides, which may result in a rise in TSS and sugars. Due to the fact that polysaccharides are the main substrate for respiration, after they have completely hydrolysed, no further growth takes place, and a subsequent drop in the parameters

is expected. Chacon *et al*. (2017) in tomato and Minh *et al*., (2019) in capsicum both found similar results. The increase in non-reducing sugar was due to the conversion of starch into sugar during storage. The findings in the present investigation were obtained similar in Ber (Bhowmik *et al*., 2015) and in guava (Singh *et al*., 2018).

4. CONCLUSION

The starch-based coating also found to be cost effective, bio-degradable edible coat. It is an excellent option for post-harvest packing as well as preservation for various fruits including Sapota.The minimum fruit shrinking observed under fruit coated with Alovera gel and corn starch might be due to the anti-senescent action of coatings which had an inhibitory effect on ethylene biosynthesis and retard the activity of enzymes responsible for ripening, cell degradation was prevented which in turn facilitated reduced moisture loss and slow down the respiratory gas exchange, hence delay in senescence and lower the shrinkage percentage.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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