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Effect of edible herbal coatings to extend the shelf life of banana cv. 'Ney Poovan' (not exposed to smoke) stored at room temperature

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Abstract
The present investigation was carried out on the harvested banana bunch which was not exposed to smoke for regulating the ripening of fruits in the banana bunch. The treatments were consist of 2.0 percent corn starch, 4.0 percent corn starch and 6.0 percent corn starch with different combination of herbal extracts such as Tulsi leaf extract, Mint leaf extract and papaya leaf extract at 2.0 percent, 4.0 percent, 6.0 per cent. The experiment was conducted in Completely Randomized Design (CRD) with thirteen treatments and three replication. The results showed the treatment of 6.0 per cent of corn starch with papaya leaf extract at 6.0 per cent were significantly increased the shelf life, reduced the physiological loss in weight and fruit spoilage percentage compared to control and other edible herbal coatings.

Keywords: Edible herbal coating, corn starch, papaya leaf extract, tulsi extract, mint leaf extract, ney poovan, shelf life

Introduction
Banana is one of the oldest and tastiest fruit known to mankind. Banana originated from South East Asia. Banana is popularly called as "Apple of paradise, Adam's fig, tree of wisdom. It is specially known as "Kalpatharu or Kalpaviruksham which means each and every part of banana is used as effectively. The major banana producing states of India such as Tamil Nadu, Maharashtra, Karnataka, Gujarat, Andhra Pradesh, Assam and Madhya Pradesh. Among the different cultivar of banana 'Ney Poovan' is most popular cultivar and commercially cultivated cultivar, especially in Tamil Nadu and Karnataka. The fruits are small in size, extremely sweet in taste. It is a slender, medium tall plant bearing dark green fruits which turn golden yellow with highly fragrant, tasty, powdery and firm fruits. The pulp of the fruit is ivory white in colour. Being a climacteric of this fruit causes rapid changes in physico-chemical properties such as colour, texture, aroma, chemical composition, respiration rate and senescence, higher oxygen consumption, starch to sugar conversion, chlorophyll degradation (Marriott *et al*., 1981) [7]. These post-harvest changes cannot be stopped but can be slowed down within certain limits through the application of good post-harvest management practice (Elda *et al*., 2018) [4]. Edible herbal coatings are one of the best post-harvest practices to enhance the storage life of horticulture crops. The edible herbal coatings are safe to human as well as environment, cheaply available, cost effective and simplest method. It had many medicinal properties and antimicrobial properties such as vitamins, antioxidants and essential minerals. Hence in the view of above facts an attempt has been made to increase the shelf life of banana cv. 'Ney Poovan' stored at room temperature.

Materials and methods
An experiment was carried out in Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar during the year 2018-2020. The Experiment was laid out in Completely Randomized Design (CRD) with 13 treatments with three replication. The harvested bunch was exposed to smoke for regulating the uniform ripening of all fruit in the bunch. The treatments comprised of corn starch at 2.0, 4.0, and 6.0 per cent and then different starch percent with combination of three edible herbal coating materials such as *ocimum* extract, mint extract, papaya leaf extract. The control was maintained (Table 1). The coated fruit samples were analysed for physical properties at an interval of alternate days.

Preparation of Tulsi leaf extract coating material
Fresh tulsi leaves were collected from the medicinal plant unit and the leaf extract was prepared by grinding the clean and washed tulsi leaves.

After grinding the leaves, the leaf extract was taken from the grinded leaves by squeezing it. The tulsi leaf extract herbal coating material was prepared for three different formulations *i.e.*, 2.0 per cent, 4.0 per cent and 6.0 per cent. For preparing 2.0 per cent tulsi leaf extract coating material 40 g of fresh tulsi leaves, 40 g of corn starch, and 4 ml of glycerol is needed. Extract the juice of 40g tulsi leaves and made it up to 500 ml. 40 g of corn starch in 1.5 litres of water and heated at 90ºC for 10-15 minutes with continuous agitation. After attaining the room temperature, add 4 ml of glycerol and 500 ml of tulsi leaf extract. The same procedure is followed for 4.0 per cent and 6.0 per cent concentrations. The composition of tulsi leaves and corn starch each 80 g for 4 per cent concentration whereas 120 g of tulsi leaves and 120 g of corn starch for 6.0 per cent concentration. The same procedure followed for preparing mint leaf extract and papya leaf extract as coating materials.

Preparation of Corn starch coating material

The commercial corn flour was used for edible coating material. Corn starch coating solution was prepared by dissolving 40 g (2.0 per cent), 80 g (4.0 per cent) and 120 g (6.0 per cent) starch in distilled water with agitation for 10 min at 90^0C. Glycerol 87 per cent was added as a plasticizer at a concentration of 2 ml/litre solution (Ghosh *et al.*, 2015) [5].

Table 1: Treatment details

Treatment. No	Treatment details
T_1	Control
T_2	Corn starch @ 2.0%
T_3	Corn starch @ 4.0%
T_4	Corn starch @ 6.0%
T_5	Corn starch @ 2.0% + Tulsi leaf extract @ 2.0%
T_6	Corn starch @ 4.0% + Tulsi leaf extract @ 4.0%
T_7	Corn starch @ 6.0% + Tulsi leaf extract @ 6.0%
T_8	Corn starch @ 2.0% + Mint leaf extract @ 2.0%
T_9	Corn starch @ 4.0% + Mint leaf extract @ 4.0%
T_{10}	Corn starch @ 6.0% + Mint leaf extract @ 6.0%
T_{11}	Corn starch @ 2.0% + Papaya leaf extract @ 2.0%
T_{12}	Corn starch @ 4.0% + Papaya leaf extract @ 4.0%
T_{13}	Corn starch @ 6.0% + Papaya leaf extract @ 6.0%

Results and discussion

Effect of edible herbal coatings on physical traits of banana cv. 'Ney Poovan'

Physiological loss in weight

The data on the effect of edible herbal coatings on physiological loss in weight (%) of fruits on 3rd, 5th 7th, 9th, 11th, 13th and 15th day after treatments were presented in the Table 2. Significant differences on physiological loss in weight were observed due to the influence of different edible herbal coating treatments. Among the treatments the minimum percentage of physiological loss in weight was recorded in the fruits dipped in corn starch at 6.0 per cent with papaya leaf extract at 6.0 per cent (T_{13}) which registered the values of 2.04, 3.99, 5.18, 7.33, 4.26, 3.33 and 2.94 per cent at 3rd, 5th, 7th, 9th, 11th, 13th and 15th day after treatments respectively.

The next best treatment was T_{10} (corn starch @ 6.0 per cent with Mint extract @ 6.0 per cent) which was registered the physiological loss in weight of 2.33, 4.45, 5.57, 7.82, 4.69, 3.54 and 3.01 per cent at 3rd, 5th 7th, 9th, 11th, 13th and 15th day after treatments respectively. The maximum physiological loss in weight of 5.29, 8.77, 10.13, 12.62, 9.41 and 5.99 per cent respectively were recorded in the control (T_1) at 3rd, 5th, 7th, 9th, 11th, 13th and 15th day after treatment. Among the treatments T_1; T_2, T_3; T_4 and T_6; T_7 lied on pair with each other.

Table 2: Effect of edible herbal coatings on physiological loss in weight (%) of banana cv. 'Ney Poovan' (Fruits not exposed to smoke)

Treatments	3rd day	5th day	7th day	9th day	11th day	13th day	15th day
T_1 – Control	5.29	8.77	10.13	12.62	9.41	5.99	-
T_2 –Corn Starch @ 2.0%	5.26	8.74	10.10	12.60	9.41	5.93	-
T_3-Corn Starch @ 4.0%	4.18	6.88	8.85	10.48	8.10	4.65	-
T_4-Corn Starch @ 6.0%	4.16	6.85	8.81	10.43	8.10	4.62	-
T_5-Corn Starch @ 2.0% + Tulsi Leaf Extract @ 2.0%	5.23	8.66	10.04	12.42	9.38	5.77	-
T_6-Corn Starch @ 4.0% + Tulsi Leaf Extract @ 4.0%	3.53	6.02	7.85	9.61	6.92	4.30	-
T_7-Corn Starch @ 6.0% + Tulsi Extract @ 6.0%	3.52	6.01	7.81	9.58	6.91	4.29	-
T_8-Corn Starch @ 2.0% + Mint Leaf Extract @ 2.0%	4.96	8.24	9.77	11.93	9.01	5.57	-
T_9-Corn Starch @ 4.0% + Mint Leaf Extract@ 4.0%	3.06	5.46	7.29	8.87	5.93	4.01	-
T_{10}-Corn Starch @ 6.0%+ Mint Leaf Extract @ 6.0%	2.33	4.45	5.57	7.82	4.69	3.54	3.01
T_{11}-Corn Starch@ 2.0% + Papaya Leaf Extract @ 2.0%	4.71	7.87	9.24	11.42	8.52	5.06	-
T_{12}-Corn Starch @ 4.0%+ Papaya Leaf Extract @ 4.0%	2.68	4.95	6.03	8.32	5.25	3.75	-
T_{13}-Corn Starch @ 6.0% + Papaya Leaf Extract @ 6.0%	2.04	3.99	5.18	7.33	4.26	3.33	2.94
S. Ed	0.251	0.368	0.380	0.407	0.396	0.205	NS
CD (P=0.05)	0.512	0.735	0.762	0.814	0.792	0.409	-

Fruit spoilage percentage

From the results of Table 3 shows fruit spoilage percentage at 9th, 11th, 13th and 15th day after treatment was found to be significant. A progressive reduction in the fruit spoilage were observed in all the edible herbal coating treatments. Among the various treatments the corn starch at 6.0 per cent with papaya leaf extract @ 6.0 per cent (T_{13}) registered the least spoilage percentage of 9.72, 22.12, 48.25 and 62.27 per cent respectively at 9th, 11th, 13th and 15th day after treatment followed by T_{10} (corn starch @ 6.0 per cent with Mint extract

@ 6.0 per cent) which was recorded 10.24, 23.70, 51.77 and 65.26 per cent respectively. The maximum spoilage percentage of 15.93, 42.62 and 79.82 per cent at 9th, 11th day and 13th day after treatment respectively were observed in the control (T_1). Among the treatments T_1; T_2, T_3; T_4, and T_6; T_7 lied on pair with each other.

Shelf life of fruit

From the results of Table.4 the shelf life (days) was varied significantly among the various treatments. The shelf life was maximum (15.00 days) in the fruits dipped in corn starch at 6.0 per cent with papaya leaf extract at 6.0 per cent (T_{13}) which recorded an increase of 87.5 per cent over the control. The next best treatment was T_{10} (corn starch at 6.0 per cent with papaya leaf extract at 6.0 per cent) which extended the shelf life up to (15.00 days) which was 87.5 per cent higher over the control. The shelf life of fruit was least (8.00 days) in the control (T_1). Among the different treatments T_1; T_2, T_3; T_4 and T_6; T_7 lied on pair with each other.

Table 3: Effect of edible herbal coatings on fruit spoilage (%) of banana cv. 'Ney Poovan' (Fruits not exposed to smoke)

Treatments	3rd day	5th day	7th day	9th day	11th day	13th day	15th day
T_1 – Control	-	-	-	15.93	42.62	79.82	-
T_2 –Corn Starch @ 2.0%	-	-	-	15.85	42.53	79.74	-
T_3-Corn Starch @ 4.0%	-	-	-	13.38	35.77	65.31	-
T_4-Corn Starch @ 6.0%	-	-	-	13.33	35.68	65.26	-
T_5-Corn Starch @ 2.0% + Tulsi Leaf Extract @ 2.0%	-	-	-	15.77	40.33	75.98	-
T_6-Corn Starch @ 4.0% + Tulsi Leaf Extract @ 4.0%	-	-	-	12.52	30.16	62.14	-
T_7-Corn Starch @ 6.0% + Tulsi Leaf Extract @ 6.0%	-	-	-	12.49	30.01	62.11	-
T_8-Corn Starch @ 2.0% + Mint Leaf Extract @ 2.0%	-	-	-	15.12	40.15	71.35	-
T_9-Corn Starch @ 4.0% + Mint Leaf Extract@ 4.0%	-	-	-	11.69	27.75	59.68	-
T_{10}-Corn Starch @ 6.0%+ Mint Leaf Extract @ 6.0%	-	-	-	10.24	23.70	51.77	65.26
T_{11}-Corn Starch@ 2.0% + Papaya Leaf Extract @ 2.0%	-	-	-	14.30	38.59	68.73	-
T_{12}-Corn Starch @ 4.0%+ Papaya Leaf Extract @ 4.0%	-	-	-	10.90	25.62	57.01	-
T_{13}-Corn Starch @ 6.0% + Papaya Leaf Extract @ 6.0%	-	-	-	9.72	22.12	48.25	62.27
S. Ed	-	-	-	0.478	1.577	2.428	NS
CD (P=0.05)	-	-	-	0.955	3.154	4.857	-

Table 4: Effect of edible herbal coatings on shelf life of banana (Days) cv. 'Ney Poovan' (Fruits not exposed to smoke)

Treatments	Shelf life	Percentage over control
T_1 – Control	8	0.00
T_2 –Corn Starch @ 2.0%	8	0.00
T_3-Corn Starch @ 4.0%	11	37.5
T_4-Corn Starch @ 6.0%	11	37.5
T_5-Corn Starch @ 2.0% + Tulsi Leaf Extract @ 2.0%	9	12.5
T_6-Corn Starch @ 4.0% + Tulsi Leaf Extract @ 4.0%	12	50.0
T_7-Corn Starch @ 6.0% + Tulsi Leaf Extract @ 6.0%	12	50.0
T_8-Corn Starch @ 2.0% + Mint Leaf Extract @ 2.0%	9	12.5
T_9-Corn Starch @ 4.0% + Mint Leaf Extract@ 4.0%	13	62.5
T_{10}-Corn Starch @ 6.0%+ Mint Leaf Extract @ 6.0%	15	87.5
T_{11}-Corn Starch@ 2.0% + Papaya Leaf Extract @ 2.0%	10	25
T_{12}-Corn Starch @ 4.0%+ Papaya Leaf Extract @ 4.0%	14	75
T_{13}-Corn Starch @ 6.0% + Papaya Leaf Extract @ 6.0%	15	87.5
S. Ed	0.538	-
CD (P=0.05)	1.077	-

Banana is one of the most appreciated fruit all over the world because of its multipurpose use as food. Banana is a highly perishable fruit and it possess very short shelf life under ambient condition, due to improper handling and storage the wholesalers and retailers are often forced to dispose of their fruits over a short period of time (Haidar and Demisse, 1999) [6]. Hence it is imperative to find out to reduce the spoilage during post- harvest period. Most of the synthetic preservatives produce several side-effects as carcinogenicity, teratogenicity and residual toxicity (Basilico and Basilico, 1999) [1].

Edible herbal coatings are one of the best post- harvest practices to enhance the storage life of horticulture crops. The herbal extract and their combinations are also used in preparation of edible coatings this can act as antimicrobial, antioxidant and preservative as well as known as herbal edible coating (Pramod *et al*., 2018) [8]. The coated fruits should be maintained all physical and chemical properties than uncoated fruit (control) and it barrier against moisture loss, oxygen and provide good strength and structural integrity, maintain the glossiness and retard the ripening and increase the shelf life. Considering the benefit and health of future generation, adopting ecofriendly, easily available and cheap price, being bio degradable as well as edible materials were used for coating the banana fruits to extend the shelf life. The results of the present investigation have been discussed here under.

The results of the present study indicated that the physiological loss in weight and shelf life was significantly influenced by the edible herbal coating treatments. The maximum shelf life and the reduction of physiological loss in weight of fruit was observed in the fruits dipped in corn starch @ 6.0 per cent with papaya leaf extract at 6.0 per cent followed by corn starch @ 6.0 per cent with Mint extract at 6.0 per cent. A significant reduction in physiological loss in weight and extension of shelf life was observed in the fruits coated with corn starch @ 6.0 per cent with papaya leaf extract at 6.0 per cent. This may be due to the papaya leaves contains a bio active phytochemical that can serve as a source

of natural antimicrobial agents, which protect both human being as well as the fruits and vegetable from the infection leads the lower physiological loss in weight and extended the shelf life. Coating of fruits with papaya leaf extract have excellent potential in maintain the firmness of fruit and reduction of physiological loss in weight extended the shelf life of sweet cherry (Yaman *et. al.* 2002) [10].

In this experiment, the banana fruits were exposed to smoke. Further, weight loss of the fruit is mainly related with respiration and moisture transfer through their surface. Evaporation of water activated by a gradient of vapor pressure at different locations in fruit is contributing to weight loss (Zhou *et al*., 2008) [11]. This could also be effective in extending the shelf life of banana.

Dipping the banana cv. 'Ney Poovan' fruits in corn starch at 6.0 per cent with papaya leaf extract at 6.0 per cent significantly reduced the spoilage percentage and could maintain their marketable acceptability up to 15th day of storage when compared to control. The decrease in spoilage percent might be due to the effect of coating on delaying senescence, which makes the commodity more vulnerable to pathogenic infection as a result of cellular or tissue integrity (Tanada-Palmu and Grosso, 2005) [9] similar views were also expressed by (Dey *et al*., 2014) [3] in sapota and (Ghosh *et al*., 2015) [15] in Assam lemon. The fruits dipped in the combination of corn starch at 6.0 per cent and papaya leaf extract at 6.0 per cent decreased in spoilage per cent might be due to the effect of papaya leaf extract that suppressed spoilage in fruits not only with their antimicrobial properties but also with their promotion of decay resistance in the fruit tissue through increasing the amount of phenol compounds, anthocyanins, flavonoids and anti-oxident capacities (Chavez-Quintal *et al*., 2011) [2].

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