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# Production of edible antimicrobial food packaging film from agro industrial waste

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**ABSTRACT**
*Emerging agro industries are resulting into a large amount of industrial residues and their disposal has become a serious environmental issue for developing countries. In the present study, this issue was focused and agro industrial banana peel waste were utilised for production of value added and industrially important product such as antimicrobial edible active food packaging films. Biochemical, microbiological, sensory and statistical tests were performed for developed edible film. After the complete analysis, it can be concluded that the present study was successful trial for utilization of agro waste for production of value added products.*
***Keywords:*** *agro waste, banana peels, antimicrobial, edible film.*

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## INTRODUCTION

Banana (*Musa* spp., Musaceae family) is one of the major fruit crops cultivated for in tropical and subtropical regions of India. As per Leading Producers of Bananas Worldwide report in 2019, India produced 30.4 million tons of bananas, followed by China with 11.6 million tons [Fig.1]. Amongst states of India, Gujarat is the 4$^{th}$ largest producer of fruits and vegetables after Uttar Pradesh, Karnataka and Bihar and 2$^{nd}$ largest producer of Banana after Tamil Nadu [1]. Banana can be consumed either as fruit as well as jams, jellies, chips, figs, biscuits ,wine ,juice, baby foods and banana fibre but unfortunately the post harvest losses and post processing losses are very high ,reaching 40% of total production which includes banana peels, damaged banana leaves ,pseudo stems, young stalks and bruised banana [4,5,7].

Most of the times banana peels are either discarded or underutilized which contributes around 40% of the total fruit's weight but according to the literature reviewed banana peels can possibly used as a substrate for production of soup, alcohol, wine, citric acid ,biogas ,cattle feed ,biomass and bio plastics. Different kinds of antioxidants and other photochemical were extracted from banana peels by while with fortified yellow noodles with banana peel flour to increase its fibre content [8].

The present study was performed at Saurashtra University Rajkot, Gujarat to explore the objective to extract starch and pectin from banana peel powder for production of edible antimicrobial active food packaging film and analysis to check the overall credibility of the performed study.

## MATERIAL AND METHODS

**Raw Materials –** Fresh peels of banana was procured from banana wafer division of Hari Om Farm, Amreli Gujarat India**.**

**Chemicals –** 1% (w/v) sodium Meta bisulphite solution, iodine solution, 0.50 N HCL, methanol, clove oil, glycerol.

### Experimental Procedure

### Extraction of starch and pectin from banana peels

Banana peels were dried in hot air oven at 55°C for 24 hours after procurement, sorting and washing prior to dipping in 1% sodium met bisulphite solution. Dried peels were then grounded to powdered form for further processing. Dried peels powder were then subjected to starch extraction by AOAC, 1999 method .Banana peel powder was soaked in distilled water in 1:20 ratio for 24 hours. After complete soaking the solution was heated at 90±5 °C for 1.5 hours with continuous stirring and then sieved till the filtrate has given negative iodine test. Collected filtrate was then centrifuged at 5000 rpm for ten minutes to collect clear solution of starch. Starch solution were then stored at refrigeration temperature.

For extraction of pectin from banana peel powder methanol extraction method was used. Banana peel powder was dissolved in water in 1:5 ratio after that pH of the solution was adjusted to 1.5 by 0.5N HCL**.** The solution was heated at 90±5 °C for 2 hours with continuous stirring and filtered by Whatman's filter paper no. 1. Collected filtrate was then washed with methanol to collect precipitate as pectin which was stored at 4°C for further processing.

**Production of edible antimicrobial active food packaging film**

For production of food packaging films solution of starch as a carbohydrate agent (58%) , precipitate of pectin as binding agent(38%) , glycerol as plasticizer (2%) , clove oil as active antimicrobial agent (2%) were blended together to form a solution. The ratio of different constituents was formulated after multiple trials and standardization. A total 3 samples S1, S2, S3 were produced by keeping the abovementioned constituents in similar ratio but varied by addition of different food grade colours to improve sensory characteristics of the film developed. In sample S1, no additional flavour was added while in S2, 0.5% orange flavour was added and in S3, 0.5% pineapple flavour was added to the final developed product [Table 1]

**Table 1: Composition of the film samples developed**

| Constituents (in %) | S1 | S2 | S3 |
|---|---|---|---|
| Starch | 58% | 58% | 58% |
| Pectin | 38% | 38% | 38% |
| Glycerol | 2% | 2% | 2% |
| Clove oil | 2% | 2% | 2% |
| Orange flavour | - | 0.5% | |
| Pineapple flavour | - | | 0.5% |

**Analysis of antimicrobial edible active food packaging film**

Bio polymer based packaging films prepared from polysaccharides have advantages due to factors such as environmental concerns, biodegradability, edibility, and biocompatibility properties. The bio-film can serve as a carrier for antimicrobial compounds in order to preserve the food. The bio- films produced from polysaccharides generally have good physical properties like solubility and water sorption, and mechanical properties like tensile strength and elongation at break, as well as antimicrobial properties [9].

**Sensory analysis of antimicrobial edible active food packaging film**

Antimicrobial edible active food packaging film was analyzed by panelists. Three samples were evaluated from which S1 was none flavored, S2 was orange flavored and S3 was pineapple flavored. Parameters such as color, consistency, aroma, flavor, taste, mouth feel, and overall acceptance on the 7 point hedonic scale were performed.

**Antimicrobial analysis of antimicrobial edible active food packaging film**

Diffusion test is a direct contact method using the solid medium to measure the antimicrobial activity of edible film. For overlay diffusion tests, biofilms with different concentration of antimicrobial agent were aseptically cut into discs and then deposited over the agar plate inoculated with test bacteria. After 18 to 24 hour of incubation, the inhibition diameter around each film disc was measured with a digital capillary [2].

**Shelf life study of antimicrobial edible active food packaging film**

In our present study, samples of film were stored at room temperature (35 ± 1 °C), incubator (30 ± 1 °C) and refrigerator temperature (7± 1°C) for regular physical and microbial assessment.

**Statistical analysis**

Statistical analysis of antimicrobial edible active food packaging film developed from banana peel was conducted in the study for acceptance of sample by sensory panelists. T –test was performed for 3 samples of films to check statistical significance at p value ≥ 0.05.

**RESULTS**

From methods employed for production of antimicrobial, edible active food packaging film mentioned in methodology a firm textured, eye appealing film was produced for active packaging of food products by combining starch & pectin as edible binding agents, clove oil as antimicrobial active agent, and glycerol for employing plasticity and food grade flavors for flavor enhancement and increased palatability in mentioned quantities. Total three samples of the film was produced as F1, F2, and F3 in which no flavor was added in F1 sample, whereas to F2 &F3 samples orange and pineapple flavor is added for increasing sensory attributes. A score card was filled for sensory qualities of the film by 5 trained, 5 semi trained and

their scores were calculated as mean ± SD as mentioned in below mentioned table 2. Where Mean ± SD of component used in film production starch, pectin, glycerol, clove oil and flavor was 59.73±1.65, 36.13±2.21, 2.06 ± 0.87, 2.06 ± 0.87 and 0.43 ± 0.04.

**Table 2 Composition of antimicrobial edible food packaging films developed with below mentioned contents**

| Contents | F1 | F2 | F3 | Mean ± SD |
|---|---|---|---|---|
| Starch | 62% | 59.1% | 58.1% | 59.73±1.65 |
| Pectin | 33% | 37.7% | 37.7% | 36.13±2.21 |
| Glycerol | 1.5% | 3.3% | 1.4% | 2.06 ± 0.87 |
| Clove oil | 1.5% | 3.3% | 1.4% | 2.06 ± 0.87 |
| Flavours | No flavour | 0.5% | 0.8% | 0.43 ± 0.04 |

F1 stands for no flavor added film, F2 stands for orange flavor film, and F3 stands for pineapple flavor film.

**Pictorial depiction of produced antimicrobial edible active food packaging film**

**1. Film without addition of flavor**

**2. Film added with orange flavor**

**3. Film added with pineapple flavor**

**Physicochemical and mechanical properties of antimicrobial edible active food packaging film**

**Solubility,** Highest percentage of solubility 54.57 ± 0.25 in Chitosan film. This high solubility of Chitosan film could be attributed to the water binding. While in our study starch, pectin, glycerol based film gives higher solubility was 98±1.91, with difference in mean ± SD 43.43 1.66 (Table 3.1.2) due to the higher water solubility of starch and their functional groups. The solubility of edible film in the water will determine the application of edible film because if discharge into the environment can decompose naturally and alternate option for reduced environmental pollution [3].

**Colour,** Chitosan based film, which showed yellow colour films may be considered as a natural characteristic of Chitosan components. The presence of a light brown colour of film may be considered as a natural Characteristic in the pectin, since this colour has been associated with the presence of repeat units of -Alpha- (1-4) – linked D-galactouronic acid [3].

**Moisture** The moisture content was calculated as the percentage of water removed from the film and moisture content was found to be 0.45± 0.17 with difference in mean ± SD 11.35±2.03.

**Thickness,** Thickness of the film was ranging from 0.116 ± 0.002. While in our study, we measure thickness of the film by using a micrometer screw gauge, and thickness of film was 0.37±0.052 with the difference in mean ± SD 0.25 0.05 .Thickness of film was depended upon components of film, which is utilized during film production [3].

**Opacity** of the film is measured by spectrophotometric analysis at wavelength 600 nm was found to be 0.96±0.89 in the range of visible wavelength (350–800 nm.

**Tensile strength** was measured by instrument TA.XT PLUSE TEXTURE ANALYSER from Food Testing Laboratory of Junagadh Agricultural University. Tensile strength value 1.2±0.08 with difference in Mean ±SD 13.75±2.08 (Table 3)

**Elasticity** of antimicrobial edible active food packaging film was measured by instrument TA.XT PLUSE TEXTURE ANALYSER from Food Testing Laboratory of Junagadh Agricultural University. Elasticity value found to be 48.96±3.54 with difference in Mean ±SD 36.3±3.28.

**Table 3.Analysis of antimicrobial edible active food packaging film**

| Parameters | Mean ± SD | | Difference |
|---|---|---|---|
| | Observed value | Expected value | Mean ± SD |
| Solubility of film | 98±1.91 | 54.57 ± 0.25 | 43.43 1.66 |
| Thickness of film | 0.37±0.052 | 0.116 ± 0.002 | 0.25 0.05 |
| Opacity of film | 0.96±0.89 | 85.21 ±0.27 | 84.25±0.62 |
| Moisture content of film | 0.45± 0.17 | 11.8 ± 2.2 | 11.35±2.03 |
| Tensile strength | 1.2±0.08 | 14.95±2.16 | 13.75±2.08 |
| Elasticity | 48.96±3.54 | 12.66 ±0.26 | 36.3±3.28 |

Where, Observed value stands for obtained value by performing tests in the study and expected value stands for standard value from above mentioned reference

**Sensory analysis of antimicrobial edible active food packaging film**

Sensory analysis was carried out by 5 trained, 5 semi trained panelists with help of hedonic scale method. All result were mentioned in Table 4 on 7 point hedonic scale with corresponding descriptive terms is ranging from 1 **"**Dislike extremely" to 7 "Like extremely" over all acceptations of package products given in as Mean ± SD.

**Table 4.Sensory analysis of antimicrobial edible active food packaging film**

| Sample | Trained panelist | Semi trained panelist |
|---|---|---|
| **F1** | 2.8±1.83 | 3.14 ±0.98 |
| **F2** | 5.8±2.18 | 6.42±0.70 |
| **F3** | 5.5±1.89 | 6.0±1.30 |

Where, F1 is no flavor, added film, F2 is orange flavor film, and F3 is pineapple flavor film

**Antimicrobial activity of edible active food packaging film**

As mentioned in methodology, we have developed antimicrobial edible active food packaging film and evaluated its antimicrobial activity against four major food borne pathogen i.e. *E. coli,*
*S. aureus, S. thyphi, Enterobacter.* The antimicrobial activity was determined by agar diffusion methods by measuring the zone of inhibition obtained after incubation of 24 hours and compared with narrow spectrum antibiotic, Std. cephaloridine (30mcg). The following results of zone of inhibition were obtained after incubation for *E. coli*-2.5±0.40, for *S. aureus* 3.0±0.81, for *S. thyphi*3.0±0.81, for *Enterobacter aerogenes* 2.0±0.81 (Table 5) .Mean ± SD similar study was performed to determine antimicrobial properties of edible film against *E. coli, S. aureus, Enterobacter, S. type* was respectively 22.33±1.52,

31.33±1.52, 16.64±0.89, 18.96±1.08 [9].

**Table 5 Comparison of antimicrobial activity of antimicrobial edible and active food packaging film with standard cephaloridine (30mcg)**

| Test Organisms | Mean ± SD | | Difference Mean ± SD |
|---|---|---|---|
| | Observed value | Expected value | |
| *E. coli* | 2.5±0.40 | 22.33±1.52 | 19.83±1.12 |
| *S.aureus* | 3.0±0.81 | 31.33±1.52 | 28.33±0.71 |
| *E.aerogenes* | 3.0±0.81 | 16.64±0.89 | 13.64±0.8 |
| *S.typhi* | 2.0±0.81 | 18.96±1.08 | 16.96±0.27 |

Where, Observed value stands for obtained value by performing tests in the study and expected value stands for standard value from above mentioned reference

Picture 1.: Pictorial depiction of antimicrobial activity of film against four food borne Pathogens: 1) *E. coli* 2) *S.aureus* 3) *E.aerogenes* 4) *S.typhi*

**Statistical analysis of antimicrobial edible active food packaging film**

Statistical analysis of antimicrobial edible active food packaging film developed from banana peel was conducted in the study for acceptance of sample by sensory panelists. T –test was performed for 3 samples of films to check statistical significance at p value ≥ 0.05 and obtained values of Mean ± SD as 249.33±11.16 and t value of 2.45. From obtained values of statistical tests it can be concluded that the developed film is accepted by sensory panelists as the obtained value is less than p value. Hence the product is statistically significant.

## CONCLUSION

After the complete analysis, it can be concluded that edible antimicrobial food packaging film can be produced from banana peels as they are potent source of starch and pectin which are base materials of film along with glycerol and clove oil. As conclusion , the produced films has promising applications for food packaging industry because of its high tensile strength and solubility or biodegradability .They can serve as an innovation to current food packaging industry because of their edible and antimicrobial nature. Perishable foods can be packed without refrigeration in these films for shelf life enhancement.

## REFERENCES


1. Leading Producers of Bananas Worldwide in 2019, by Country (in 1000 Metric Tons). Available online: https://www.statista.com/statistics/811243/leading-banana-producing-countries/ (accessed on 22 July 2021).
2. W Du W-X, Olsen, C.W., Avena-Bustillos, R.J., McHugh, T.H., Levin, C.E., Mandrell, R., Friedman.M. (2009). Antibacterial effects of all spice, garlic, and oregano essential oils in tomato films determined by overlay and vapor phase methods. Journal of Food Science, 74(7), M390-M397.
3. Marco A. López-Mata 1, Saul Ruiz-Cruz 1,*, Norma P. Silva-Beltrán 1, José de Jesús Ornelas- Paz 2, Paul B. Zamudio-Flores 2 and Silvia E. Burruel-Ibarra 3 Physicochemical,
4. Singh, V., Hedayetullah, M., Zaman, P., & Meher, J. (2014). Postharvest technology of fruits and vegetables: An overview. *Journal of Post-Harvest Technology, 2*, 124–135.
5. Umeh, I.B., 1998. Commonly Used Fruits in Nigeria. In: Nutritional Quality of Plant Foods, Osagie, A.U. and O.U. Eka (Eds.). Trinity Press, Benin, Nigeria, pp: 84-120.
6. Dadzie, B.K.K., & Wainwright, H. Plantain utilization in Ghana. *Tropical Sci.* **35**(4), 405--410, 1995.
7. Ramli, S., et al. Utilization of banana peels as a functional ingredient in yellow noodle. *As.J. Food Ag-Ind.* **2**(3), 321-

-329, 2009.
8. Salah S M (2012). Antibacterial activity and uv protection property of some Egyptian cotton fabrics treated with aqueous extract from Banana peel. *International Journal of Clothing Science*. 1: 1-6.
9. Ayala-Zavala, J.; Soto-Valdez, H.; González-León, A.; Álvarez-Parrilla, E.; Martín-Belloso, O.; González-Aguilar, G. Microencapsulation of cinnamon leaf (*Cinnamomum zeylanicum*) and garlic (*Allium sativum*) oils in β-cyclodextrin. *J. Incl. Phenom. Macrocycl. Chem.* **2008**, *60*, 359–368.

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