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Development of an Edible Coating for Extending the Shelf Life of Manilkara Zapota (Sapodilla)

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ABSTRACT

The Scientific Name for the Sapodilla fruit, which belongs to the Sapotaceous family, is Manilkara Zapota. When kept at room temperature, Sapodilla fruits are perishable and have a short shelf life.

It is a delightful tropical fruit that is also economically significant and ranks first among all fruit crops. In tropical nations, such as India, post-harvest losses are considerable, ranging from 25 to 30 %. The study's purpose was to look into an optimal coating formula for prolonging the shelf life of Sapodilla. Fruits were bought at the main market of Dadri. Diseased and damaged fruits were discarded, keeping just medium-sized fruits. Edible Coating materials were brought from Amazon Online and some from Nursery plants.

Three different concentrations of Rice Bran (1 %, 2 %, 3 %) with 2 % Cassava Starch + 1 % Mint + 1 % Tulsi and Aloe Vera (1 %, 2 %, 3 %) with 2 % Cassava Starch + 1 % Mint + 1 % Tulsi were used for treatments, and the quality evaluation was performed to check out the better concentration between the Rice Bran and Aloe Vera based Edible Coating along with the other three concentrations.

Keywords

Sapodilla; Manilkara Zapota; Sapotaceous; Edible Coatings; Rice Bran; Cassava Starch; Shelf Life; Aloe Vera, Mint, and Tulsi Extract.

INTRODUCTION

Fruits and vegetables include bioactive substances including antioxidants and phytochemicals that aid in the prevention of a wide range of biological illnesses and diseases. As a result, they are necessary for a balanced and nutritious diet. Consumer demand for meals has altered as a result of recent years their hectic schedules, extended health awareness, and increased spending power, as opposed to a few years ago. The rising demand

for high-quality, long-lasting ready-to-eat foods has prompted the development of innovative storage methods to preserve their natural, fresh appearance while also keeping them safe. The quality and nutritional content of meals differ depending on how they are cooked. The Central Institute of Post Production Engineering and Technology (CIPHET) estimates that 18 percent of India's fruit and vegetable harvest is wasted each year, amounting to Rs 13,300 million.

It has become a very popular fruit crop in Gujarat, Maharashtra, Karnataka, Tamil Nadu, Province, and Kerala. With just 21,274 acres and a production of 2, 26,512 (Anon, 2005), the province is one of India's leading sapodilla producers, accounting for nearly 25% of the country's sapodilla production. The Sapodilla accounts for 3.87 Lakh tonnes of the country's entire fruit production, which totals 813 Lakh tones. It is indigenous to North America as well as various tropical South American nations.

A thin layer of edible and ecologically acceptable materials is put to meals as an edible coating and may be digested while simultaneously acting as a barrier against gasses, germs, and moisture in food. Because of its environmentally benign nature, the edible coating is issued to make food look more appealing while also providing food safety. It may be obtained from both animal and vegetable sources. They operate as a moisture and gas barrier during manufacture, handling, and storage. Its action, or the addition of antimicrobial compounds, lowers food spoilage and increases food safety. As a result of these numerous issues, an emphasis on the use of renewable resources to preserve food and improve its quality has emerged.

OBJECTIVE OF RESEARCH WORK

- The goal of the study was to determine the best coating solution for extending the life of Sapodilla.
- Edible coatings and films can be used to extend the shelf life of modern fruits and vegetables, equivalent to modified atmospheric storage in which the interior gas composition is changed (Park, 1999).
- The purpose of this research is to create natural-based edible coatings and their application on fruits taking into mind all of these properties and functions, to maximize their post-harvest shelf life, quality, and durability. We also evaluated the physical and chemical parameters of coated and uncoated fruits in order to determine their quality and stability under controlled storage.

MATERIAL AND METHODOLOGY

The current study, titled "**Development of an Edible Coating for Extending the Shelf Life of Manilkara Zapota (Sapodilla)**" was carried out at the laboratories of the School of Vocational Studies and Applied Science at Gautam Buddha University in Greater Noida during the academic year 2021-2022. The materials and processes required to manufacture and optimize Edible Coating Solutions (ECS) derived from Rice Bran, Aloe Vera, Cassava Starch, Mint, and Tulsi are covered here. The materials and processes used to determine the properties of Films/Coatings are also described here. The Edible Covering on Manilkara Zapota key components has been meticulously crafted. The procedures for optimizing Coating Parameters were meticulously explained. The components and methods used to calculate the Shelf Life of Edible Coated Manilkara Zapota (Sapodilla) fruits are also covered.

SELECTION OF FRUITS

The Sapodilla was purchased fresh from the market (Dadri market). Diseased, damaged, and unusually large or small fruits were killed to reduce biological variety, and the selected fruits were almost identical in form, size, and hue. The fruits were cleaned with distilled water and dried before the experiment to eliminate any possible defection

SELECTION OF COATING MATERIALS

The investigation was carried out to determine the appropriate concentrations of the materials for the coating articulations. In varying quantities, we used Rice Bran, Aloe Vera, Cassava Starch, Mint, and Tulsi. Rice Bran was taken from the Ghaziabad Rice Mill. Before making the coatings, rice bran from white uncooked rice was pulverized into fine particles. Rice Bran extract was used to make the edible coating. Fresh Aloe Vera leaves were taken from the Nursery plant and cleaned with distilled water and 2 % (v/v) Sodium Hypochlorite to remove the dirt from the surface of the Aloe Vera leaves. After separating the Aloe Vera matrix from the outer cortex of the leaves, then the colorless hydro parenchyma was homogenized in a blender. After that, the gel was filtered to eliminate the fibers, yielding fresh Aloe Vera Gel.

Cassava roots were acquired from Amazon online, and pure and clean cassava starch was prepared using the procedure (Dziedzoave et al 2003). Cassava roots were peeled, cleaned, and grated. The grated pulp was mixed with water and filtered to remove the particles. After washing, settled starch was recovered and crushed.

Fresh Tulsi (Ocimum sanctum) and Mint leaves were harvested from the same nursery plant and washed with water. It was then thoroughly dried in an oven at 45–50 ° C. Following that, dried leaves were crushed by the grinder, 25 g leaves powder was measured for producing the thimble, and it was inserted into a Soxhlet apparatus siphon tube and filled with distilled water. Leaves were extracted using a Soxhlet device at 70°C for 48 hours. The extract was then concentrated by evaporation, allowed to cool, and put for air drying. The leaf extract was then used to create the Edible Coating.

COATING OF FRUITS

As a consequence, the fruits were classified into three categories. Group A is considered in which fruits were coated with the Rice Brain-based Edible Coating Solution in several concentrations (1%, 2%, and 3 %). Group B in which aloe vera-based Edible Coating was done in different concentrations (1%, 2%, and 3%). Group C was classified as a Control Sample because no coating treatment was applied. Rice Bran-based Edible Coating was used in three concentrations: 1%, 2%, and 3% with 1:1 Mint and Tulsi, and Aloe Vera-based Edible Coating was used in the same three concentrations: 1%, 2%, and 3% with 1:1 Mint and Tulsi.

The fruits were coated with the dipping method in the coating concentrations mentioned above. Fruits were dipped for 2 minutes at room temperature and then kept for air drying before storage under ambient temperature (28- 30℃ , 55% - 60% RH).

The storage qualities of the treated Sapodilla and Control Sapodilla were evaluated at the two days interval.

PHYSICOCHEMICAL ANALYSIS

1. PHYSIOLOGICAL WEIGHT LOSS

The weight loss was assessed at every 2 days intervals using the (AOAC15) technique, which determined the difference between the end and beginning weight of the fruit and then divided by the difference in starting weight.The observed value was noted in the form of a percentage (%). The weight loss was determined by the formula –

$$\text{weight loss} = \frac{Wi \times Wf}{Wi} \times 100$$

Where Wi is the initial weight of the sample and Wf is the final weight of the samples.

2. FIRMNESS

The Texture Profile Analyzer with a probe (p/5) determines the firmness. Set the pre-test speed to 1 mm s (-1) and the post-test speed to 10 mm s. (-1). Newtonian values were used to calculate stiffness (N).

3. COLOR VALUES

At room temperature, the color values of Sapodilla were determined using a Hunter Lab Color Spectrometer. L*, a*, and b* were used to assess color values. Where L* is the level of intensity of lightness/darkness, a* is the difference between red/green colour, and b* is the difference between yellow/blue color.

4. TOTAL SOLUBLE SOLIDS (TSS) AND pH

The fruits' total soluble solids (TSS) content was measured using the Hand Refractometer after calibrating it properly with distilled water. After calibrating the pH meter, the pH of the fruit pulp was measured using a digital pH meter. The pH meter was calibrated first using 4pH, 7pH, and 10pH buffer solutions, and then the pH meter probe was inserted in the fruit juice and measurement was obtained immediately. (Ranganna, 1999).

5. TITRABLE ACIDITY

Titrable Acidity is calculated using the volumetric method. A solution (0.1 mol L (-1)) containing phenolphthalein as an indicator solution was used to neutralize the juice. Under neutral conditions, the NaOH solution did indeed turn the juice pink. A known sample of fruits was measured and crushed before being put in a 250 ml volumetric flask for filtration. Furthermore, 10 ml of filtration was titrated with 0.1N NaOH using Phenolphthalein as an endpoint indicator of light pink color.

$$\text{TA (\%)} = \frac{titre\ value * normality\ of\ NaOH * total\ volume\ acid\ factor}{weight\ of\ sample * volume\ of\ filtrate\ taken}$$

6. TOTAL SUGAR AND REDUCING SUGAR

The total sugar and reducing sugar methods were done according to Lane and Eynons method. In which titration were done against methylene blue indicator until a brick red color appears.

$$\text{Total sugar \%} = \frac{0.05 \times volume\ made\ up \times 100}{titre\ value \times weight\ of\ sample}$$

$$\text{Reducing sugar \%} = \frac{0.05 \times volume\ made\ up \times stock's solution}{titre\ value \times weight\ of\ sample\ originally\ taken \times 25}$$

7. ASCORBIC ACID CONTENT

The ascorbic acid concentration was determined using Sharma and Saini's 2, 6 dichlorophenolindophenol method. Titrations of the filtrate were done against 2, 6 dichlorophenolindophenol dye until a rose pink colour was achieved. The main acid found in the Sapodilla Fruit is ascorbic acid. The ascorbic content of fresh juice was given as mg 100 g (-1).

$$\text{Ascorbic acid } \frac{mg}{100\ g} \text{ of sample} = \frac{0.5mg\ V1\ 100ml}{V2\ 5ml\ weight\ of\ sample} 100$$

Where, V1 is the titre value of standard ascorbic acid, and V2 is the titre value of fruit pulp.

8. PECTIN CONTENT

Carre and Hayne's technique (Rangana, 1986) is used to determine the pectin content in sapodilla fruit, which is expressed as a percentage of calcium pectate.

RESULT AND DISCUSSION

1. PHYSIOLOGICAL WEIGHT LOSS

1% Rice Bran + Cassava Starch + Mint and Tulsi treatment showed the lowest mean weight loss concerning the Rice Bran based Edible Coating and 3% Aloe Vera + Cassava Starch + Mint and Tulsi recorded the lowest mean weight loss concerning Aloe Vera based Edible Coating. The coating materials caused the largest weight loss in the control group because of unrestricted transpiration, evaporation, and respiratory losses, control fruit may lose the most moisture.

Table 1(A) EFFECT OF PHYSIOLOGICAL WEIGHT LOSS (%) ON RICE BRAN BASED COATED SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
Control	3.38	13.03	17.33	22.62	14.09
T1	0.62	7.03	12.43	17.56	9.41
T2	0.92	10.2	13.98	19.93	11.25
T3	1.42	9.5	11.03	16.48	9.60

Rice Bran-based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract Control – Without Coated Fruit

Table 1 (B) EFFECT OF PHYSIOLOGICAL WEIGHT LOSS (%) ON ALOE VERA BASED COATED SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
Control	3.23	11.42	18.96	20.94	13.63
T1	1.03	5.93	12.08	20.03	9.76
T2	2.01	7.56	12.3	19.03	10.22
T3	0.88	4.82	9.52	12.63	6.9

Aloe Vera-based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

2. *FRUIT FIRMNESS*

During storage, the fruit hardness of Sapodilla fruits gradually decreased. (Table 2(A)). 2% Rice Bran + Cassava Starch + Mint and Tulsi extract was the most effective treatment in retaining a higher mean value of fruit firmness (847.4 N) while the control sample showed a greater decrease in fruit firmness from 902.56N to 286.35N.

Table 2 (A) EFFECT OF THE RICE BRAN BASED COATING ON A FIRMNESS (N) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	902.56	846.32	563.38	286.35	649.65
T1	1077	972.28	753.79	586.53	847.40
T2	975	740.53	549.74	246.97	628.06
T3	1128	993.517	653.84	428.08	800.85

Rice bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

In Aloe Vera based Edible Coating the treatment 3% Aloe Vera + cassava starch + mint and Tulsi extract gives the highest mean value of fruit firmness (1031.03) as compared with the control sample exhibiting a higher reduction of fruit firmness throughout the storage. Softening reduces fruit firmness because the inner middle lamella of the cell wall dissolves to become more soluble, leading the cell wall to be disturbed and loosened (Arvanitoyannis and colleagues 2005). Because of the delayed ripening, the treatment resulted in greater firmness. Despite this, there was a statistically significant interaction between treatment and storage intervals.

Table 2(B) EFFECT OF ALOE VERA BASED COATING ON FIRMNESS (N) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	1063.54	954.63	541.84	247.91	701.98
T1	800	694.57	328.06	214.80	509.35
T2	694.09	584.15	442.08	232.60	488.23
T3	1379	1038.80	900.71	805.62	1031.03

Aloe Vera-based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

3. COLOUR VALUES

Fruit quality is most affected by enzymatic browning mediated by peroxidase and polyphenol oxidase. The colour of the samples was determined using a Hunter Lab colour spectrophotometer, and the findings are displayed in the table as L*, a*, and b*, where L* is the amount of intensity of lightness/darkness, a* is the difference between red and green colour, and b* is the difference between yellow and blue colour. The colour of the peel is a significant aspect in assessing fruit quality in terms of ripening and maturity.

Table 3(A) EFFECT OF RICE BRAN AND ALOE VERA BASED COATING ON THE COLOUR (L*) OF SAPODILLA

Treatments	2 Day	4 Day	6 Day	8 Day	mean
1 % RB	52.18	49.16	47.87	43.23	48.11
2 % RB	53.89	50.61	49.83	47.16	50.37

3 % RB	54.73	52.67	50.13	46.78	51.07
1 % AV	51.36	46.37	43.92	37.53	44.79
2% AV	53.49	50.68	47.93	40.15	48.06
3% AV	51.36	48.78	46.37	42.17	47.17
Control	52.68	45.14	39.16	34.62	42.09

Rice bran based Edible Coating: *1% RB – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, 2% RB -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract ,3% RB – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – without Coated Fruit*

Aloe Vera based Edible Coating: *1% AV – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, 2% AV - 2% Aloe Vera + Cassava Starch + Mint and Tulsi extract, 3% AV – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract*

The L* value decreases gradually and it is the amount of intensity of lightness/darkness. In Rice Bran based Edible Coating the lowest mean treatment is 1% Rice Bran + Cassava Starch + Mint + Tulsi shows a 48.11. And In Aloe Vera based Edible Coating the treatment 1% Aloe Vera + Cassava Starch + Mint + Tulsi shows a lowest mean value which is 44.79 as compared to the Control Sample which shows the highest mean value that is 42.09 as shown in the Table 3(A).

Table 3(B) EFFECT OF RICE BRAN AND ALOE VERA BASED COATING ON THE COLOUR (a*) OF SAPODILLA

Treatments	2 Day	4 Day	6 Day	8 Day	mean
1 % RB	5.65	6.37	7.93	8.62	7.14
2 % RB	6.37	7.82	9.53	10.78	8.62

3 % RB	5.64	6.95	7.67	8.86	7.28
1 % AV	5.83	6.37	7.84	8.53	7.14
2% AV	5.97	6.59	7.78	10.63	7.74
3% AV	5.53	6.17	7.35	8.89	6.98
Control	6.03	9.60	10.91	10.83	9.34

Rice bran based Edible Coating: *1% RB – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, 2% RB -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract ,3% RB – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract , Control – without Coated Fruit*

Aloe Vera based Edible Coating: *1% AV – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, 2% AV - 2% Aloe Vera + Cassava Starch + Mint and Tulsi extract, 3% AV – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract*

The a* value decreases gradually and it is the difference between yellow and blue colour. In Rice Bran based Edible Coating, the lowest mean treatment is 1 % Rice Bran + Cassava Starch + Mint + Tulsi showings a 7.14. And In Aloe Vera-based Edible Coating the treatment 3 % Aloe Vera + Cassava Starch + Mint + Tulsi shows a lowest mean value which is 6.98 as compared to the Control Sample which shows the highest mean value that is 9.34 as shown in the Table 3 (B).

Table 3(C) EFFECT OF RICE BRAN AND ALOE VERA BASED COATING ON THE COLOUR (b*) OF SAPODILLA

Treatments	2 Day	4 Day	6 Day	8 Day	mean
1 % RB	24.48	22.52	20.17	19.37	21.63
2 % RB	26.53	21.58	18.58	13.53	20.05
3 % RB	25.78	22.59	19.15	15.59	20.77
1 % AV	23.35	22.72	20.59	16.67	20.83
2% AV	23.98	20.37	16.72	14.61	18.92
3% AV	25.21	19.50	14.67	11.32	17.67
Control	24.88	23.58	20.46	19.39	22.07

Rice bran based Edible Coating: *1% RB – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, 2% RB -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract ,3% RB – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – without Coated Fruit*

Aloe Vera based Edible Coating: *1% AV – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, 2% AV - 2% Aloe Vera + Cassava Starch + Mint and Tulsi extract, 3% AV – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract*

The b* value decreases gradually and it is the amount of intensity of lightness/darkness. In Rice Bran based Edible Coating the lowest mean treatment is 2 % Rice Bran + Cassava Starch + Mint + Tulsi shows a 20.05. And In Aloe Vera based Edible Coating the treatment 3 % Aloe Vera + Cassava Starch + Mint + Tulsi shows a

lowest mean value which is 17.67 as compared to the Control Sample which shows the highest mean value that is 22.07 as shown in the Table 3 (C).

4. TOTAL SOLUBLE SOLIDS (TSS)

TSS changes were slower in the 3% Rice Bran + Cassava Starch + Mint and Tulsi extract and the 3% Aloe Vera + Cassava Starch + Mint and Tulsi extract. TSS increased with time in all treatments (Table 4(A) & Table 4(B)), owing to increased starch hydrolysis to simple sugar during fruit ripening.

Table 4(A) EFFECT OF RICE BRAN BASED COATING ON THE TOTAL SOLUBLE SOLIDS (TSS) (0 BRIX) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	11	17.2	21.6	29.4	19.8
T1	8.4	10.6	15.3	19.7	13.5
T2	9.6	14.6	19.7	24.9	17.2
T3	8.6	11.1	13.8	17.5	12.75

Rice Bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

TSS is shown to be reduced when the conversion is lower than the usage (1987, Gupta and metha). The TSS undercoating treatment's slower rate of development might be related to ripening delays.

Table 4(B) EFFECT OF THE ALOE VERA BASED COATING ON A TOTAL SOLUBLE SOLIDS (0 BRIX) OF FRUIT SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	11	17.2	21.6	29.4	19.8
T1	10.2	11	14.6	16.4	13.05
T2	12.4	16.6	18.2	21.3	17.12
T3	9.74	11.4	13.2	16.2	12.63

Aloe Vera based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

5. PH

1% Rice Bran + Cassava Starch + Mint and Tulsi(T1) treatment showed the lowest mean pH concerning the Rice Bran based Edible Coating and 3% Aloe Vera + Cassava Starch + Mint and Tulsi recorded the lowest mean pH concerning Aloe Vera based Edible Coating as compare to the Control Sample.

Table 5(A) EFFECT OF RICE BRAN BASED COATING ON PH OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	5.68	5.78	5.98	6.21	5.91
T1	5.23	5.43	5.62	5.67	5.48
T2	5.20	5.73	5.79	5.80	5.63

T3	5.62	5.67	5.71	5.86	5.71

Rice Bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

Table 5(A) shows that the 1 % Rice Bran + Cassava Starch + Mint and Tulsi(T1) treatment had the lowest mean pH content of 5.48 in Rice Bran-based Edible Coating. When compared to the Control Sample, 1% Aloe Vera + Cassava Starch + Mint and Tulsi had the lowest mean pH content of 5.27 in Aloe Vera-based Edible Coating treatments. As demonstrated in Tables 5(A) and 5(B), the control sample has the highest mean pH content of 5.91 in both cases with Rice Bran and Aloe Vera based Edible Coating Solution.

Table 5 (B) EFFECT OF ALOE VERA BASED COATING ON pH OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	5.68	5.78	5.98	6.21	5.91
T1	5.0	5.29	5.32	5.5	5.27
T2	5.09	5.31	5.52	5.84	5.44
T3	5.63	5.66	5.71	5.80	5.71

Aloe Vera-based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

6. TITRABLE ACIDITY

The acidity of Sapodilla fruits varied throughout storage under various coating treatments, revealing a steady reduction in TA during ambient storage. The control treatment had the highest mean acidity content (0.14

%) at the end of storage, whereas the 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract had the lowest change in acidity (0.09 % mean value). The acidity content of fruits covered with Rice Bran-based Edible Coatings was modestly reduced at room temperature.

Table 6(A) EFFECT OF RICE BRAN BASED COATING ON TITRABLE ACIDITY (CITRIC ACID %) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	0.20	0.13	0.09	0.06	0.14
T1	0.15	0.13	0.11	0.08	0.11
T2	0.17	0.14	0.09	0.07	0.11
T3	0.15	0.11	0.07	0.03	0.09

Rice Bran- based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

In addition, as compared to the control sample, the treatment 1 % and 2 % Aloe Vera + Cassava Starch + Mint and Tulsi Extract of Aloe Vera based Edible Coating Solutions had the lowest acidity mean value of 0.09. The reduction in acidity and increase in pH during storage might be ascribed to the use of organic acid as respiratory substrates during storage, as well as the conversion of acid into sugars, whereas the acidity decrease appears to be a result of the ripening process (Rodriguez and Mabery, 2006).

Table 6(B) EFFECT OF ALOE VERA BASED COATING ON TITRABLE ACIDITY (CITRIC ACID %) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	0.19	0.14	0.07	0.08	0.12
T1	0.12	0.10	0.08	0.08	0.09
T2	0.13	0.10	0.09	0.06	0.09
T3	0.13	0.11	0.10	0.08	0.10

Aloe Vera-based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

7. TOTAL SUGAR

The total sugar content of fruits increased as the storage time progressed (Tables 7(A) and 7(B)). The 3 % Aloe Vera + Cassava Starch + Mint and Tulsi Extract treatment showed slower fluctuations in sugar content decrease, with (8.68 %) at the end of storage.

Table 7(A) EFFECT OF RICE BRAN BASED COATING ON TOTAL SUGAR (%) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	9.06	10.53	13.70	17.03	12.58
T1	7.68	9.53	11.54	15.56	11.07
T2	7.43	9.42	12.63	16.46	11.48
T3	6.83	8.49	12.47	15.87	10.91

Rice Bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

With a mean sugar reduction of 12.58 %, the control treatment showed the biggest reductions in total sugar. As demonstrated in Tables 7 (A) and 7 (B), the Rice Bran-based Edible Coating treatment with 3 % Rice Bran + Cassava Starch + Mint and Tulsi Extract had the least alterations in decreasing sugar level, with 10.91 %.

Table 7 (B) EFFECT OF THE ALOE VERA BASED COATING ON A TOTAL SUGAR (%) OF FRUIT SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
T1	7.58	8.73	10.53	13.48	10.08
T2	8.06	9.58	11.67	14.97	11.07
T3	6.73	7.42	9.07	11.53	8.68

Aloe Vera based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera+ Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

8. REDUCING SUGAR

Reducing sugar content of fruits increased with the advancement in the storage period (Table 8 (A) & 8(B)). Slower variations in sugar content reduction were found in the 3 % Aloe Vera + Cassava Starch + Mint and Tulsi Extract treatment, which had (5.78 %) at the end of storage.

Table 8(A) EFFECT OF RICE BRAN BASED COATING ON REDUCING SUGAR (%) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	5.60	6.53	8.97	14.78	8.97
T1	4.63	5.57	7.97	11.59	7.44
T2	3.83	6.45	9.58	12.67	8.13
T3	2.47	6.27	9.63	13.58	7.98

Rice Bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract , T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract , Control – Without Coated Fruit

The control treatment demonstrated the greatest changes in sugar reduction, with a mean sugar reduction of 8.97%. The decreasing sugar content of rice bran-based coatings increased after storage. Treatment 1 % Rice Bran + Cassava Starch + Mint and Tulsi Extract had the smallest modifications in lowering sugar content, with 7.44 % at the end of storage as shown in Table 8 (A) and 8 (B).

Table 8(B) EFFECT OF ALOE VERA BASED COATING ON REDUCING SUGAR (%) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
T1	3.57	4.43	7.58	10.58	6.54
T2	4.98	5.67	9.15	12.68	8.12
T3	3.27	4.36	6.17	9.35	5.78

Aloe Vera based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

9. ASCORBIC ACID

During ambient storage, ascorbic acid levels in both control and coated Sapodilla fruits declined. Ascorbic acid concentration decreases as the amount of total soluble solids increases during fruit ripening (Padmaja et al., 2015). In both coating treatments, the coated fruits with Rice Bran and Aloe Vera based Edible Coating Solution had the lowest ascorbic acid levels of 11.93% and 10.68%, respectively.

Table 9(A) EFFECT OF RICE BRAN BASED COATING ON ASCORBIC ACID (%) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	16.03	10.52	8.68	6.53	10.44
T1	14.54	13.36	10.43	9.42	11.93
T2	15.24	14.62	11.43	7.67	12.24
T3	15.53	13.97	10.43	8.28	12.05

Rice Bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

The ascorbic acid content of control Sapodilla fruits was decreased by 10.44%. The ascorbic acid content of sapodilla fruits coated with Rice Bran and Aloe Vera-based Edible Coating differed considerably from the control. The ascorbic acid content of Aloe Vera coated sapodilla fruits dropped at a slower rate as compared to control fruits. This decrease in ascorbic acid is mostly owing to a rise in sugar concentration during storage (Padmaja 2015).

Table 9(B) EFFECT OF AN ALOE VERA BASED COATING ON THE ASCORBIC ACID (%) OF FRUIT SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	16.03	10.52	8.68	6.53	10.44
T1	15.56	13.43	10.7	8.96	12.16
T2	14.32	11.82	09.74	6.84	10.68
T3	15.12	13.54	10.12	8.68	11.86

Aloe Vera based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

10. PECTIN CONTENT

1% Rice Bran + Cassava Starch + Mint and Tulsi(T1) treatment showed the lowest mean pectin content concerning the Rice Bran based Edible Coating and 3% Aloe Vera + Cassava Starch + Mint and Tulsi recorded the lowest mean pectin content concerning Aloe Vera based Edible Coating as compare to the Control Sample.

Table 10(A) EFFECT OF RICE BRAN BASED COATING ON PECTIN CONTENT (%) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	6.03	7.48	9.14	9.67	8.08
T1	5.04	5.67	6.31	6.98	6.00
T2	5.53	6.27	7.35	8.94	7.02
T3	5.24	6.46	7.21	9.83	7.18

Rice Bran based Edible Coating: T1 – 1% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T2 -2% Rice Bran + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Rice Bran + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

1% Rice Bran + Cassava Starch + Mint and Tulsi(T1) treatment showed the lowest mean pectin content 6.00% as shown in table 4.10(A) in Rice Bran based Edible Coating.

Table 10(B) EFFECT OF ALOE VERA BASED COATING ON PECTIN CONTENT (%) OF SAPODILLA

TREATMENTS	2 DAY	4 DAY	6 DAY	8 DAY	MEAN
CONTROL	5.64	7.58	8.94	9.78	7.98
T1	5.27	5.51	6.23	7.08	6.02
T2	5.14	6.17	6.42	7.58	6.32
T3	5.03	5.21	6.09	6.52	5.71

Aloe Vera based Edible Coating: T1 – 1% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T2 -2% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, T3 – 3% Aloe Vera + Cassava Starch + Mint and Tulsi Extract, Control – Without Coated Fruit

In Aloe Vera based Edible Coating treatments 3% Aloe Vera + Cassava Starch + Mint and Tulsi recorded the lowest mean pectin content 5.71% in contrast to the Control Sample. In which control sample shows the highest mean pectin content 8.08% and 7.98 % in both cases with Rice Bran and Aloe Vera based Edible Coating Solution as shown in the Table 10(A) and 10(B).The progressive change in pectin concentration with storage time might be due to pectin enzyme action on natural pectin in the fruits.

FIG 1. SAPODILLA AT 0 DAY

FIG 1. SAPODILLA AT 2 DAY

FIG 1. SAPODILLA AT 4 DAY

FIG 1. SAPODILLA AT 6 DAY

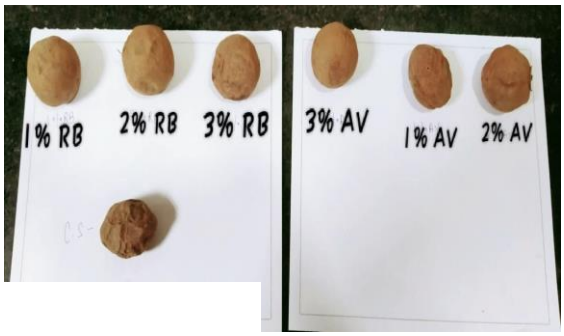
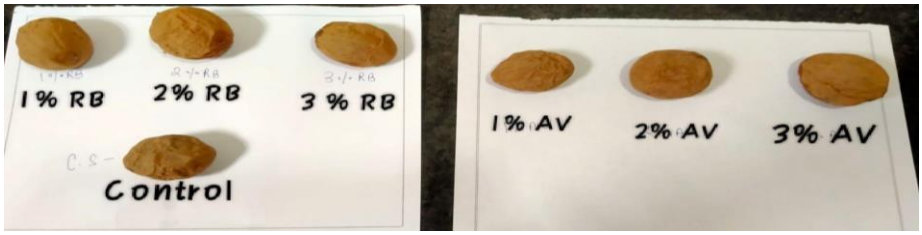


FIG 1. SAPODILLA AT 8 DAY



CONCLUSION

This research found that a rice bran and aloe Vera-based edible coating with herbal extract coating materials increased the shelf life and quality of Sapodilla at room temperature while also protecting them from damage. The coated Sapodilla was better for all quality parameters as compared to the uncoated Sapodilla on the 8th day of storage. In Rice Bran based Edible Coating treatment 2 % Rice Bran + 1% Cassava Starch + 1% Mint and 1% Tulsi and In Aloe Vera based Edible Coating treatments 3% Aloe Vera + Cassava Starch + 1% Mint and 1% Tulsi is the most effective as compare to the Control Sample of Sapodilla.

These edible coating materials were most effective in reducing weight loss, firmness, pH, and TSS and similarly, no significant difference was reported between the coated and uncoated Sapodilla. Therefore, the conclusion of this study is that the Edible Coating of Rice Bran and Aloe Vera was an effective and healthy source used for enhancement of shelf life of fresh Sapodilla.

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