Journal of Postharvest Technology
2021, **09**(2): 58-70
www.jpht.in

RESEARCH ARTICLE

Nutritional, functional and shelf-life assessment of processed banana inflorescence (*Musa paradisiaca*)

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Received: 21.03.2021 Accepted: 14.04.2021

ABSTRACT

Banana inflorescence is an underutilised agricultural by-product, though rich in therapeutic properties. Although valued for its fibre content, consumption is restricted due to the tedious preparation procedures involved. Moreover, it is a highly perishable product and browning is the major problem associated with processing. Developing a packaged, shelf-stable, ready-to cook product from the inflorescence would offer consumers a convenient, highly nutritious option. This will also reduce agricultural wastage and improve the economic status of farmers. Our study aimed at storage studies of processed inflorescence in a suitable packaging material for a minimum period of 60 days and its value addition. Nutritional and functional properties were also analysed. Shelf life study indicated that the product packed in metallised polyester-polyethylene pouches was microbiologically safe at every stage of storage and no peroxides and free fatty acids were formed. Cutlet made out of dehydrated and stored inflorescence were well accepted. Methanolic extract of dried inflorescence showed good antioxidant activity. Antimicrobial activity was appreciable and it had fairly good anti-diabetic activity too. Results obtained were promising and revealed that well packaged inflorescence could be stored at room temperature for at least a period of two months without affecting nutritional and sensory qualities.

Keywords: Banana inflorescence, storage studies, nutritional properties, antioxidant, anti-diabetic, antimicrobial

Citation: Ravindran, A., John, J. A., and Jacob, S. 2021. Nutritional, functional and shelf-life assessment of processed banana inflorescence (*Musa paradisiaca*). *Journal of Postharvest Technology*, **9**(2): 58-70.

INTRODUCTION

Banana (*Musa* species) is one of the most significant tropical fruits in the Musaceae family. They grow in almost all types of soil; except in salty soil. Though India leads in the production of banana, health benefits of banana inflorescence are less focused on. Inflorescence, also termed as banana inflorescence is a major by-product of banana processing industry. It is a complex structure including flower that develop into banana.

Banana inflorescence is a health boon to mankind due to its medicinal properties including, anti-oxidant, anti-diabetic, anti-microbial activity, among others. Compounds such as alkaloids, phenols, tannins, flavonoids are responsible for these activities (Mahmood et al., 2011). Consumption of dietary fiber is very important to maintain our body health (Marlett et al., 1997). The

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ISSN: 2348-4330

recommended intake of dietary fibre is 20-35g/day for a healthy adult, which is however not frequently met due to low intake of good sources of dietary fiber. Banana inflorescence contains abundant dietary fibre (5.74g/100g) (Elaveniya and Jayamuthunagai, 2014).

Banana is grown in around 120 countries and according to FAO (2020), average global banana production rose from 69 million tonnes in 2000-2002 to 116 million tonnes in 2017-2019, at an approximate value of 31 billion USD. Fruit part constitute of only 12% by weight of the plant. Remaining parts become agricultural waste, causing environmental issues (Elanthikkal et al., 2010). India ranks first in banana production, contributing about 23% to the world banana production (Biswas and Kumar 2010). Agricultural waste is another menace that can be a burden to the farmer in terms of their disposal problem. Many fruits and vegetables get wasted due to lack of post-harvest technology and ignorance. Banana inflorescence is one such by-product. From an environmental perspective, it is highly important to re-use these by-products (González-Montelongo et al., 2010).

Banana inflorescence can be cut once the banana start to develop. Stalk will continue to produce smaller and smaller fruits. So, removal of inflorescence will help the plant to produce sweet, tasty and full-sized bananas. Even though it is nutrient rich and available throughout the year, consumer acceptability is very less, due to short shelf life and susceptibility to browning. Hence proper processing and marketing of inflorescence will bring additional income to the farmers. Products dried either by sun drying or artificial drying methods have been used since ancient time to increase the shelf life of food products. Developing a process that will prevent browning is an important step in dehydration. Manimegalai and Ramah (1998) have shown that browning of inflorescence can be prevented by citric acid dip.

Development of a ready-to-cook product from inflorescence will eliminate the difficulty in cleaning and consumers get advantages such as, prolonged shelf life, increased intake of nutrient and fiber etc. Dehydration is an inexpensive processing technique for the production of such a product. There are however, hardly any studies on the shelf-life stability of processed, packaged banana inflorescence. This study was therefore carried out in order to develop a shelf stable, ready-to-cook banana inflorescence of the cultivar, *M. paradasiaca* and to evaluate its nutritional composition and health benefits.

MATERIALS AND METHODS

Collection of raw material

Banana inflorescence was purchased from vegetable market, Kochi, Kerala. The variety, *Musa paradisiaca* was opted for the study.

Sample preparation

Raw materials collected were cut into small pieces using a stainless knife. As browning takes place faster in banana inflorescence, they were transferred to the pre-treatment solution. i.e., 0.2% citric acid solution for 30 minutes as soon as possible (Wickramarachchi and Ranamukhaarachchi, 2005). Citric acid was then drained off and samples are taken for further processing.

Pre-treated samples were dried for 10 hours in a tray drier in which a temperature of 50°C is maintained (Padam et al., 2012). A portion of the dried samples was taken for the extraction of phytochemicals and another portion was packed, sealed in laminated pouches and stored at room temperature for 2 months storage studies.

Proximate composition

Moisture, fat, protein, ash, carbohydrate and crude fibre was analysed by following the AOAC (2000) methods. Minerals elements were determined by ashing method followed by elemental analysis of metal ions by flame photometer.

Extraction of phytochemicals from banana inflorescence

Shahidi, Chandasekara and Zhong (2011) reported that phytochemicals are the bioactive compounds found in vegetables, fruits, seeds, grains etc. Both raw and tray-dried banana inflorescence were analysed for phytochemical content and their functional properties. 10g (in triplicates) of both the samples were taken in a 250mL conical flask and 100mL of methanol was added to each flask. Samples were sonicated for 20 min at room temperature. The mouth of the flask was covered with a paraffin film, so that no solvent evaporates out of the system during extraction. The supernatant was filtered through a Whatman filter paper. The residue was re-extracted using methanol and the supernatants were combined. Evaporation of the solvent was carried out in rotary evaporator (IKA RV10). Extract were stored in a screw caped bottle at -20°C for further analysis.

Estimation of phenols

Total phenolic content (PC) of methanolic extract was estimated according to the method of Singleton et al. (1999) with some modifications. To 0.5mL of each samples, 0.5mL of Folin Ciocalteu reagent was added and mixed well. 1mL of sodium carbonate was added and vortexed after the addition of 10mL distilled water. The mix was allowed to stand for 45min and then centrifuge at 4000g for 5 min. The absorbance of the sample was determined against a blank using a colorimeter at 720 nm. Gallic acid was taken as the standard.

Estimation of flavonoids

The total flavonoid content (TFC) was determined by the procedure by Zhishen et al. (1999). To 1mL of the extract, 150 µL sodium nitrite solution (5 %) was added, followed by 5min incubation. Further, 150µL aluminium chloride solution (10%) was added. This was followed by the addition of 2 mL sodium hydroxide solution (4%) after 6 min, and the content was made up to 5mL. The mix was vortexed and allowed to stand for 1 min at room temperature. Absorbance was read at 510nm against a blank. Quercetin was used as the standard.

Anti-oxidant activity

The scavenging ability of banana inflorescence was determined by the method followed by Ao et.al. (2008) with some modifications. To 3mL of different concentrations of both the samples, 1mL DPPH was added and kept in dark for 30 min. A standard curve was plotted using butylated hydroxy anisole (BHA) and ascorbic acid. Absorbance was read at 520nm.

$$\% \text{ Inhibition} = \frac{(A_0 - A_1)}{A_0 \times 100}$$

A_0 - Absorbance of the control

A_1 - Absorbance of the test

Anti-diabetic activity

Anti-diabetic activity was determined by following the chromogenic method by Ali et al. (2006) with slight modifications. 100µl of the extract was mixed with 100µl PBS buffer (pH=6.9) and α-amylase (0.5mg/mL). The system was allowed to react for 10 min at room temperature. To this, 100µl of 1% starch in buffer was added. The mixture was allowed to stand for 10min at room temperature. 200µl Dinitrosalicilic acid (DNSA) was added and boiled for 15 min. It was then cooled and diluted with 3mL distilled water. Absorbance was read at 540nm. % inhibition can be calculated as (Marikkar et al., 2016),

$$\% \text{ Inhibition} = \frac{[C_{blank} - (S - S_{blank})]}{C_{blank}} \times 100$$

C_{blank} - Absorbance of control blank
S – Absorbance of sample
S_{blank} – Absorbance of sample blank

Anti-microbial activity

The standard culture of Bacillus subtilis, E.coli, Salmonella and Staphylococcus aureus were used for the screening by following the standard microbiological procedures.

All the 4 cultures were inoculated in peptone water and incubated at 37°C for 3-4 hours. These cultures were then swabbed on Muller Hinton Agar (MHA) plates. Discs were dipped in both raw and dried sample extracts and are then placed separately on the plate, previously spread with cultures. Methanol was taken as the control. These plates were incubated at 37°C for 12-24 hours. Zone of inhibition was measured in mm.

Screening is helpful in identifying the cultures that have activity. So, those bacteria that were inhibited were further tested. 'Disc diffusion method will not however help us understand the exact concentration at which the bacterial growth is inhibited. So the best method is 'well diffusion method'. Well is cut in the MHA plates after swabbing the culture (Padam et al., 2012). To each well, a known concentration of extract is added. 4 different volumes (10µL, 20µL, 30µL and 40µL) of stock extract of both raw and dried inflorescence were used. Then plates are incubated at 37°C for 12-24 hours. Zone of inhibition was then measured in mm (including the diameter of the well).

Value addition of dried banana inflorescence

Value addition of the tray-dried inflorescence was attempted by preparing cutlets as detailed in this section. List of ingredients and their quantities used for the preparation of cutlet is given below:

Banana inflorescence - 150g (30%); Potato - 150g (30%); Onion - 100g (20%); Ginger - 5g (1%); Garlic -5g (1%); Curry leaves - 2g (0.4%); Coriander leaves - 2g (0.4%); Chilli - 5g (1%); Bread crumbs – 50g (10%); Oil - 4tsp (4%); Turmeric - 1.25g (0.25%); Chilli powder - 5g (1%); Garam masala - 2.5g (0.5%); Salt - 2.5g (0.5%).

Oil was first heated in a pan. Finely chopped ginger, garlic, chillis were added to the hot oil, along with curry leaves and sautéed till the raw smell disappeared. Next, the chopped onions were added and sautéed till brown. Further, chilli powder, turmeric

powder, garam masala and salt were added and stirred till oil separated. Previously cooked and mashed potato was then added and mixed well. Finally, the previously cooked banana inflorescence (both fresh raw and stored dried) was added to the mixture and heated for a few minutes. The mix was then allowed to cool, moulded into the desired shape, dipped in egg white, battered with bread crumbs and fried in oil before analysis.

Storage studies

Shelf life study was carried out for a period of two months. Cutlets were prepared from both fresh raw and tray dried packaged inflorescence at an interval of 15 days. The cutlets thus prepared were analyzed for sensory quality. The cutlet samples were prepared and tested on 0^{th}, 15^{th}, 30^{th}, 45^{th} and 60^{th} day. Both the fresh raw and tray dried packaged banana inflorescence samples were also analyzed for microbiological quality, peroxide value and free fatty acid during the same interval period.

Peroxide value and Free fatty acid

Peroxide value is determined by titration method (AOAC, 2000) and it involves two steps: extraction of fat from the sample and titration of defatted sample against sodium thiosulphate. Approximately 2g sample was weighed and transferred into a clean iodine flask. 20mL chloroform: methanol (1:1) was added to the flask and allowed to stand for 20 min with intermittent shaking. Extract was collected and to that one small spatula of anhydrous sodium sulphate was added, so that it traps all the moisture if present. 30mL glacial acetic acid was added to the flask, followed by a pinch of potassium iodide. Reaction system was then kept in the dark for 30 min. 20 mL distilled water was then added to the flask and titration was carried out using 1% starch as indicator against 0.02N sodium thiosulphate.

$$\text{Peroxide value} = \frac{(\text{titre value} \times \text{normality} \times 1000)}{\text{weight of the fat}}$$

Free fatty acid is determined by titration method (AOAC, 2000). 2g sample was weighed and transferred into a clean iodine flask. 20mL chloroform: methanol (1:1) was added to the flask and allowed to stand for 20 min with intermediate shaking. To the flask, 10 mL hot neutral alcohol was added.

FFA = (titre value × molarity of NaOH × molecular weight of FFA × 100) / weight of the sample

Microbiological analysis

Packed and stored samples were tested for bacteria, yeast and mold. Total Plate Count (TPC) agar can be used for bacteria, while Potato Dextrose Agar (PDA) is best for yeast and mold. Samples were serially diluted up to 10^{-10} and 0.1mL from each dilution was spread on both TPC and PDA plates. Plates corresponding to each dilution were taken in duplicates and incubated at room temperature (bacteria-24 hours and yeast and mold-72-96 hours). Colonies in each plate were counted and are expressed as colony forming units (CFU). 30-300 number of colony is considered as the countable range; above which it was considered as TNC (Too Numerous to Count).

$$\text{Number of CFU} = \frac{\text{No. of colonies} \times \text{dilution factor}}{\text{Volume taken to plate}}$$

Sensory evaluation

Cutlets prepared from both raw and tray dried inflorescence were analysed for sensory parameters (colour, texture, flavour, appearance, taste and overall acceptability) by trained panel consisting of 10 members from among the Faculty of the Department of Food Science and Technology, KUFOS, using a nine point hedonic scale. They were asked to rate the product on a scale of points varying from “dislike extremely” to “like extremely”.

Statistical analyses

All the reported values are the mean of three replicates each and statistical analysis was carried out by using statistical software (Microsoft Excel, 2013). Experimental results were subjected to two way analysis of variance (ANOVA) for significance ($p < 0.05$) using Duncan’s multiple range tests. Correlation between chemical parameters and overall acceptability scores were evaluated for significance ($p < 0.05$).

Results and discussion

The present investigation was carried out with an objective to analyse the proximate composition, functional properties, storage stability and to develop a product from dehydrated ready-to-cook banana inflorescence.

Table 1 shows the results of proximate analysis of both raw and tray dried banana inflorescence. The amount of fat, ash and moisture present in these samples were similar to the values obtained by Awedem et al. (2015). However, the value obtained for protein content in the present study was slightly higher than results reported by Sheng et al. (2010). This difference can be due to the difference in the chemical composition of the different genotypes and the difference in geographical zone (Miranda et al., 2012).

Table 1: Proximate and phytochemical analyses of raw and tray dried banana blossom

Proximate composition		Raw inflorescence (%)*	Tray dried inflorescence (%)*
Moisture		92.80 ± 0.52^{a}	12.49 ± 0.01^{b}
Fat		0.23 ± 0.01^{a}	3.70 ± 0.1^{b}
Protein		0.99 ± 0.01^{a}	13.75 ± 1.01^{b}
Ash		0.88 ± 0.02^{a}	12.14 ± 0.1^{b}
Carbohydrate		5.10 ± 0.44^{a}	57.92 ± 0.78^{b}
Crude fiber		1.06 ± 0.02^{a}	14.90 ± 0.32^{b}
Sodium (mg/100g)		198 ± 2.29^{a}	152 ± 0.5^{a}
Potassium (mg/100g)		1086 ± 1.5^{b}	1052.5 ± 0.5^{b}
Calcium (mg/100g)		219.5 ± 0.5^{c}	311.5 ± 2.0^{c}
Phenolic content	(mg/kg of dried sample)	599.33 ± 16.74^{a}	1082.33 ± 30.005^{b}
Flavonoid content	(mg/kg of dried sample)	1512.67±88.50^{a}	3291±117.18^{b}

**Values are expressed as Mean ± S.D (n=3), Means in rows with different letters (a-b) are significantly different (p<0.05), based on ANOVA*

Apart from these, they are good source of minerals and carbohydrates too. So they can be used for nutritional purpose of human being especially problems arising due to malnutrition (Seal et al., 2014). Mineral analysis indicated that amount of potassium

was found to be higher in both raw and tray dried inflorescence samples, followed by calcium and sodium (Table 1). Compared to dried sample, potassium and sodium was higher in raw sample, and calcium was low.

However, there were no significant ($p>0.05$) difference between the individual mineral contents in the raw and dried samples. Similar studies conducted by Adeolu and Enesi (2013) on the mineral composition of dried *M. paradisiaca* bract showed that sodium was present in higher amount and potassium was the lowest.

Extraction of phytochemicals

Sumathy et al. (2011) reported methanol as the best solvent to carry out complete extraction of bioactive compounds from banana inflorescence. The yield of extract was 0.75g from 20g of raw sample and it was 4.77g/20g dried sample. Extraction was efficient with dried sample. Extracts were then transferred to a screw capped bottle and stored at -20°C. These extracts were then used for the analysis of antioxidant, anti-diabetic, anti-microbial activity and phytochemical evaluation of inflorescence.

Estimation of phytochemicals

Total phenols and flavonoids

Phenolic content of methanolic extract of raw *M. paradisiaca* was found to be 599.33 ± 16.74 mg GAE/kg sample, which was lower than that in the dried sample (1082.33 ± 30.005 mg GAE/kg) (Table 1). This value is relatively low when compared to the value obtained in the study conducted by Sheng et al. (2010). According to the study, phenolic content of dried extract was 6580.00 ± 0.03mg/kg of the dried sample. This can be because of the seasonal difference and variety of the banana inflorescence (Imeh and Khokhar, 2002). The solvent mixture used for extraction can also play a detrimental role in the amount of phenolics extracted.

Extracts obtained from banana inflorescence were analyzed for flavonoid content (Table 1). Flavonoid content was estimated at 1512 and 3291 mg QE/kg raw and dried banana inflorescence, respectively. Flavonoids, which are responsible for aroma, are the most commonly distributed phenolic constituents of the kingdom plantae. Flavones and flavonols are the main two subgroups of flavonoids. In the study conducted by Mahmood et al. (2011) total flavonoid was found to be 39.8 ± 0.15 mg quercetin /kg of dried sample. This is very low compared to the value obtained in our study. Similarly, a study by Herrmann (1976) confirms that the levels of phytochemicals will vary from outer to the inner part of the inflorescence. Thus samples taken from the outer bract will have a higher level of phytochemicals.

Anti-oxidant activity

In the present investigation, raw inflorescence extract, at a concentration of 20mg/mL, showed an inhibition of 92%. And in the case of dried sample, it had 91.66% inhibition at a lower concentration of 8mg/mL. According to Ao et al. (2008), the discoloration of DPPH depends on the capacity of extract that act as the hydrogen donor.

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While comparing the IC_{50} of raw inflorescence extract with the dried one, it is clear that concentration required to achieve 50% inhibition is lower for the dried inflorescence sample than the raw sample. Similarly, IC_{50} value of BHA and dried sample are comparable (Table 2). There is significant ($p<0.05$) difference between the concentration of extract obtained from raw banana inflorescence and the percentage of inhibition. Similar trend was observed for dried banana inflorescence extract. i.e., there was significant interaction between concentration and % inhibition.

Table 2: IC_{50} value of ascorbic acid, BHA, raw inflorescence and tray dried inflorescence

Standards/samples	IC_{50} (mg/assay)*
Ascorbic acid	0.008 ± 0.0005^{a}
BHA	0.015 ± 0.001^{b}
Raw inflorescence	0.34 ± 0.007^{c}
Dried inflorescence	0.16 ± 0.003^{d}

**Values are expressed as Mean ± S.D (n=3). Means in columns with different letters (a-d) are significantly different (p≥0.05), based on ANOVA*

According to Velioglu et al. (1998), the total amount of phenolics and flavonoids has a significant impact on the antioxidant activity of banana inflorescence. Phytochemical evaluation of banana inflorescence in our study indicated that the flavonoid content is high compared to the phenolic content in both raw and dried inflorescence extract. So, the high antioxidant activity shown by the extract can be due to the presence of flavonoids. DPPH scavenging activity of fresh fruits varies from 32 to 891mg TE/100g with highest inhibition for guava and in the case of dry fruits, it is 271 to 1541 mg TE/100g with highest activity for walnut (Reddy et al., 2010). These results confirm that banana inflorescence is a promising source of antioxidants compared to food items consumed on a daily basis.

Anti-diabetic activity

Methanolic extract of both dried and raw banana inflorescence were tested for its ability to inhibit α-amylase enzyme. Since both raw and dried inflorescence sample extracts were found to have high level of phenolics and flavonoids, these might also contribute to the outstanding inhibitory activity of extracts on α-amylase. Strong relation between anti-diabetic and antioxidant activity was reported by Manaharan et al. (2012) in ethanolic extract of *Peltophorum pterocarpum*.

Both the samples were diluted at different concentrations. Minimum concentration taken for both was 0.5g/mL. Inhibition at that concentration for raw inflorescence extract was found to be 65.05% and for dried it was 46.03%. At 2g/mL, inhibition was 88.88% for raw sample and 84.12% for dried one (Table 3). But in contradiction to our expectation, inhibitory action was slightly lower for dried inflorescence extract compared to the raw sample, probably because of the loss of bioactive components contributing to anti-diabetic activity during drying process.

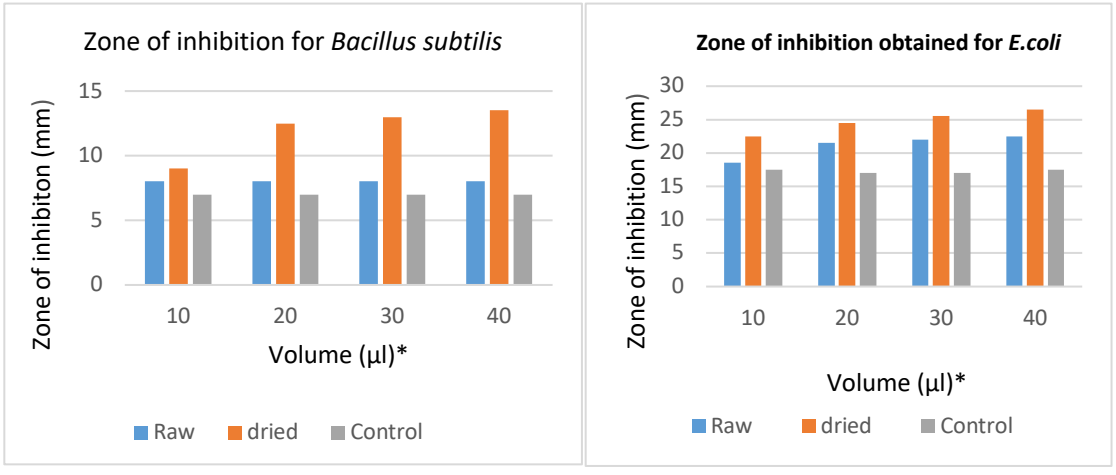
Table 3: α-Amylase inhibitory activity of raw and dried banana inflorescence extract

Sample	Concentration(g/mL)	Inhibition (%)*
Raw inflorescence extract	0	0
	0.125	46.03 ± 2.86
	0.5	65.05 ± 0.00
	1	80.95 ± 2.74
	2	88.88 ± 7.98
Dried inflorescence extract	0	0
	0.5	46.03 ± 1.58
	1	58.73 ± 1.58
	1.5	77.77 ± 0.00
	2	84.12 ± 0.91

**Values are expressed as Mean ± S.D (n=3).*

Anti-microbial activity

Methanolic extract of both raw and dried samples were studied for its anti-microbial activity. Screening of anti-microbial activity were carried out on active culture of *Bacillus subtilis, Salmonella, Staphylococcus aureus and E.coli* using disc diffusion method in Muller Hinton Agar (MHA). Discs (5mm diameter) were dipped in two extracts separately and were placed in the plates that were previously inoculated and labelled. Preliminary study indicated that both the extract failed to inhibit the growth of *Salmonella* and *Staphylococcus aureus; w*hereas, a good zone of inhibition was obtained in the case of dried sample extract, in the plates inoculated with *Bacillus subtilis* and *E.coli.*



(a) **(b)**

Fig 1 a, b Zone of inhibition obtained for *Bacillus subtilis* and *E.coli* against different concentrations of both raw and dried banana inflorescence extract

Our study revealed that the dried inflorescence extract was effective against both *Bacillus subtilis* and *E.coli.* With increase in concentration, an increase in the zone of inhibition was observed. Compared to the dried extract, raw inflorescence extract was not as effective against the bacteria. (Figure 1; values shown are including the diameter of the well).

In the case of *E.coli*, significant difference in the zone of inhibition was observed for both raw and dried inflorescence extract for any given concentration (**p<0.05) and in the case of *Bacillus*, no significant difference was observed in the inhibition zone for both samples.

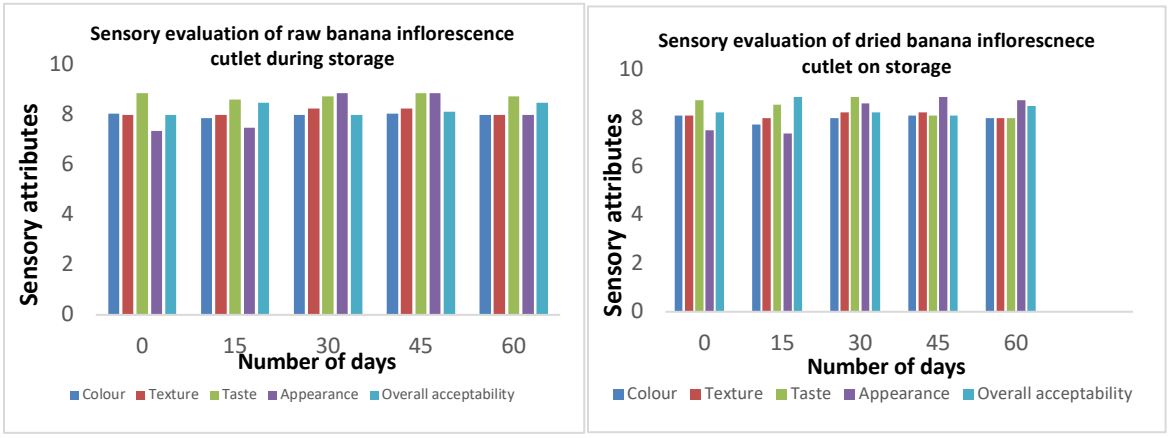
Thus, for the extraction of anti-microbial compounds, methanol proved to be the best solvent. Probable reason or this can be the presence of short chain hydrocarbon with a negatively charged hydroxyl ion attached to it, and this will give a better extracting ability (Lee and Li 1991). Methanol has the ability to penetrate through the cell membrane and will dissolve the polar compounds that has anti-microbial activity.

Storage study of dehydrated banana inflorescence

Shelf life study of tray dried banana inflorescence was carried out for a period of 60 days after packing them in metallized polyester coated with polyethene and stored at room temperature. Each packaging (20cm × 12cm) contained 30g of dehydrated inflorescence and was stored in triplicates for the analysis to be carried out at every 15 days. Storage parameters included peroxide value, free fatty acid, sensory evaluation and microbiological analysis.

Peroxide value and Free fatty acid

Tray dried inflorescence sample were analyzed for its peroxide value and free fatty. It was found that both the parameters did not increase upon storage. It was zero from 0th day to 60th day. This indicated that the product did not undergo any undesirable changes and it is acceptable even on 60th day when stored. Development of free fatty acid is generally responsible for the undesirable taste, aroma during storage of food products. They are formed as a result of partial hydrolysis of fat, while peroxides as a result of oxidation of fat (Eldin, 2010). Since, inflorescence is a vegetable with low fat content (3.7%), there is less chance to get rancid.



(a) **(b)**

Fig. 2 (a, b): Sensory evaluation of cutlet made from raw and stored dried banana inflorescence

Sensory evaluation

Sensory evaluation was carried out by a sensory panel of 7 trained sensory panelists. Cutlets were prepared by using 30% banana inflorescence (both raw and dehydrated). Tray dried banana inflorescence cutlets were well accepted by the sensory panel till the last day of storage. Sensory attributes were not affected during the storage period (Figure 2). Statistical analysis showed that sensory attributes such as color, texture, appearance, taste and overall acceptability showed no significant difference ($p \geq 0.05$) and the product was acceptable for 60 days.

Microbiological evaluation

Microbiological analysis of stored, tray dried banana inflorescence was carried out from day 0 to the 60th day. The study revealed that the number of colony forming unit (CFU/mL) increased first and then declined (Table 4). On the 60th day, the count was found to be zero. Situation was same in the case of both PCA and PDA plates. This reduction can be due to the unavailability of oxygen that support the growth of microbes. As days passed, available oxygen declined. This arrested the growth of microbes. The reduction in CFU/mL indicates the barrier property of packaging material against moisture and air.

Table 4: Microbiological evaluation of tray dried banana inflorescence

Day	Microbiological analysis of tray dried inflorescence	
	Total plate count ($\times 10^9$)	Yeast and mold ($\times 10^3$)
0	TNC*	2 ± 1.21
15	TNC	3 ± 0.22
30	9 ± 1.41	3 ± 1.34
45	4 ± 1.36	2 ± 1.01
60	0	0

**TNC: Too Numerous to Count*

CONCLUSION

Results obtained in our study were encouraging and promising. In the present investigation, attempts were made to evaluate the nutritional and functional properties of tray dried ready-to-cook banana inflorescence. Further, shelf-life studies were also carried out at room temperature on the dried inflorescence packed in laminated multilayer pouches for a period of 60 days. Drying parameters were standardized and proximate analysis indicated that inflorescence are rich in crude fiber, potassium and calcium. Samples were found to have good anti-oxidant and anti-microbial activity and fairly good anti-diabetic activity. Value addition was attempted and well accepted cutlets were prepared from dehydrated banana inflorescence. It was thus shown that it is possible to store dried banana inflorescence without losing its nutritional and sensory qualities for a period of at least two months at room temperature. It is recommended that modified atmospheric packaging, active packaging and the use of packaging material with better barrier property may help in increasing the storage period of banana inflorescence. Such shelf stable, ready-to-cook banana inflorescence can attract more consumers with its high nutritional value and convenience; in addition to reducing agricultural waste, adding to farmer's income and being a boon to the food industry.

ACKNOWLEDGEMENTS

The first author thanks the Department of Collegiate Education, Kerala for the Aspire scholarship to carry out the work. The authors are thankful to Dr. S. Suresh Kumar, Director, SOST and Dr. K. Gopakumar, Emeritus Professor and Head of

Department of Food Science and Technology, KUFOS for providing necessary facilities and support. Support by Dr. P.T. Mathew, Dr Maya Raman and Dr. K. Manjusha, SOST, KUFOS is highly appreciated.

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