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Studies on use of plant extracts as natural coatings for enhancing shelf life and quality of banana fruits

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Abstract
As a climacteric fruit, bananas have a relatively limited shelf life. One crucial objective is to increase the shelf life of fruit. The use of prepared edible coatings made of natural plant extracts is one such natural way to increase the shelf life of fruits after harvest. Natural coatings have long been recognized to delay dehydration, limit respiration, improve textural quality, aid retain volatile flavor components, and inhibit microbiological development in order to preserve perishable food goods from degradation. Fresh fruits and vegetables have just begun to employ plant-based compounds as bio-preservatives. One of the promising bio-preservatives that has a great chance of becoming widely used for most fresh fruits and vegetables is *Aloe vera* gel. Legumes, cereals, and tuber vegetables including potatoes, cassava, corn, rice, and bananas all include starch, a storage polysaccharide. It is an effective barrier against the passage of oxygen but not water vapor. Due to the presence of curcumin, turmeric extract applied to edible film can work as an antioxidant. Banana peel has the potential to prolong shelf life and inhibit microbiological development in banana preservation. The antifungal and antibacterial properties of pomegranate peel operate as a protective barrier against microbial contamination of fruits and vegetables, while the influence of essential oils and their components lowers the incidence of post-harvest illnesses of horticultural goods and fruits. The T_2 (*Aloe vera* gel (20%) therapy had the highest phenol content and the lowest microbial count, illness score, and disease index among the various treatments.

Keywords: Aid retain volatile, flavor components, inhibit

Introduction

The most extensively grown and consumed fruit in tropical and subtropical areas of the world is the banana (*Musa* spp.), which is a significant staple food crop for millions of people (Deka and Choudhury, 2018) [9]. According to production and area of cultivation, bananas are the most produced fruit in the world, with India being the main producer (TIFAC Report quoted in Surendranathan *et al*., 2004) [30]. Compared to many other fruits, bananas have a more equal distribution of nutrients. They include virtually all of the elements that are necessary, including vitamins and minerals (Prodhan *et al*., 2017) [22]. Bananas are distinctive due to their high calories and nutritive values.

With a production of 97.35 MMT of fruits and 184.39 MMT of vegetables in 2019–20, India is the world's top producer of both fruits and vegetables (Jha, 2021) [13]. Sadly, India also ranks first in terms of post-harvest and harvest losses for horticulture crops. According to estimates, fruits and vegetables worth Rs. 40,811 crores are wasted on average every year (16%, Jha, 2021) [13]. One of the main causes of such large post-harvest losses is inefficient post-harvest management during storage, packaging, and transportation, as well as the prevalence of illnesses and a lack of adequate storage facilities.

The most important quality for food is still its look, which has a big impact on whether or not consumers choose to purchase it. The acceptance of a product is also fundamentally influenced by the texture of the meal. A fruit or vegetable's appearance and texture are solely determined by genetic, environmental, postharvest management, and storage variables. Researchers have created eco-friendly coatings and packaging technologies to extend the shelf life of these items because customers nowadays are more health aware and prefer fresh fruits and vegetables. Therefore, establishing efficient strategies to manage the aforementioned aspects that enhance the quality and shelf life of these items requires comprehensive knowledge of the processes resulting in the appearance and textural variations.

There are several fruit post-harvest management preservation techniques available. The use of prepared edible coatings made of natural plant extracts is one such natural approach of increasing the shelf life of fruits after harvest (Baldwin *et al*., 2018) [5]. By using organic plant-based materials, bio-preservation is a post-harvest process that tries to increase the storage/shelf life of fruits and vegetables. In recent years, the food sector has been increasingly concerned about edible coating solutions as a practical and safe way to increase the shelf life of fruits. The fact that this coating is completely safe for the environment is another benefit. In fact, it can be viewed as a greener substitute for artificial coatings and other post-harvest chemical treatments. Fruits can be treated edible coatings to increase their quality and shelf life. These are safe to consume when consumed with the product and do not alter the food's nutritional value. Because of its antifungal properties, there has been a surge in interest in employing *Aloe vera* gel as an edible covering material for fruits and vegetables.

According to Mchugh & Senesi (2000) [17], an edible coating is a thin covering of material that may be consumed and protects fruit from moisture, oxygen, and solute movement. According to Thakur *et al*. (2019) [32], edible films have the protective properties of preventing oxidation, moisture absorption and desorption, contamination, microbial development, and sensory modification. The use of various plant extracts to increase the shelf life of various fruits and vegetables has recently caught the attention of researchers, for example, pomegranate leaf and banana pulp extracts for mango (Sarmin *et al*., 2018) [26].

The use of natural coatings may be a good substitute for synthetic fungicides, meeting customer demands for more wholesome and natural foods. Fresh fruits and vegetables are given a post-harvest treatment that includes edible protective coatings and waxes to preserve them. Fresh fruits and vegetables may be safely preserved while maintaining their freshness and functioning by using plant-based natural coverings. It has long been a practice in postharvest technology to use plant-based solutions to prolong the shelf life of fruits and vegetables. Fresh fruits and vegetables have just begun to employ plant-based compounds as bio-preservatives.

One of the promising bio-preservatives that has a great chance of becoming widely used for most fresh fruits and vegetables is *Aloe vera* gel. Using *Aloe vera* gel (100%) to preserve papaya fruit at room temperature (25–29 °C, 82–84% RH), it was shown that uncoated fruit lost weight by 22.5% while coated fruit lost weight by 7.93% (Brishti *et al*., 2013) [7].

Curiosity aside, Ali *et al*. (2016) found that the *Aloe vera* gel covering was successful at preventing microbial development on the "Crimson" table grape. No illness signs were noticed in the case of banana fruits covered with *Aloe vera* until one week following the storage period. At the conclusion of the storage period, uncoated fruits had a 100% illness incidence rate, but Aloe gel-coated fruits had a 27% disease incidence rate (Brishti *et al*., 2013) [7]. This was caused by coated materials' propensity to be anti-microbial. It has been documented that the fresh juice and aqueous extracts of turmeric and ginger have antifungal properties against the molds Aspergillus niger and Penicillium digitatum (Kapoor, 1997) [14]. Mango storage rot has also been linked to the use of natural plant products, with fruits dipped in plant extracts showing a decrease in the disease's occurrence (Anjum *et al*., 2016) [3].

When applied to edible film, turmeric extract has antioxidant properties. This characteristic will lessen the process of respiration that takes place, extending the quality and storability of fruits. The function of edible films may be improved by the inclusion of active ingredients. The mechanical characteristics of edible films will change if turmeric extract and *Aloe vera* are added to edible starch films.

Additionally, it has been shown that *Aloe vera* gel can increase the shelf life of fruits and vegetables by reducing respiration rates and retaining quality characteristics (color, flavor, etc.). Due to its antifungal and antibacterial properties, it protects fruits and vegetables against microbial infection. According to Belgacem *et al*. (2021) [6], pomegranate peel extracts are safe, all-natural ways to manage plant diseases, extend the shelf life of fresh produce, and improve its safety.

Legumes, cereals, and tuber vegetables including potatoes, cassava, corn, rice, and bananas all include starch, a storage polysaccharide. It is an effective barrier against the passage of oxygen but not water vapor. It is used to cover fruits and vegetables with a high respiration rate. The various starch-based coatings used to preserve fruits and vegetables, as well as the variables impacting the coating effectiveness, were discussed by Sapper and Chiralt (2018) [25].

Citrus maxima Merr., a fruit that has had minimum processing, has a reduced weight loss of 4.8-7.7% when coated with starch-based coatings made from cassava and rice (Kerdchoechuen *et al*., 2011) [15]. A study was done by Rahman *et al*. in 2020 to determine the impact of banana peel extract (BPE) on the shelf life and qualitative traits of ripe bananas (cultivar: sagar). Banana peel can be utilized as a viable source to preserve bananas with increased shelf life stability, according to this study. For pears, citrus, bananas, strawberries, tomatoes, cherries, and grapes, the impact of essential oils and their components on post-harvest illnesses of horticultural goods has been studied (Tzortzakis, 2007) [33].

Being a climacteric fruit, bananas can ripen on the plant as well as after being harvested with the use of various chemicals and plant materials. One crucial objective is to increase the shelf life of fruit. In order to increase the selling range and holding times for commodities after harvest, many storage systems have been devised. Numerous preservation techniques have been researched. Use of the edible coatings is one way to increase postharvest shelf life. In order to preserve the nutrients in food, especially fruits and vegetables, and to provide it a long shelf life, edible coatings are frequently used (Gol *et al*., 2021) [10]. By delaying dehydration, stifling respiration, enhancing textural quality, aiding in the retention of volatile flavor components, and inhibiting microbiological development, edible coatings have long been known to prevent perishable food items from degrading (Debeaufort *et al*., 2020) [8].

Materials and Methods

An investigation entitled "Studies on use of plant extracts as natural coatings for enhancing shelf life and quality of banana fruits" was carried out in the Department of Post Harvest Technology, College of Horticulture, Bagalkote, Karnataka during the year 2020-21. The details of the experimental material used and methods adopted in the investigation are presented in this chapter. The experiment was conducted in Completely Randomized Design with fourteen treatments and three replications.

Starch aqueous extract: Corn starch (2.5) g was dissolved in water and agitated well. By addition of glycerol, the PH was adjusted and thus corn starch solution was prepared

***Aloe vera* gel aqueous extract**

Clean gel was extracted from fresh *Aloe vera* leaves by washing, chopping with a knife, and scooping. To eliminate heavy particles, the new gel was carefully mixed before being strained through muslin cloth. *Aloe vera* gel matrix was separated from the outer cortex of leaves and the colour less hydro parenchyma was mixed in a blender. The resulting mixture was filtered to remove the fibres. The liquid obtained constituted fresh *Aloe vera* gel. The gel matrix was pasteurized at 50 °C for few min. Then the selected fingers are dipped into gel for 5 min and allowed it to dry for a period of 10 min.

Banana peel aqueous extract

After being coarsely cut, fresh banana peels were sun dried. The powder was subsequently sieved through a mesh and stored in 70% ethyl alcohol. The liquid was then homogenized in a blender and placed in a shaker for around 48 hours. Later, a Whattman filter was used to separate banana peel extract from the whole slurry.

Pomegranate peel aqueous extract

The fine peel powder was obtained in an electric blender after tray-drying the peels at 40°C for 24 hrs. Then, the powder was sieved through a mesh. This powder (10g) was extracted with 250 ml of 80% methanol and kept in shaker for 48 hrs. Then final extract was then filtered and then used.

Turmeric extract

Six grams of turmeric powder was dissolved in 100 ml 80% of methanol and kept in shaker for 48 hrs. Later the entire slurry was filtered through Whattman filter to get turmeric extract.

Observations recorded

Total phenolic compounds (mg GAE/100 mL)

In accordance with the method described by Singleton and Rossi (1965), total phenols were estimated. 20 ml of 80% methanol were used to extract a one gram sample. The extracts (0.5 ml) were added in test tubes along with Ciocalteau's Phenol reagent (IN) and 0.2 ml of folic. 3.25 ml of distilled water was then added, and all the tubes were thoroughly shaken. After that, 1 ml of Sodium Carbonate (20%) solution was added to each tube, and each tube was left to incubate for 30 minutes at room temperature. A spectrophotometer reading at 700 nm was taken of the color after development.

Gallic acid is prepared in various concentrations and used as the standard; the optical density was read at 700 nm, and the concentration of the samples was determined using the standard curve.

$$\text{mg gallic acid equivalence per 100 g} = \frac{O.D \times Factor \times volume\ made\ up \times 100}{Aliqot\ taken \times weight\ of\ sample \times 1000}$$

General microbial count load (log cfu/g of sample)

The pre-treated banana fruits were subjected to microbial analysis by employing serial dilution method. For enumeration of yeast and mould counts, a 10 g sample of banana fruits was weighed aseptically and was diluted in 100 ml sterile water and subsequent dilutions were prepared up to 10^{-3} by transferring 1ml aliquot from 10^{-1} to 9 ml water blank. The sample was serially diluted to 10^{-1}, 10^{-2}, 10^{-3} and used for enumerating yeast and mould population by planting on suitable media. The culture media used were yeast extract agar and martins rose bengal agar for total counts of yeast and mould, respectively. Required dilution, 1 ml was transferred to sterilized petri plates and 15-20 ml of media was poured to it. The plates were rotated clockwise and anticlockwise direction to attain uniform distribution of dilution to the culture media. The plates were then allowed to solidify the media and incubated for 3- 5 days at 26 ± 2º C. The plates were observed after the incubation period for yeast and mould colonies. The total colonies in each dilution plate were counted and results expressed as colony forming units (log cfu/g of sample) using the following formula given below:

$$\text{Total Microbial Count} = \frac{Total\ no.of\ colonies \times dilution\ factor}{Weight\ of\ sample}$$

Disease scoring (%)

Disease scoring on fruits was by visual inspection of fruits during storage. For the disease score, damage caused by fungi or mould was considered based on scale mentioned below.

Disease scale: 0-5 scale is used

0 - No lesions
1 - 5 to 15% lesions
2 - 15 to 25% lesions
3 - 25 to 50% lesions
4 -50 to 75% lesions

Finally disease scoring was calculated with the following formula (Narasimhudu, 2007) [18].

$$\text{Disease score (\%)} = \frac{Sum\ of\ all\ disease\ rating}{Total\ number\ of\ rating \times maximum\ disease\ grade}$$

Fruit Disease Index

Per cent Disease Index (PDI) of post harvest disease was calculated by using the formula given below.

$$\text{Disease score (\%)} = \frac{Sum\ of\ all\ disease\ rating}{Total\ number\ of\ rating \times maximum\ disease\ grade} \times 100$$

Observations were recorded on Phyto-chemical parameters of banana fruits coated with plant extracts like total phenol content (mg GAE/100 mL), microbial count load (log cfu/g), disease score (%) and disease index (%).

Results and Discussion

Total phenol content (mg GAE/100 mL)

The data pertaining to total phenols (mg/100 g) as influenced by different plant extracts coating on banana fruits did not vary significantly (Table 1). Irrespective of the treatments, total phenols (mg/100 g) mean was noted to decrease gradually along the storage period of 7 days (Initial – 17.41, 3 DAS – 13.59, 5 DAS – 12.62, and 7 DAS – 11.72). Maximum phenol content was noted in T_2 (3 DAS –16.26, 5 DAS – 14.96, and 7 DAS – 14.10). Minimum phenol content was recorded in T_{14} (3 DAS – 11.28, 5 DAS – 11.33, and 7 DAS – 10.57). Total phenolic content was found to be higher in coated fruits than in control fruits in the current investigation. The coatings may have created a barrier of protection on the fruit's surface and cut down on the oxygen supply needed for enzymatic oxidation of phenolics, which improved the retention of total phenols compared to control. The impact of applying *Aloe vera* gel postharvest on shelf life, anti-oxidative enzyme activities, and banana fruit quality was researched by Rehman *et al*., (2020). In comparison to untreated controls, the *Aloe vera* gel-treated fruits had decreased levels of total sugar, malondialdehyde, and total carotene. In compared to control fruits, fruits treated with *Aloe vera* gel had greater levels of ascorbic acid, flavonoids (quercetin and rutin), and total phenolics. The overall phenolic content in harvested horticulture commodities demonstrated the same impact as antioxidants, and edible coatings have the capacity to boost antioxidants.

Microbial count load (log cfu/g of sample)

The data did not reveal significant differences among different plant extracts coating on banana fruits with respect to microbial count studies (log cfu/g of sample) (Table 2). Irrespective of the treatments, microbial count load mean was found to increase gradually along the storage period of 7 days (Initial – Nil, 3 DAS – 2.24, 5 DAS – 6.17 and 7 DAS – 9.21). However, microbial count was minimum in T_2 (3 DAS - 0.00; 5 DAS - 3.33 and 7 DAS - 7.00) followed by T_4 and T_8. Similarly, maximum microbial count was observed in T_{14} (3 DAS - 4.00; 5 DAS - 8.33 and 7 DAS-14.00).

Total microbial count increased and showed non- significant differences with the advancement of the storage period particularly in uncoated fruits. Fruits treated with starch, *Aloe vera* gel and different concentrations of peel extracts numerically reduced microbial population under ambient storage condition. In contrast to the control treatment, the treatments coated with various edible coatings showed decreased levels of microbial load. According to Ali *et al*. (2016), the *Aloe vera* gel covering proved successful in preventing microbial development on banana fruits. According to studies by Habeeb *et al*. (2007) [11], Tajkarimi and Ibrahim (2011) [31], and Pokhrel *et al*. (2015) [19], the antibacterial activity of these coating materials may be responsible for the lower microbial population in coated fruits.

Mould

Microbial mould count was not observed during storage of banana fruits by coating with plant extracts and the banana fruits were totally free with mould count throughout the storage period of 7 days under ambient conditions.

Disease score (%)

The data revealed a significant difference among the different plant extracts coating on banana fruits with respect to disease score (%) (Table 3). Irrespective of the treatments, mean disease score was observed to be increased gradually along the storage period of 7 days (Initial – NIL, 4 DAS – 19.96%, 6 DAS – 38.44% and 7 DAS – 55.49%) similar with T_3 (12.13%) and the highest disease score (%) was registered in T_{14} (33.26%). At 6 DAS, the lowest disease score (%) was registered in T_2 (20.67%) which, was on par with T_3 (23.23%) and the highest disease score (%) was reported in T_{14} (52.83%). At 7 DAS, the lowest disease score (%) was reported in T_1 (32.47%) which was statistically similar with T_2 (34.46%), where as the highest disease score (%) was noticed in T_{14} (76.38%).

Table 1: Disease intensity in different treatments was scored using 0-4 scale.

Extent of infection	Severity grade
No infection	0
0.1-25.0% fruit surface infected	1
25.1-50.0% fruit surface infected	2
50.1-75% fruit surface infected	3
>75.0% fruit surface infected	4

Table 2: Effect of natural plant extract coatings on total phenols (mg GAE/100 mL) of banana fruits under ambient storage condition

Treatments	Total phenols (mg GAE/100 mL)			
	3 DAS	5 DAS	7 DAS	Mean
Initial	17.41			
T_1	13.02	13.15	12.05	12.74
T_2	16.26	14.96	14.10	15.10
T_3	12.44	11.71	10.70	11.61
T_4	12.67	11.16	10.01	11.2
T_5	12.36	11.41	10.69	11.48
T_6	14.04	13.18	12.40	13.20
T_7	13.72	12.82	11.97	12.83
T_8	13.50	12.44	11.55	12.49
T_9	12.60	12.13	11.21	11.98
T_{10}	14.83	13.54	12.59	13.65
T_{11}	14.46	13.11	12.18	13.25
T_{12}	13.53	12.46	11.57	12.52
T_{13}	14.44	13.26	12.57	13.42
T_{14}	11.28	11.33	10.57	11.06
Mean	13.59	12.62	11.72	
S.Em±	0.46	0.47	0.45	
CD@1%	NS	NS	NS	

Table 3: Effect of natural plant extract coatings on microbial count load (log cfu/g) of banana fruits under ambient storage condition

Treatments	Microbial count load (log cfu/g) (yeast)				
	3 DAS	5 DAS	7 DAS	Mean	Mould
Initial		NIL			
T_1	0.33	5.00	6.33	3.88	NIL
T_2	0.00	3.33	7.00	3.44	NIL
T_3	1.33	4.67	5.67	3.89	NIL
T_4	2.67	3.68	4.00	3.45	NIL
T_5	1.33	5.67	7.02	4.67	NIL
T_6	2.33	5.66	9.33	5.77	NIL
T_7	2.34	7.67	11.67	7.22	NIL
T_8	2.00	4.00	5.00	3.66	NIL
T_9	3.33	7.67	13.00	8.00	NIL
T_{10}	2.66	7.50	12.33	7.49	NIL
T_{11}	3.31	7.83	12.00	7.71	NIL
T_{12}	2.67	8.00	8.67	6.44	NIL
T_{13}	3.00	7.33	13.00	7.77	NIL
T_{14}	4.00	8.33	14.00	8.77	
Mean	2.24	6.17	9.21		
S.Em±	0.68	1.19	1.09		
CD@1%	NS	NS	NS		

Table 4: Effect of natural plant extract coatings on disease score (%) of banana fruits under ambient storage condition

Treatments	Disease score (%)			
	4 DAS	6 DAS	7 DAS	Mean
Initial	NIL			
T_1	16.30	23.37	32.47	24.04
T_2	12.07	20.67	34.46	22.40
T_3	12.13	23.23	42.46	25.94
T_4	14.03	31.81	43.17	29.67
T_5	16.53	30.15	44.44	30.37
T_6	15.67	42.07	65.13	40.95
T_7	21.98	46.69	68.13	45.60
T_8	25.79	48.36	68.47	47.54
T_9	13.49	33.80	42.79	30.02
T_{10}	22.17	45.79	62.13	43.36
T_{11}	28.44	48.74	67.61	48.26
T_{12}	23.81	44.80	61.80	43.47
T_{13}	23.81	45.84	65.47	45.04
T_{14}	33.26	52.83	76.38	54.15
Mean	19.96	38.44	55.49	
S.Em±	0.39	0.75	1.46	
CD@1%	1.23	2.94	5.70	

Table 5: Effect of natural plant extract coatings on disease index (%) of banana fruits under ambient storage condition

Treatments	Disease index (%)			
	3 DAS	5 DAS	7 DAS	Mean
Initial	0			
T_1	0.45	0.57	7.13	0.88
T_2	0.21	0.53	6.14	0.75
T_3	0.32	0.61	6.55	0.88
T_4	0.45	0.60	5.22	1.01
T_5	0.47	0.65	6.32	0.96
T_6	0.60	0.70	4.48	0.98
T_7	0.61	1.27	5.32	1.52
T_8	0.74	1.49	6.32	1.62
T_9	0.58	0.73	5.22	1.07
T_{10}	0.72	1.82	6.33	1.95
T_{11}	0.78	1.51	5.32	1.87
T_{12}	0.75	1.47	6.23	1.86
T_{13}	0.76	1.80	4.33	1.98
T_{14}	1.14	2.51	5.79	3.03
Mean	0.61	1.16	0.10	
S.Em±	0.04	0.07	0.38	
CD@1%	0.14	0.29	0.53	

At 4 days after storage (DAS), significantly lowest disease score (%) was reported in T_2 (12.07%), which was statistically After harvest, fruits lose quality as a result of disease contamination and environmental stress. The main factors affecting quality degradation and shelf life are lipid oxidation and microbiological contamination (Rozman and Jersek, 2009) [23]. Fruit and vegetable surfaces can become contaminated, which leads to the development of spoiling bacteria; as a result, contamination must be minimized by sanitizing the produce (Potter and Hotchkiss, 1993; Magashi and Bukar, 2017) [20, 16]. Crown rot and anthracnose are the main post- harvest diseases of banana (Stover, 1972; Stover and Simmonds, 1972) [27].

These two disease complexes differ in one important respect. While crown rot germs enter after harvest, typically as a consequence of mechanical damage to the fruit, anthracnose is a latent infection that develops in the plantation (Simmonds, 1966) [26].

Fruits coated with different plant extracts (alove- vera gel (20%), starch (2%), turmeric powder (6%), pomegranate peel extract (4% dry powder), bananas peel extract (20% dry powder) and sesame oil recorded minimum microbial count. The edible coating application extends the banana shelf life up to 7 days with no disease incidence.

Disease index (%)

The data pertaining to disease index as influenced by different plant extracts coating varied significantly (Table 4). Irrespective of the treatments, disease index increased gradually along the storage period of 7 days (Initial – 0.00, 3 DAS – 0.61, 5 DAS – 1.16 and 7 DAS – 2.60). At 3 DAS, significantly maximum disease index was noted in T_{14} (1.14) and minimum disease index was noted in T_2 (0.21). At 5 DAS, significantly maximum disease index was documented in T_{14} (2.51) and minimum disease index was registered in T_2 (0.53). At 6 DAS, significantly highest disease index was recorded in T_{14} (5.44) and lowest disease index was noted in T_2 (1.51).

The control samples (without any treatment) showed the highest disease index rate compared to coated samples. (Table 4). The lowest disease index was recorded for the samples treated with (*Alove vera* gel (20%), starch (2%), turmeric extract (6%), pomegranate peel extract (4% dry powder), bananas peel extract (20% dry powder) and sesame oil. The antimicrobial activity of (*Alove vera* gel (20%), turmeric extract (6%), pomegranate peel extract (4% dry powder), bananas peel extract (20% dry powder) had an impact on lowering disease index. The same disease index rate and severity of banana sample were reported by Tabassum *et al.* (2018) [29], Hossain and Iqbal (2016), and Bagwan (2001), with unambiguous identification of treated samples' superior acceptability to control samples.

T_1. Starch (2%)
T_2. *Aloe vera* extract - (AVE) (20%)
T_3. Banana peel extract – (BPE) (20% dry powder)
T_4. Pomegranate peel extract – (PPE) (4% dry powder)
T_5. Turmeric extracts (6%)
T_6. Sesamum oil (2%)
T_7. BPE + Starch (20% + 2%) T_8. BPE + AVE (20% + 20%)
T_9. PPE + Starch (4% + 2%) T_{10}. PPE + AVE (4% + 20%)
T_{11}. Turmeric extract (6%) + Sesamum oil (2%) + Starch (2%)
T_{12}. Turmeric extract (6%) + Sesamum oil (2%) + AVE (20%)
T_{13}. Turmeric extract (6%) + Sesamum oil (2%)
T_{14}. Control

Results revealed that among different treatments, the highest phenol content were noticed in Treatment T_2 (*Aloe vera* gel 20%), respectively and Treatment T_2 recorded lowest value in all the parameters *i.e.*, microbial count load, disease score and disease index. From this, it may be concluded that banana fruits coated with 20 percent of *Aloe vera* gel extract is considered best with respect to phyto chemical properties.

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