



# FORMULATION AND STANDARDIZATION OF ANTIOXIDANTS ENRICHED EDIBLE CUTLERY

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**Abstract:** This study aims on developing edible cutlery enriched with antioxidants. Standardize, evaluate its sensory characteristics and its nutrient content. It was carried out with different proportions of millet flour incorporated with antioxidant extracts in the edible cutlery prepared. The products were analyzed for organoleptic characteristics (colour, texture, taste, flavour and overall acceptability) using a 5-point Hedonic scale formulated especially for the edible cutlery. Two samples with standard and three variations were prepared and compared. Among all variations of edible cutlery prepared, Sample A - Variation III prepared with incorporation of 30 per cent extract has  $4.70 \pm 0.59$  c of acceptability and has given 5 % significance in all the aspects such as nutritional content and its organoleptic characteristics. It was the most accepted variation among all the variation. Hence the study proves that the prepared antioxidant enriched edible cutlery is nutritious, eco-friendly, cost effective and suitable to use for consuming all kinds of food without affecting its actual characteristics.

**Index Terms** - Barn yard millet, Anti-oxidant extract, Phenolic compounds, Total antioxidant capacity, Ferric reducing ability of plasma.

## I. Introduction

Nowadays, innovations constantly appear in food packaging, which lead to a demand for new foods, always aiming at creating a more efficient quality preservation and eco-friendly system. The bio active compounds plays a major in promotion of health and it is very important for the normal functioning of the body. Anti-oxidants have numerous functional properties and also consist of specific health benefits beyond the normal nutritional content. They are used in formulation of nutraceuticals and drugs to treat several medical conditions. These cutlery can also be used as replacement for nutraceuticals and the rate of acceptability will be more as it acts as a new solution to treat/ prevent the cause of medical condition in an attractive way.

Being a primary binding agent, millets and cereals makes best pair on forming a structure and promotes strong outlook for a product. They have less penetration which will improve the stability and rigidity of the product and also provides extended shelf life. As they are non-perishable product the rate of microbial growth will be very less and the nutritional value remains the same for a long period of time. It adds the texture, aroma and acceptability for the consumer with more functional benefits. It also has ability to hold the nutrients and trap the properties and enhance the quality of the product. So, incorporating anti-oxidants in the products made out of millets and cereals may be trapped and help promote maximum utilization in the body and to overcome the medical conditions (Yam and Lee, 2012).

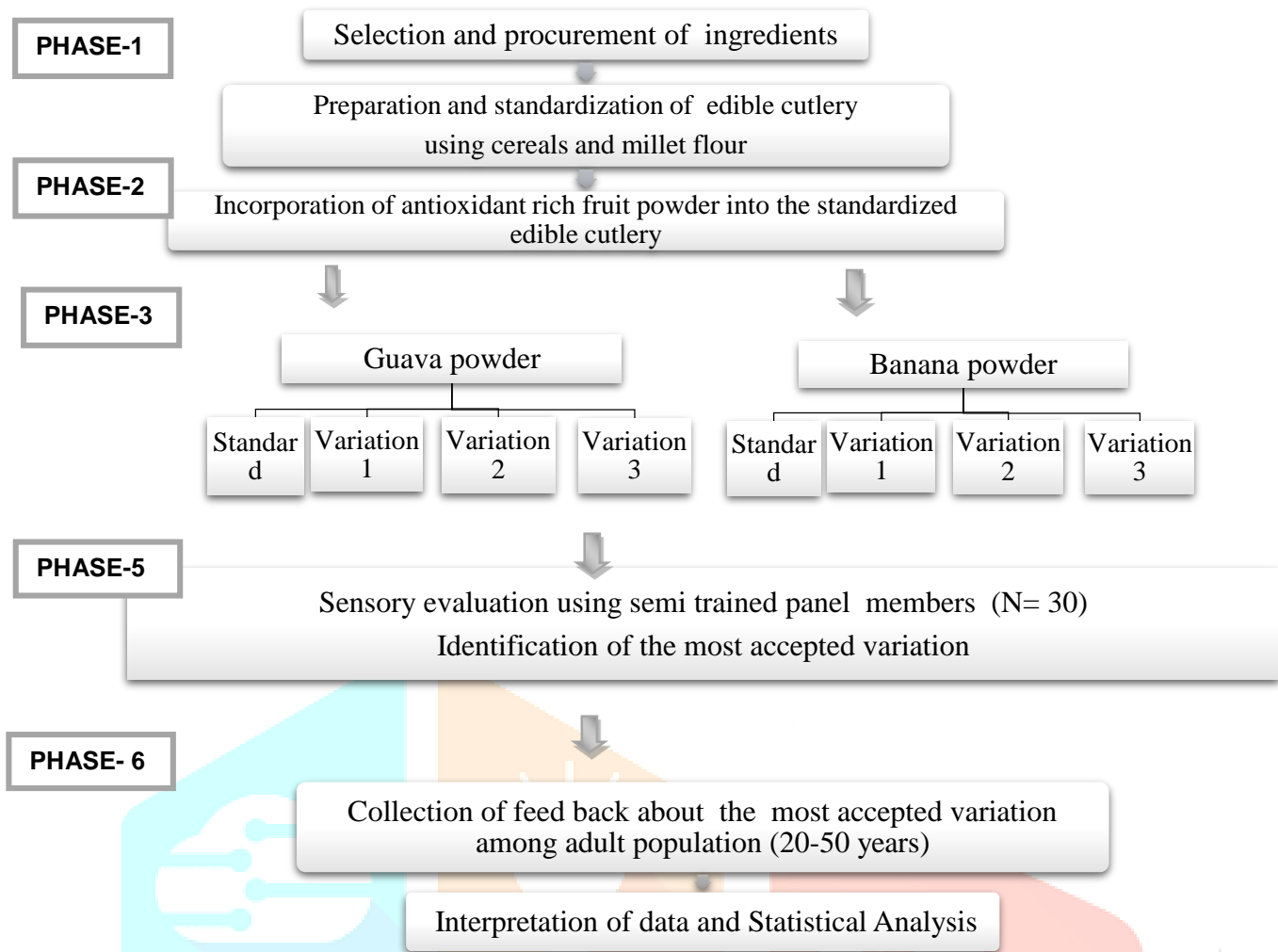
## II. Material and Methods

### 2.1 Selection and procurement of ingredients

The study was carried out to develop antioxidant rich edible cutlery which reduces oxidative stress. It is formulated with nutritious ingredients such as cereals, millets and locally available foods that are rich in antioxidants. The foods incorporated in formulation were selected based on certain edible characteristics such as presence of bioactive components and antioxidants, nutritious, food that reduces the oxidative stress in the body, blending with other food ingredients thoroughly, cheap, easily available, non toxic and more acceptable by the consumer. The ingredients required for the standardization of the edible cutlery was procured from the local departmental stores. This ensures quality of the ingredient without any impurities.

### 2.2 Formulation and standardization of antioxidant enriched edible cutlery

Antioxidants, bioactive compounds, phytochemicals and phenolic components facilitate to reduce the oxidative stress and helps to keep up healthy body. Incorporation of antioxidant rich fruit powder aids to delay / stop the radical formation and scale back the chance of oxidative stress. Enthraling of these into account, a standard formulation was done to provide replacement version of edible cutlery possessing antioxidant property (Liguoriet *al.*, 2018).



### Research design

#### 2.3 Formulation and standardization of edible cutlery

The ingredients used in the formulation of the standard edible cutlery are wheat flour (*Triticum*), barnyard millet flour (*Echinochloaesculenta*), sorghum flour (*Sorghum bicolor*) and corn flour (*Zea mays L*). They were incorporated in the ratio of 4:2:2:1. Measured quantity of flour with the specific ratio was taken and sieved thrice. This ensures uniform mixing of all the flour together, removes impurities and incorporates aeration. To this, 50 ml of water was taken and kneaded to make a smooth and soft dough. The dough was sheeted to 5 mm of uniform thickness. It was then molded into required shapes of spoons, cups and plates and baked in a preheated oven at 160°C for 20 minutes. The combination of flour with different millets were tried out and with different percentages.

**2.3.1** The temperature and time taken for baking was standardized and the amount of water used was standardized after repeated trials. To this antioxidant rich fruit powder was incorporated.

**2.3.2** The method of application of hydraulic pressure was also tried along with baking method. In this method, the cutlery were tried out with same proportion of ingredients and procedure followed to make the dough similar to that of baking method in oven, In this method, dough was sheeted to an uniform thickness of 7mm and was placed in the semi-automatic hydraulic machine, which has different molds for

spoons and plates. With the application of 1.5 ton of weight to the mold and by passing 5 KW of electricity, uniform heat at 70<sup>0</sup>C was applied for 5-6 minutes. The dough was molded into a plate. The plates were molded in two different sizes of 8 -inch and 12-inch (diameter). The spoons were made with the hydraulic machine at a temperature of 220<sup>0</sup>C with the application of 1.5 ton of weight and 5 KW of electricity for 7 minutes. The dough was converted into a spoon. The plate/spoon was made in the same machine but with the use of different molds. When the pressure was applied the excess dough was removed by the machine. Plate/ spoon of uniform thickness was obtained .

The research design of the study is presented in Figure 1

## 2.4 Formulation of antioxidant enriched edible cutlery

After standardization of the edible cutlery, antioxidants in the form of dehydrated fruit powder was incorporated into the standardized edible cutlery. The dehydrated fruit powder was incorporated into the standardized formula by partially replacing the cereal flour. After a thorough survey of literature, antioxidant rich fruits that help to combat the stress namely guava and banana was selected. Dehydrated fruit powders was prepared. The guava was cut into 2.5 mm piece cubes and allowed to dry in a cabinet drier. The temperature was set at 80<sup>0</sup> C and dried until the moisture content reduced to less than 5%. It was dried for approximately 20 hours. Simultaneously banana was cut into 5 mm thickness. Spread in a tray and allowed to dry in a cabinet dried at 80<sup>0</sup>C until the moisture content decreased to less than 10%. It was dried for approximately 35 hours. The dried fruits were then powdered using a pulverizer and sieved in a sieve to ensure no residues and lumps. The powder was then stored in air tight containers for incorporation into the standardized cutlery (Figure 3).

The guava and banana fruit powders were incorporated into the standard formulation with the replacement of wheat flour with guava powder in one variation and banana powder in another variation. The fruit powders were incorporated by replacing the quantity of wheat flour in three different proportions as 10, 20 and 30 percentage. Each fruit powder was tried with three variations with the following proportions (Table II).

**TABLE II**

### COMPOSITION OF FORMULATED ANTIOXIDANT ENRICHED EDIBLE CUTLERY

Ingredients	Standard	Variation I (%)	Variation II (%)	Variation III (%)
Corn flour	10	10	10	10
Barnyard millet flour	20	20	20	20
Sorghum flour	20	20	20	20
Wheat flour	50	40	30	20
Dehydrated Banana/ Guava powder	-	10	20	30

## 2.5 Conducting organoleptic evaluation of the developed edible cutlery

Sensory qualities is the key for food acceptance because the customers request the merchandise with specific sensory characteristics. The acceptance of the food depends on the sensory characteristics that are normally accepted by the patron. The measuring of sensory properties and determination of specific properties play a significant accomplishment in sensory analysis. The standard attributes was scaled using hedonic rating scale of a food product (Meilgaard *et al.*, 2007)

Sensory evaluation of the developed edible cutlery was done with inclusion of thirty semi trained panel members. Coded samples namely standard, variation I, II, III of the cutlery made out of guava powder and banana powder was served to the panelist at around 10.30 am in the morning along with water. They were made to sit comfortably and the score card was given.

## 2.6 Quality attributes of developed edible cutlery

Quality attributes has been defined as scientific description used to evoke chief analysis core relationship to those characteristic foods and materials as they are professed by a sense of sight, smell, taste, touch and hearing. These are based on hedonic scale. The products are formed only once or twice and the segment of the target population that will accept the product is determined (FSSAI, 2015). The sensory attributes used in the scale are flavour, colour, texture, taste, apperanance, and overall acceptability.

### 2.6.1 Hedonic Test

The hedonic scale may be used to determine the degree of acceptability of one or more products. This scale is a category-type scale with an odd number (five to nine) categories ranging from “dislike extremely” to “like extremely.” A neutral midpoint (neither like nor dislike) is included. Semi trained panel members rate the product on the scale based on their response (FSSAI, 2015). In the present study the hedonic scale is rated with score ranging from 5 to 1 corresponding to different credentials for each characteristic of the edible cutlery.

#### 2.6.1.1 Flavour

The developed cutlery is ranked from 5 through 1 representing the corresponding criteria with highly acceptable, partially acceptable, acceptable, unacceptable and off flavour respectively.

#### 2.6.1.2 Colour

In the present study, the colour was ranked based on the criteria creamish brown, creamish white, brownish white, dark brown and blackish brown with the corresponding scores of 5 to 1 respectively.

### 2.6.1.3 Texture

The criterias used in the hedonic scale for evaluation are strong and crunchy, crispy, brittle, hard and too hard with scores corresponding to 5 to 1 respectively.

### 2.6.1.4 Taste

Taste was ranked with criteria excellent, very good, good, fair and poor based on their acceptability with scores corresponding to 5 to 1 respectively.

### 2.6.1.5 Appearance

In the present study, the edible cutlery were assessed based on the following criteria like most attractive, attractive, normal, sobber and dull with scores corresponding to 5 to 1 respectively.

### 2.6.2 Overall acceptability

In this study, the product is assessed based on the following criterias like excellent, very good, good, fair, poor with scores corresponding to 5 to 1 respectively.

The scores as scored by the panelist are consolidated and tabulated for further interpretation of the results.

## III. Formulation and standardization of antioxidant enriched edible cutlery

The millets like sorghum flour (*Sorghum bicolour*), barnyard millet flour (*Echinochola esculenta*), wheat flour (*Triticum*), corn flour (*Zea mays L*) were used as the basic ingredients for the formulation of the edible cutlery. These were enriched with antioxidants and acts as a key to prevent the cause of oxidative stress. The fruits were used in the form of dried powder as the key ingredient to include into the cutlery enhancing the antioxidant property.

Reviewing the literature for antioxidant rich fruits, it was decided to use guava (*Psyidium guajava*) and banana (*Musa paradisiaca*) for the study. These fruits were dehydrated using cabinet drying method to a residual moisture content of less than 10 per cent. They were dried, powdered and incorporated into the standardized formula of edible cutlery.

## IV. Result and Discussion

4.1.1 Table III given below depicts the composition of variations of standardized edible cutlery incorporated with dehydrated fruit powder.

**TABLE III**  
**COMPOSITION OF STANDARDISED EDIBLE CUTLERY INCORPORATED WITH DEHYDRATED FRUIT POWDER**

Ingredients	Standard	Variation I (%)	Variation II (%)	Variation III (%)
Corn flour	10	10	10	10
Barnyard millet flour	20	20	20	20
Sorghum flour	20	20	20	20
Wheat flour	50	40	30	20
Dried guava/ banana powder	-	10	20	30

The temperature, time and moisture content were the most important aspects that affects the physicochemical, nutritional and microbial characteristics of the product. Hence, the temperature and time taken for dehydration using cabinet drier and weight (both initial and final) of the guava and banana fruit was recorded.

4.1.2 Table IV given below depicts the temperature, time, moisture content and weight (initial and final) of the cabinet dried fruit.

**TABLE IV: TEMPERATURE, TIME, MOISTURE CONTENT AND WEIGHT OF THE CABINETDRIED FRUIT POWDER**

Fruit	Temperature C <sup>0</sup>	Time for drying (hours)	Weight		Moisture %	
			Fresh	After drying yield	Fresh	After drying
Guava	80	20	1000	185	129.6	5.4
Banana	80	35	1000	155	116.8	7.6

One kilogram of guava with the moisture content of 129.6 per cent was taken and was dehydrated for 20 hours. After dehydration using cabinet drier, the moisture content was found to be 5.4 per cent with a final weight of 185 g. So 1000 g of fresh guava yielded 185 g of dried product after drying with 5.4 per cent moisture. One kilogram of banana with the moisture content of 116.8 per cent was taken and were dehydrated for 35 hours. The weight after dehydration reduced to 155 g with a moisture content of 7.6 per cent. It was observed that banana took 35 hours than guava with 20 hours for dehydration. The temperature used for dehydrating the sample was 80<sup>0</sup>C for both guava and banana fruits.

## 4.2 Organoleptic Evaluation of the formulated culteries

The score card was given to the panel members for evaluation of the edible cutlery incorporated with fruit powder at different concentrations.

The sensory evaluation was done for two samples of dehydrated powders of guava and banana enriched edible cutlery with three variations along with the standard.

4.2.1 The mean scores of evaluation of the dehydrated guava powder incorporated edible cutlery along with the variations is given in Table V and Figure 4.

TABLE V

### SENSORY CHARACTERISTICS OF THE DEHYDRATED GUAVA POWDER INCORPORATED EDIBLE CUTLERY

Criteria	Standard	Variations		
		I	II	III
Flavour	5.00±0.00 <sup>c</sup>	4.56±0.77 <sup>b</sup>	4.63±0.66 <sup>b</sup>	*4.73±0.58 <sup>c</sup>
Colour	5.00±0.00 <sup>c</sup>	4.46±0.97 <sup>b</sup>	4.50±0.90 <sup>b</sup>	4.80±0.55 <sup>c</sup>
Appearance	5.00±0.00 <sup>c</sup>	4.60±0.67 <sup>b</sup>	4.46±0.86 <sup>b</sup>	4.76±0.57 <sup>c</sup>
Texture	4.97±0.18 <sup>c</sup>	4.16±1.20 <sup>b</sup>	4.13±1.22 <sup>b</sup>	4.93±0.37 <sup>c</sup>
Taste	4.90±0.31 <sup>c</sup>	4.36±1.03 <sup>b</sup>	4.33±0.92 <sup>b</sup>	*4.50±0.77 <sup>c</sup>
Overall acceptability	4.97±0.18 <sup>c</sup>	4.46±0.89 <sup>b</sup>	4.53±0.86 <sup>b</sup>	4.70±0.59 <sup>c</sup>

b- Not significant within groups, c- significant for both between and within groups. \*p<0.05; Significant at 5 per cent level

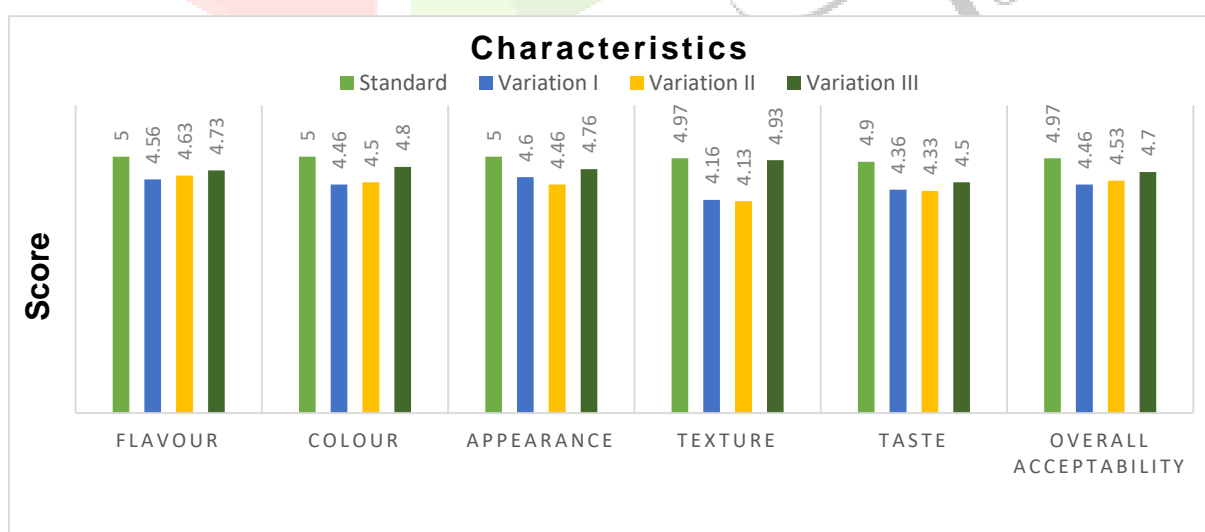


Figure 4



### Sensory characteristics of the dehydrated guava powder incorporated edible cutlery

Sensory evaluation of dehydrated guava powder incorporated edible cutlery revealed that the flavour for standard is 5, variation III is 4.73, variation II is 4.63 and the variation I is 4.56 and is found to be statistically significant at 5 per cent. The mean value obtained for colour was 5 for standard, followed by 4.8 for variation III, 4.5 for variation II and 4.4 for variation I. The mean score for appearance of standard is 5, followed by 4.76 for variation III, 4.6 for variation I and the least is 4.4 for variation II. The mean score for texture of standard is 4.97, followed by 4.93 for variation III, 4.16 for variation I and the least is 4.14 for variation II. The mean scores for taste of standard is 4.9, followed by 4.5 for variation III, 4.36 for variation I and the least is 4.33 for variation II.

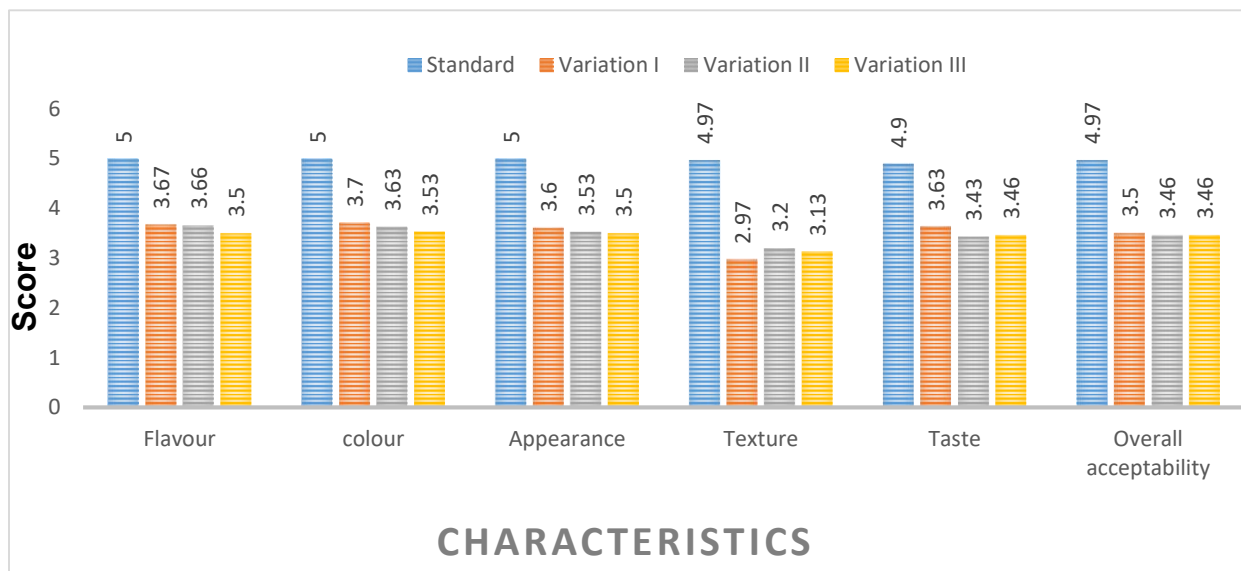
The overall acceptability of dehydrated guava powder incorporated edible cutlery revealed that variation III had a maximum mean score of 4.7 and was comparable with the standard with 4.9. Overall the variation I and II were not significant within groups but standard and variation III was significant at 5 per cent level for both within and between the groups.

**4.2.2** The mean scores of the sensory evaluation of the dehydrated banana powder incorporated edible cutlery along with the variation is presented in the Table VI and Figure 5.

**TABLE VI**  
**SENSORY CHARACTERISTICS OF THE DEHYDRATED BANANA POWDER**  
**INCORPORATED EDIBLE CUTLERY**

Criteria	Standard	Variations		
		I	II	III
Flavour	5.00±0.00 <sup>c</sup>	*3.67±0.8 <sup>ab</sup>	3.66±0.75 <sup>ab</sup>	3.50±0.77 <sup>ab</sup>
Colour	5.00±0.00 <sup>c</sup>	*3.70±0.84 <sup>ab</sup>	3.63±0.71 <sup>ab</sup>	3.53±0.77 <sup>ab</sup>
Appearance	5.00±0.00 <sup>c</sup>	*3.60±0.72 <sup>ab</sup>	3.53±0.73 <sup>ab</sup>	3.50±0.77 <sup>ab</sup>
Texture	4.97±0.18 <sup>c</sup>	2.97±0.61 <sup>ab</sup>	3.20±0.61 <sup>ab</sup>	3.13±0.62 <sup>ab</sup>
Taste	4.90±0.31 <sup>c</sup>	*3.63±0.80 <sup>ab</sup>	3.43±0.72 <sup>ab</sup>	3.46±0.73 <sup>ab</sup>
Overall acceptability	4.97±0.18 <sup>c</sup>	*3.50±0.73 <sup>ab</sup>	3.46±0.68 <sup>ab</sup>	3.46±0.73 <sup>ab</sup>

a-Not significant between groups, b- Not significant within groups, c- significant for both between and within groups.\* p<0.05; Significant at 5 per cent level



**Figure 5**

### **Sensory characteristics of the dehydrated banana powder incorporated edible cutlery**

Sensory evaluation of dehydrated banana powder incorporated edible cutlery revealed that the mean score for flavour for standard is 5.00, variation I is 3.67, variation II is 3.60 and the variation III is 3.50. The mean value obtained for colour was 5.00 for standard, followed by 3.70 for variation I, 3.60 for variation II and 3.5 for variation III. The mean value for appearance for standard is 5.00, followed by 3.60 for variation I, 3.53 for variation II and 3.50 for variation III. The mean scores of texture for standard is 4.97, followed by 3.20 for variation II, 3.13 for variation III and the least is 2.90 for variation I. The mean values of taste for standard scored 4.90, followed by 3.46 for variation III, 3.63 for variation I and the least is 3.43 for variation II.

The overall acceptability of dehydrated banana powder incorporated edible cutlery revealed that variation I had a maximum mean score of 3.50 and was comparable with the standard of 4.90. When compared with variation II and III seems to be the same *i.e.* 3.46. Overall the variation I, II and III were not significant within groups and also between the groups. Standard was significant at 5 per cent level for both within and between the groups.

### **V. Conclusion:**

In conclusion, the study revealed that the antioxidant enriched edible cutlery prepared by incorporating dehydrated guava powder has more yield after processing and the time consumption for processing is less than dehydrated banana powder. On sensory characteristics, the dehydrated guava powder incorporated at 30 per cent proportion is more acceptable among the variations prepared out of guava and the dehydrated banana powder incorporated at 10 per cent is more acceptable among the variations prepared out of banana. Overall the dehydrated guava powder incorporated edible cutlery at 30 per cent has positive significance at 5 per cent in all aspects such as method of preparation, acceptance on sensory characteristics, cost effective and accepted by the community. Thus, among all variations of edible cutlery prepared with dehydrated guava powder incorporated at 30 per cent was the most accepted

variation. As this variation of edible cutlery is most acceptable among the community in all aspects and also plays major role in promoting their health. It also prevents environmental pollution, reduces the plastic usage and ecofriendly. However, there is a need in customization of the machineries for formulation of edible cutlery with less molding thickness, temperature, preparation time, etc as like waffle makers which may bring a great revolution on the field of food technology.

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