

# Potency of Antioxidant Rich Spices in Delaying Rancidity of Deep Fat Fried Banana Chips

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**Abstract**—The potency of antioxidant rich spices in delaying rancidity of Nendran banana chips was explored. Spices like garlic, black pepper, curry leaves and coriander leaves were tried. Among the form of spices tried fresh form is found superior to oven dried powdered form and direct addition of oven dried powdered form of spices along with slices was better than pre-soaking banana slices in solution of spices before frying. Presoaking impaired physical, chemical and sensory quality parameters irrespective of the spices used and thereby accelerates rancidity.

Banana chips prepared by direct addition of 0.02% oven dried powders of coriander leaves and curry leaves into frying oil had lowest FFA value (2.52 and 3.02 mg KOH/g respectively), peroxide value (6.20 and 6.50 meq. O<sub>2</sub> / kg respectively) and highest iodine value (6.35 and 6.73 respectively) at three months of storage indicating superiority of curry leaves and coriander leaves over other spices. Though curry leaves and coriander leaves had potency to delay rancidity chips prepared using oven dried coriander leaves had sensory characters next only to chips with oven dried curry leaves.

The study revealed that Nendran banana chips can be prepared by adding 0.02% oven dried curry leaf powder to frying oil along with banana slices which could delay rancidity, enhance shelf life and provide curry flavoured banana chips.

## 1. INTRODUCTION

Banana chips is a deep fat fried crispy snack, prepared by deep-fat frying the mature and unripe banana slices in suitable edible oil. Frying oil acts as a heat transfer medium, which gets absorbed and becomes a major part of the finished product. When an oily substance is exposed to air, its unsaturated components are converted into hydro peroxides, which break down into volatile aldehydes, esters, alcohols, ketones and hydrocarbons which produce disagreeable odours, leading to increased rancidity [9].

Antioxidants have been added to frying media to improve the shelf life of deep fried snack food products [18]. Antioxidants are the substances that are able to prevent or inhibit oxidation processes in human body as well as in food products. The protection of foods from oxygen is the basic principle upon which antioxidant protective technologies are based.

Synthetic antioxidants such as butylated hydroxyl anisole (BHA), butylated hydroxy toluene (BHT) and propyl gallate (PG) are widely used as food additives, but their application has been reassessed because of possible toxic or carcinogenic components formed during their degradation [13].

A large range of plant polyphenols presenting antioxidant properties has been proposed for protection against lipid oxidation [15]. Several spices are rich in phenolic compounds which are potent antioxidants. Spicy chips are becoming popular in our market and several spices are added during chips preparation to enhance flavor and to create variability. Garlic [10], black pepper [2], curry leaf [6] coriander leaves [20] are reported to have potent antioxidant activity. Hence in the present study, it was explored to find out whether addition of these spices can enhance shelf life of banana chips.

## 2. MATERIALS AND METHODS

Fully mature unripe banana bunches of cultivar Nendran were harvested between 85 – 95 days after inflorescence emergence from Instructional Farm, College of Agriculture, Vellayani. Good sized fingers were selected, separated, washed to remove adhering dirt and dust; subsequently peels were removed and sliced using an adjustable hand slicer into uniform slices of two mm thickness. Chips were prepared in unrefined coconut oil at 165<sup>0</sup>C with an oil- slice ratio of 2:1 by adding 0.7% salt and 0.15% turmeric as 20% aqueous solution at the end of frying [1].

Four different spices rich in antioxidant principles viz., garlic (G), black pepper (P), curry leaves (C1), coriander leaves (C2) were collected from local market, cleaned and incorporated into chips.

Form of application-2

Fresh form (F = crushed/ powdered) and oven dried powdered form (D = crushed/ powdered fresh spice were dried at 50<sup>0</sup> C for 7 – 10 hours till it attains 6 – 8% moisture and powdered.

Concentration [C1 - 0.01% & C2- 0.02%]

Method of application- 2

PS- pre-soaking slices in spice solution before frying.

Required quantity of spice was added in 100 ml distilled water and banana slices were soaked in it for 30 minutes. After 30 minutes, the slices were taken out, surface dried by spreading it on muslin cloth for 30 minutes, before frying.

DA- Direct addition of spices in oil.

Spices were added directly to oil at smoke point of 165<sup>0</sup>C, before addition of the banana slices.

These 32 treatment combinations of chips were prepared and stored in laminated pouches (LDPE/Metalised polyester/LDPE) under ambient storage conditions (32 ± 5 °C) for analysing physical, chemical and sensory quality parameters.

Physical quality parameters like yield, moisture content, oil uptake, integrity and shrinkage of chips were recorded. Moisture content of chips was estimated using moisture analyser, which dries the sample using a halogen lamp and gives the moisture content based on the principle of thermo gravimetric analysis. Oil content of chips was estimated by solvent extraction method using petroleum ether [5]. Twenty numbers of chips were selected at random from each treatment and the number of chips which remained intact without any breakage after frying was noted as integrity (%). Surface area was calculated before and after frying and difference in diameter was calculated [3] to find out shrinkage.

Chemical quality parameters like free fatty acid (FFA) value, peroxide value and iodine value which represent the rancidity factors of deep fried products were recorded after three months of storage [16].

Sensory evaluation of the freshly prepared banana chips were organoleptically scored by a 30 member semi trained panel drawn from the scientific staff of different departments of College of Agriculture, Vellayani and evaluated for different sensory descriptors like appearance, colour, flavour, texture and taste using a nine-point hedonic scale [11].

The treatment combinations were analyzed using one way ANOVA and significance was tested using CD. In organoleptic analysis, the different preferences as indicated by

scores were evaluated by Kruskal – Wallis test to get the mean rank values for all the treatments.

### 3. RESULTS AND DISCUSSION

Banana chips prepared using antioxidant rich spices showed significant difference in physical, chemical and sensory quality parameters.

#### 3.1 Effect of spices on physical quality of chips

Moisture content and oil uptake should be low for any deep fried product with good shelf life [8]. Banana chips prepared by directly adding 0.02% oven dried curry leaf powder to frying oil recorded the least moisture content (5.30%) (Table 1.). All curry leaf treated chips except those prepared using pre-soaked slices in fresh curry leaf solution had least moisture content. Chips prepared using dried garlic also recorded least moisture content irrespective of method of application and concentration tried. Similarly chips prepared after adding fresh or dried coriander leaves in oil at 0.01 or 0.02% concentration had least moisture content. Banana chips prepared from slices pre-soaked in 0.01% fresh garlic recorded the highest moisture content (8.25%), which was on par with all the chips prepared using pre-soaked slices in fresh spices. In the case of black pepper, pre-soaking banana slices in dried black pepper solution also resulted in high moisture content. None of the chips prepared after direct addition of spices had high moisture content, indicating superiority of direct addition of spices over pre-soaking method.

Banana chips prepared by directly adding 0.02% and 0.01% oven dried curry leaf powder to frying oil recorded the least oil uptakes of 31.40% and 33.80% respectively (Table1.). Direct addition of 0.01% and 0.02% oven dried coriander leaf powder to frying oil also recorded the least oil uptake (33.05%). Dried black pepper was also effective in reducing the oil uptake of chips (34.00%), when it was directly added to oil at 0.02% concentration. Maximum oil uptake (42.05%) was recorded by banana chips prepared using slices pre-soaked in 0.01% oven dried coriander leaf powder solution. Pre-soaking banana slices in 0.01% fresh garlic and 0.02% fresh black pepper solution resulted in chips with highest oil uptake (40.20% and 40.50%). A high oil content in fried banana chips shortens the shelf life of product and also causes a decrease in product acceptability to consumers [17].

Direct addition of 0.02% oven dried curry leaf powder to frying oil resulted in chips with lowest yield (64.15%) (Table1.). Reduced yield in treated chips is due to reduced oil uptake and moisture content [12]. Banana chips prepared from slices pre-soaked in 0.01% fresh garlic recorded the highest yield (75.40%), which is the result of high moisture content (8.25%), and higher oil uptake (40.20%).

All the treatments which had resulted in chips with low moisture content and oil uptake had low yield too indicating a negative correlation between yield and physical quality parameters. When method of application was evaluated, pre-soaking banana slices in antioxidant solution resulted in an increased moisture absorption of slices which increased the chance for more oil absorption in chips and hence resulted in higher yield.

For a good quality banana chips, the other two physical quality parameters to be considered are high integrity and low shrinkage. Banana chips prepared by direct addition of 0.02% oven dried coriander leaf powder to frying oil recorded high integrity (86.15%), which was on par with the chips prepared by direct addition of 0.01% and 0.02% oven dried curry leaf powder (84.75% and 85.90%) and 0.01% oven dried coriander leaf powder (84.85%) to frying oil. Adrika [1] could also observe a high integrity in chips prepared by adding dry curry leaf powder to frying oil. Lowest shrinkage (20.95%) was observed in banana chips prepared by direct addition of 0.02% oven dried curry leaf powder to frying oil. This was on par with the chips prepared by adding 0.02% oven dried coriander leaf powder to oil (21.00%). When all the physical parameters are considered together, direct addition of 0.02% curry leaf and coriander leaf powder resulted in low moisture, oil uptake, shrinkage with high integrity.

### 3.2 Effect of spices on chemical quality

Low free fatty acid value, peroxide value and high iodine value are the pre requisite for a good quality deep fried product with enhanced shelf life. In the present study banana chips prepared by direct addition of 0.02% oven dried powders of coriander leaves and curry leaves into frying oil had lowest FFA value (2.52 and 3.02 mg KOH/g respectively), peroxide value (6.20 and 6.50 meq. O<sub>2</sub> / kg respectively) and highest iodine value (6.35 and 6.73 respectively) at three months of storage indicating superiority of curry leaves and coriander leaves over other spices (Table2.). This is in accordance with the findings of Adrika [1] who had reported a low peroxide value when curry leaf powder is applied to frying oil. The peroxide value generally serves as a useful indicator of the extent of oxidation of lipids, fats and oils [7]. But when the banana slices were pre-soaked in solution of 0.02% oven dried curry leaf powder, free fatty acid value was the highest (10.66 mg KOH/g), indicating the superiority of direct application of antioxidants compared to pre-soaking of slices in antioxidants. Pre-soaking of banana slices in 0.02% oven dried garlic also resulted in chips with highest (10.94 mg KOH/g) free fatty acid value.

### 3.3 Effect of spices on sensory quality

Appearance is the first factor that determines the acceptance or rejection of any food product [4] and is influenced by factors like colour, gloss, viscosity, size, shape and defects if any.

Chips prepared by adding 0.02% oven dried curry leaf powder to frying oil scored highest mean rank value for appearance (281.20), which may be due to less oil uptake. This treatment also produced chips with highest colour (278.25). High integrity and low shrinkage observed might have reduced the defects in this treatment, thereby influencing appearance positively. Flavour, which includes taste, odour/ aroma & a composite sensation known as mouth feel, also plays an important role in food acceptability. The highest mean rank values for flavour (284.10), taste (282.80), texture (269.00) were also scored by chips prepared after adding 0.02% oven dried curry leaf powder to frying oil and hence with over all acceptability (291.60) (Figure 1).

Chips prepared by adding 0.02% oven dried coriander leaf powder to frying oil only scored the second highest sensory scores for appearance (198.40), colour (191.35), flavour (208.25), taste (196.05) and texture (181.55). Lowest mean rank value for all sensory quality attributes were recorded by banana chips prepared using slices pre-soaked in spices. Pre-soaking banana slices for 30 minutes results in adherence of spice powders over the surface of chips, which might have decreased the consumer acceptability. By higher oil absorption during pre-soaking, the natural flavor of the spices will be inhibited by the oil, thereby lowering the consumer acceptability resulting in low mean score for flavor and taste. Direct addition of spices in oil avoids all these negative factors, hence scored higher mean rank for sensory parameters.

It could be seen that spices like curry leaves and coriander leaves in oven dried forms were effective antioxidants in improving quality of banana chips. Direct addition of 0.02% oven dried curry leaf powder was superior in producing chips with better physical, chemical and sensory quality parameters. Chips prepared using oven dried coriander leaves had sensory characters next only to chips with oven dried curry leaves. Though having superior physical and chemical parameters comparing these two, addition of 0.02% oven dried curry leaf powder to frying oil was selected as the best method of banana chips preparation for enhanced shelf life and quality. The enhanced shelf life is due to the antioxidant activity of curry leaf, *Murraya koenigii* L. Spreng, a member of the family Rutaceae, which is attributed due to mahanimbine, murrayanol and mahanine [19] [14]. This work highlights the importance of curry leaves, which have been traditionally used in the Indian culinary system from time immemorial, as a rich source of antioxidants. The study proves that addition of dried curry leaf powder to chips can ensure an increased shelf life in addition to providing variability in chips industry.

## 4. CONCLUSION

Four different spices, rich in antioxidant principles, were incorporated to banana chips in two concentration, two forms and by two methods to study their effect in enhancing the shelf

life of banana chips. Fresh form of spices were not effective as compared to oven dried powdered forms and 0.02% oven dried powders of curry leaf and coriander were effective compared to black pepper and garlic. Direct addition of spices in oil was the effective method compared to pre-soaking of slices in spices before frying. Superior physical quality parameters like least moisture content, oil uptake, shrinkage and high integrity and chemical quality parameters like low FFA value, peroxide value and highest iodine value were recorded by banana chips prepared after adding 0.02% oven dried curry leaf powder to frying oil. Pre-soaking of slices in spice solution produced inferior quality chips compared to direct addition of spices in oil. The same treatment recorded highest sensory quality parameters too. Hence, direct addition of 0.02% oven dried curry leaf powder to frying oil at smoke point of 165°C along with banana slices was selected as the best method of chips preparation for enhanced shelf life.

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**Table 1: Physical quality parameters of chips prepared with the incorporation of spices**

| Treatments |                     |                       |               | Physical quality parameters |              |                |               |               |
|------------|---------------------|-----------------------|---------------|-----------------------------|--------------|----------------|---------------|---------------|
| Spices     | Form of application | Method of application | Concentration | Yield (%)                   | Moisture (%) | Oil uptake (%) | Integrity (%) | Shrinkage (%) |
|            |                     |                       |               |                             |              |                |               |               |
| Garlic     | Fresh               | PS                    | 0.01%         | 75.40                       | 8.25         | 40.20          | 82.05         | 23.30         |
|            |                     |                       | 0.02%         | 74.35                       | 8.00         | 39.25          | 82.50         | 23.10         |
|            |                     | DA                    | 0.01%         | 66.80                       | 6.65         | 37.05          | 80.50         | 22.55         |
|            |                     |                       | 0.02%         | 65.80                       | 7.05         | 35.80          | 82.25         | 22.95         |
|            | Dry powder          | PS                    | 0.01%         | 70.50                       | 6.30         | 39.25          | 82.90         | 22.20         |
|            |                     |                       | 0.02%         | 72.20                       | 6.05         | 38.85          | 82.00         | 23.35         |
|            |                     | DA                    | 0.01%         | 66.40                       | 5.55         | 34.40          | 84.50         | 22.50         |
|            |                     |                       | 0.02%         | 65.15                       | 5.90         | 35.85          | 83.95         | 23.15         |

|                |            |       |       |       |       |       |       |       |
|----------------|------------|-------|-------|-------|-------|-------|-------|-------|
| Pepper         | Fresh      | PS    | 0.01% | 72.40 | 7.50  | 38.95 | 82.90 | 22.90 |
|                |            |       | 0.02% | 71.70 | 8.15  | 40.50 | 82.10 | 23.30 |
|                |            | DA    | 0.01% | 68.50 | 6.50  | 35.60 | 82.75 | 22.65 |
|                |            |       | 0.02% | 68.10 | 6.70  | 36.35 | 83.15 | 23.30 |
|                | Dry powder | PS    | 0.01% | 71.00 | 7.35  | 37.40 | 83.20 | 22.65 |
|                |            |       | 0.02% | 70.70 | 7.40  | 38.05 | 82.10 | 23.00 |
| DA             |            | 0.01% | 66.05 | 6.90  | 34.85 | 84.05 | 22.25 |       |
|                |            | 0.02% | 67.00 | 6.50  | 34.00 | 83.70 | 23.05 |       |
| Curry leaf     | Fresh      | PS    | 0.01% | 72.15 | 7.50  | 37.45 | 82.25 | 23.25 |
|                |            |       | 0.02% | 71.45 | 7.40  | 37.45 | 81.95 | 23.15 |
|                |            | DA    | 0.01% | 69.95 | 5.95  | 35.95 | 83.90 | 21.85 |
|                |            |       | 0.02% | 68.85 | 6.10  | 36.45 | 84.05 | 21.90 |
|                | Dry powder | PS    | 0.01% | 67.80 | 6.20  | 38.50 | 82.65 | 23.30 |
|                |            |       | 0.02% | 68.90 | 6.15  | 37.80 | 82.65 | 23.20 |
|                |            | DA    | 0.01% | 65.30 | 5.50  | 33.80 | 84.75 | 22.35 |
|                |            |       | 0.02% | 64.15 | 5.30  | 31.40 | 85.90 | 20.95 |
| Coriander leaf | Fresh      | PS    | 0.01% | 71.70 | 7.50  | 38.70 | 82.85 | 23.30 |
|                |            |       | 0.02% | 70.50 | 7.35  | 37.75 | 83.85 | 23.45 |
|                |            | DA    | 0.01% | 66.65 | 6.25  | 36.35 | 83.70 | 23.25 |
|                |            |       | 0.02% | 68.20 | 6.15  | 38.70 | 83.85 | 22.45 |
|                | Dry powder | PS    | 0.01% | 69.85 | 6.40  | 42.05 | 82.85 | 23.30 |
|                |            |       | 0.02% | 68.80 | 6.75  | 39.10 | 82.55 | 22.95 |
|                |            | DA    | 0.01% | 66.00 | 5.65  | 33.05 | 84.85 | 21.90 |
|                |            |       | 0.02% | 65.00 | 5.40  | 33.05 | 86.15 | 21.00 |
| CD (P=0.05)    |            |       |       | 6.21  | 1.05  | 2.72  | 1.62  | 0.82  |

PS- Pre-soaking slices in peels before frying  
 DA- Direct addition of peels in oil at smoke point.

**Table 2: Chemical quality parameters of chips prepared with the incorporation of spices**

| Treatments   |                     |                       |               | Free fatty acid value (mg KOH/g) | Peroxide value (meq. O2/kg) | Iodine value |
|--------------|---------------------|-----------------------|---------------|----------------------------------|-----------------------------|--------------|
| Spices       | Form of application | Method of application | Concentration |                                  |                             |              |
| Garlic       | Fresh               | PS                    | 0.01%         | 8.98                             | 8.50                        | 3.32         |
|              |                     |                       | 0.02%         | 9.54                             | 8.20                        | 3.87         |
|              |                     | DA                    | 0.01%         | 7.02                             | 8.20                        | 4.60         |
|              |                     |                       | 0.02%         | 7.85                             | 8.30                        | 4.80         |
|              | Dry powder          | PS                    | 0.01%         | 9.54                             | 7.70                        | 4.19         |
|              |                     |                       | 0.02%         | 10.94                            | 8.40                        | 4.31         |
|              |                     | DA                    | 0.01%         | 7.58                             | 8.00                        | 4.73         |
|              |                     |                       | 0.02%         | 7.58                             | 8.10                        | 4.85         |
| Curry Pepper | Fresh               | PS                    | 0.01%         | 10.12                            | 8.50                        | 4.31         |
|              |                     |                       | 0.02%         | 8.97                             | 8.90                        | 4.63         |
|              |                     | DA                    | 0.01%         | 7.30                             | 8.40                        | 5.77         |
|              |                     |                       | 0.02%         | 7.02                             | 8.20                        | 5.58         |
|              | Dry powder          | PS                    | 0.01%         | 10.12                            | 8.10                        | 4.73         |
|              |                     |                       | 0.02%         | 9.54                             | 8.40                        | 4.68         |
|              |                     | DA                    | 0.01%         | 7.58                             | 8.10                        | 5.78         |
|              |                     |                       | 0.02%         | 7.29                             | 8.50                        | 5.86         |
| Curry leaf   | Fresh               | PS                    | 0.01%         | 10.40                            | 8.40                        | 4.49         |
|              |                     |                       | 0.02%         | 10.12                            | 8.50                        | 4.60         |

|                |            |            |       |       |       |      |      |
|----------------|------------|------------|-------|-------|-------|------|------|
| Coriander leaf | Dry powder | DA         | 0.01% | 7.30  | 8.30  | 5.52 |      |
|                |            |            | 0.02% | 7.58  | 8.60  | 5.84 |      |
|                |            | PS         | 0.01% | 9.25  | 8.30  | 4.31 |      |
|                |            |            | 0.02% | 10.66 | 8.10  | 4.63 |      |
|                |            | DA         | 0.01% | 7.30  | 7.90  | 5.52 |      |
|                |            |            | 0.02% | 3.02  | 6.50  | 6.73 |      |
|                | Fresh      | PS         | 0.01% | 10.09 | 8.20  | 3.75 |      |
|                |            |            | 0.02% | 8.69  | 8.50  | 3.81 |      |
|                |            | DA         | 0.01% | 7.85  | 7.80  | 5.78 |      |
|                |            |            | 0.02% | 7.86  | 8.20  | 6.09 |      |
|                |            | Dry powder | PS    | 0.01% | 10.10 | 9.30 | 4.12 |
|                |            |            |       | 0.02% | 9.79  | 9.00 | 4.37 |
| DA             | 0.01%      |            | 7.24  | 7.70  | 5.52  |      |      |
|                | 0.02%      |            | 2.52  | 6.20  | 6.35  |      |      |
| CD (P=0.05)    |            |            |       | 0.50  | 1.19  | 0.62 |      |

PS- Pre-soaking slices in antioxidants before frying  
 DA- Direct addition of antioxidants in oil at smoke point.

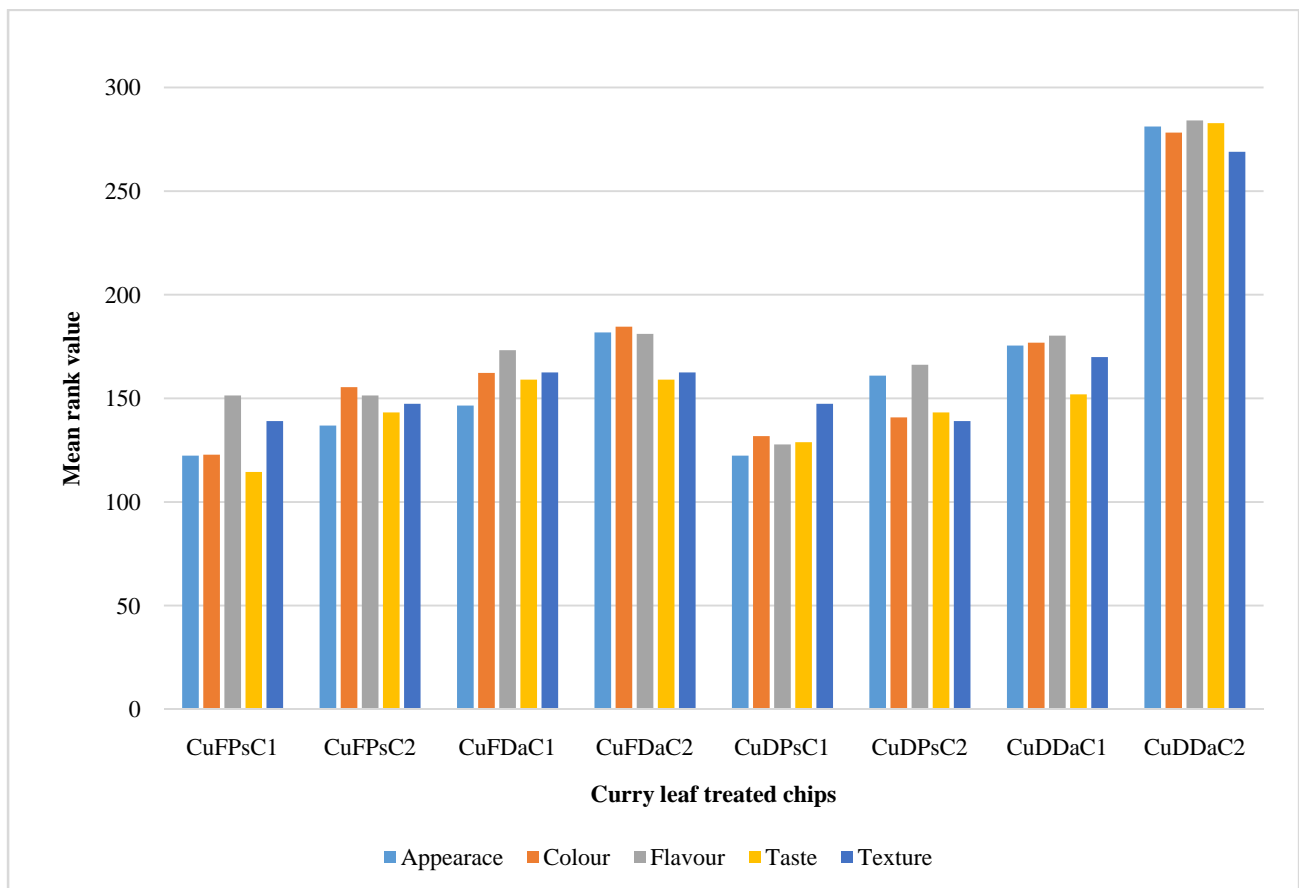


Fig. 1: Sensory quality parameters of curry leaf incorporated chips