Development of an instant spice mix from *gongura* (*Hibiscus cannabinus* L.) for deep fat fried snacks and evaluation of its antioxidant activity

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An instant spice mix based on *Hibiscus cannabinus* L. leaf (IGSM) for deep fat fried snacks was standardized and its chemical composition, antioxidant activity and storage stability was investigated. Dehydration of fresh *Hibiscus cannabinus* (*gongura*) and *Mentha spicata* (*pudina*) leaves yielded leaf powders of 13.28 and 9.78 %, respectively. The major ingredients of the standardized instant spice mix powders were *gongura* (25 %), *pudina* (12.5 %), pepper (15 %), salt and sugar were added for palatability. The spice mix is rich in dietary fibre (22.20 %) in which crude fiber is 10.82 %. Biologically active compounds such as polyphenols (1644 mg/100 gm) and ascorbic acid (9.48 mg/100 gm) were found in the spice mix. Essential amino acids were found to an extent of 42.12 and 42.62 gm/100 gm in *gongura* leaf powder and IGSM, respectively of which, l eucine, l lysine and p henylalanine were predominant. Inhibition of 2, 2'-diphenyl-2-picrylhydrazyl by 50 % was observed at a concentration of 6 mg/ml. The ABTS radical inhibition assay was found to be high (89.2 %) at 1.2 mg/ml concentration. Sorption studies indicated that the instant spice mix was stable at room temperature with an initial moisture content 3.39 %, which equilibrated at 37 % relative humidity. The overall sensory quality of instant spice mix on deep fat fried snacks was 7.27 ± 0.47 during six months of storage.

**Keywords:** *Hibiscus cannabinus* L., Instant spice mix, Chemical composition, Amino acid, Antioxidant activity

**IPC Int. Cl.**: A61K 36/00, A23L 27/00, C07, C09K 15/00, C07C 39/00

Instant mixes based on vegetables are very popular in India. The mixes are generally used as adjuncts with rice or breakfast items such as *idly*, *dosa*, *wada*, *bajji* and *bonda*. Instant mixes based on tomato, chilli, mint, onion, *jeera* and pepper are also used as sprinkling powders on snacks such as potato chips and extruded products. *Amchur*, lime, tamarind and tomatoes are the natural souring agents used popularly in such products. In the market several brands of instant mixes are also available, wherein the sourness of the mix is maintained by using synthetic acidulants such as acetic acid or citric acid. Standardization of instant mixes with various raw materials such as tamarind leaf, raw tamarind, curry leaf, tomato, raw mango and chemical composition, organoleptic quality and the storage stability of these products was reported in the literature 1-6.

*Hibiscus cannabinus* L. is a leafy vegetable belonging to the family of Malvaceae and cultivated throughout the year in south Indian states. *Gongura* is cultivated in two varieties, green stemmed leaf and red stemmed. The red stemmed variety is preferred for its higher acidity when compared to the green variety for preparation of *chutneys* and pickles. *Gongura* based culinary preparations with pulses such as *tur dal*, with non-vegetarian meats such as mutton, chicken and shrimp are popular in South Indian states of India. *Gongura* is a very rich source of iron, vitamins, folic acid and anti-oxidants essential for human nutrition 7. Mint (*Mentha spicata*) leaves are well known for its flavour rich in menthol, which has been widely used in *chutneys*, beverages, as pizza toppings, *samosas*, non-vegetarian preparations and menthol is used in medicinal formulations against cough, itching and as decongestant, antispasmodic and muscle relaxant 8. Sorrel (*Hibiscus sabdariffa* L.) leaves were found to possess higher hematopoiesis for sorrel leaves than spinach (*Spinacia oleracea*). During dehydration of green leafy vegetables with blanching treatment, higher losses in ascorbic acid and β-carotene and better retention of proteins, fibre and minerals (Ca, Mg, Fe) was observed 9. Leafy
vegetables are good source of vitamins, mineral, protein, flavanoids and phenolic acids possessing antioxidant activity and their application in fried snacks and as chutneys were found to be stable and acceptable\textsuperscript{11-14}. Among the leafy vegetable species of \textit{Amaranthus}, \textit{A. lividus} L. syn. \textit{Amaranthus blitum} subsp. \textit{oleraceus} (L.) Costea leaves were found to be rich sources of bioactive principles namely tannins, phytols, β-sitosterol, alkaloids and saponins (Nazish et al., 2016)\textsuperscript{15}. The methanolic soxhlet extract (MSE) of \textit{A. lividus} leaf exhibited highest antioxidant activity followed by methanolic (ME) and aqueous extracts (AE). The IC\textsubscript{50} values for ABTS inhibitions were 1.61, 1.89 and 83.91 mg/ml, respectively for MSE, ME and AE whereas the DPPH inhibition showed 3.18, 3.22 and 51.91 mg/ml, respectively. Though abundant literature on gongura is available, instant mixes based on gongura for snack industry are not reported. Hence, the present study was taken up to standardize an instant spice mix based on gongura with the application of mint as a flavouring agent for the development of a sprinkling powder for deep fat fried snacks.

### Materials and methods

#### Materials

Freshly harvested \textit{Hibiscus cannabinus} leaf (150 kg) were collected in 3 batches from different vendors on different days during January-June, 2015 from Rhythu Bazar at Hyderabad, Telangana, India. The processing of fresh leaves was carried within 1 hr after collection. Reagents and solvents used in the study were of analytical and laboratory grade respectively and procured from Sd Fine-Chem Ltd. (Mumbai, India). Chemicals used in antioxidant assays were purchased from Sigma Aldrich, Philadelphia, USA.

#### Preparation of dehydrated gongura and mint leaf

\textit{Gongura} and \textit{pudina} leaf was separated from stems, washed with running water, soaked in hypochlorite solution (5 ppm as chlorine), water drained and dried in a cabinet tray dryer (Chemida, Mumbai, India) at 45 ± 2 °C for 8 hrs. The dried materials were ground to powder using a high speed mixer (M/s. Sumeet, Nasik, India), and passed through BS 72 (220 μm) mesh. The powder was packed in metallized polyester polyethylene (MPE) laminate pouches and stored at 4 °C for further experiment.

#### Standardization of instant gongura spice mix (IGSM)

Instant gongura spice mix was standardized by preparing different combination of powdered ingredients like gongura powder (20-50 %), mint (10-30 %), pepper (8-20 %) with green chilli or red chilli (1-5 %) and palatable amounts of salt (12-35 %) and sugar and black salt (2-10 %) in different combinations to obtain a product suitable for application on deep-fat fried corn flakes. The product was prepared in bulk by mixing the required ingredients, ground to powder using mixer (M/s. Sumeet, Nasik, India), passed through BS 72 (220 μ) mesh, packed in metallized polyester polyethylene (MPE) laminate pouches and stored at room temperature (28 ± 2 °C) for evaluating their chemical composition, antioxidant activity and sorption studies.

#### Physicochemical composition

Physicochemical composition such as moisture, ash, fat, protein and fibre of IGSM was carried out using standard methods reported by Ranganna\textsuperscript{16}. The per cent carbohydrates content was calculated by difference method.

#### Estimation of dietary fibre

The dietary fibre content in IGSM was estimated using standard method\textsuperscript{17}. One gram of IGSM was taken in a beaker containing 50 ml 6 pH phosphate buffer and α-amylase 0.1 ml was added and incubated at 95 °C for 15 min. The contents were cooled, pH was adjusted to 7.5 using alkali and added 0.1 ml protease and incubated for 30 min at 68 °C. Later the contents were cooled to room temperature, pH was adjusted to 4-4.5, added amyloglucosidase (0.1 ml) and incubated at 60 °C for 30 min. Excess alcohol (1:4) was added and allowed at room temperature for overnight to collect the precipitate. The precipitate was filtered through Whatman No. 40 filter paper and washed with cool alcohol, acetone and dried in oven at 103 °C for 2 hrs.

#### Colour measurement

Colour characteristics namely $L^*$ (lightness) $a^*$ (red-green) and $b^*$ (yellow-blue) of IGSM were measured during regular intervals using Hunter Ultrascan colorimeter (Hunter Associates Laboratory, USA).

#### Moisture sorption studies

The spice mix (IGSM) 2 gm each was exposed to different levels of relative humidities (RH) ranging from 11 to 92 % in desiccators using saturated salt...
solutions. The equilibrium moisture content (EMC) versus RH was plotted and critical moisture content (CMC) was determined\textsuperscript{16}.

**Estimation of active components**

**Total polyphenols**

Total polyphenol content (TPC) in IGSM was estimated using Folin–Ciocalteau reagent. The total polyphenol content was calculated from a standard calibration curve of gallic acid (19-76 µg/ml) plotted against optical density. The total polyphenol content was expressed as mg of gallic acid per 100 gm sample\textsuperscript{18}.

**Estimation of ascorbic acid**

Ascorbic acid content in IGSM was measured according to a standard method titrating with a dye solution of 2, 6-dichlorophenol indophenol\textsuperscript{19}. The amount of ascorbic acid present in sample was calculated using the dye factor obtained by using standard L-ascorbic acid and expressed as mg/100 gm of IGSM.

**Estimation of β-carotene, lycopene and chlorophyll**

Pigments such as β-carotene, lycopene and chlorophyll in the IGSM were measured by extracting one gm in 50 ml of solvent mixture (acetone:hexane, 4:6) using a magnetic stirrer at room temperature for 30 min\textsuperscript{19}. The extracts of pigments were measured using a UV-Visible spectrophotometer at 452, 505, 645 and 663 nm and calculated using the following expressions and reported as mg per 100 gm IGSM.

\[
\begin{align*}
\beta \text{-carotene (mg/100 ml)} &= 0.216 \times A_{663} - 1.220 \times A_{645} - 0.304 \times A_{655} + 0.452 \times A_{453} \\
\text{Lycopene (mg/100 ml)} &= -0.0458 \times A_{663} + 0.204 \times A_{645} - 0.304 \times A_{505} + 0.452 \times A_{453} \\
\text{Chlorophyll (mg/100 ml)} &= 0.999 \times A_{663} - 0.0989 \times A_{645} \\
\text{a} &= -0.328 \times A_{663} + 1.77 \times A_{645} \\
\text{b} &= 0.999 \times A_{663} - 0.0989 \times A_{645}
\end{align*}
\]

**Estimation of amino acid composition**

Gongura leaf powder and instant gongura spice mix were analysed for amino acid profile using an automatic amino acid analyzer employing high performance liquid chromatography (Shimadzu Model LC 10A, Japan) by a reported method. The samples were hydrolysed using 6 N HCl under vacuum at 110 °C for 48 hrs\textsuperscript{20}.

**Determination of antioxidant activity**

Each sample of 5 gm of gongura powder and IGSM were extracted in 50 ml ethanol using a magnetic stirrer at RT for 30 min. The extracts of gongura powder and IGSM in the range 0.2-1.2 mg were used for determination of antioxidant activity employing 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) assay and ferric reducing power (FRP)\textsuperscript{21-23}. The activities were compared with that of Trolox at a concentration range of 5-30 µg/ml.

**Sensory evaluation of IGSM**

Commercial corn chips were deep fat fried in sunflower oil at a temperature of 160-180 °C. The hot chips were blended with IGSM in the range of 2-10 gm/100 gm chips. The spiced snacks prepared were subjected to sensory evaluation by employing eleven panel members from CSIR-CFTRI Resource Centre, Hyderabad. Appearance, colour, flavor, crispiness, taste, and overall acceptability of the snacks were evaluated on 9-point Hedonic scale with a maximum score of 9 for “like extremely” and minimum of 1 for “dislike extremely”\textsuperscript{24}.

**Statistical analysis**

Chemical composition colour units, antioxidant activity and amino acid composition were carried out in triplicate and mean values with standard deviation (SD) were computed by using MS excel, 2007. Moisture sorption isotherm studies were carried out in duplicate and graph was plotted using average values.

**Results and discussion**

**Yield and chemical composition of IGSM**

Fresh gongura and mint leaves after processing into dehydration and grinding yielded 13.26 and 9.70 % of powders, respectively. The composition of organoleptically palatable IGSM contains gongura powder (25 %), pudina powder (12.5 %) salt (17.5 %) black salt (5 %), black pepper (15 %) and sugar (25 %) as the standardised ingredients. Products prepared by addition of green chilly or red chilly powder were not acceptable for panellists and hence omitted. The physicochemical composition of gongura powder (GP) and IGSM is presented in Table 1. Application of spice mix was found to be optimum at 5 % level on deep fat fried corn chips. Photographs of fresh gongura leaf, dehydrated powder, IGSM, fried maize chips and IGSM applied maize chips are shown Fig. 1. The IGSM possessed good quantities of protein 12.11 % and crude fibre 10.82 %, in which dietary fibre contributing 22.20 %.
Table 1—Physico-chemical composition of gongura powder and instant gongura spice mix

<table>
<thead>
<tr>
<th>Parameter</th>
<th>GP</th>
<th>IGSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>2.32 ± 0.18</td>
<td>3.09 ± 0.07</td>
</tr>
<tr>
<td>Total ash</td>
<td>7.22 ± 0.27</td>
<td>25.92 ± 0.70</td>
</tr>
<tr>
<td>Acid insoluble ash</td>
<td>-</td>
<td>0.40 ± 0.01</td>
</tr>
<tr>
<td>Alkalinity of ash as potassium carbonate</td>
<td>-</td>
<td>6.33 ± 0.18</td>
</tr>
<tr>
<td>Crude fat</td>
<td>10.62 ± 0.43</td>
<td>2.75 ± 0.35</td>
</tr>
<tr>
<td>Crude protein</td>
<td>20.86 ± 0.93</td>
<td>12.11 ± 0.43</td>
</tr>
<tr>
<td>Crude fiber</td>
<td>3.94 ± 0.36</td>
<td>10.82 ± 0.69</td>
</tr>
<tr>
<td>Total dietary fibre</td>
<td>18.50 ± 0.73</td>
<td>22.20 ± 0.32</td>
</tr>
<tr>
<td>Carbohydrates by difference</td>
<td>55.04 ± 0.73</td>
<td>45.31 ± 1.40</td>
</tr>
<tr>
<td>Acidity as citric acid</td>
<td>15.6 ± 0.46</td>
<td>3.90 ± 0.31</td>
</tr>
<tr>
<td>Salt as sodium chloride</td>
<td>-</td>
<td>21.85 ± 0.83</td>
</tr>
<tr>
<td>Hunter colour</td>
<td>L*</td>
<td>66.42 ± 0.79</td>
</tr>
<tr>
<td></td>
<td>a*</td>
<td>-0.19 ± 0.02</td>
</tr>
<tr>
<td></td>
<td>b*</td>
<td>18.08 ± 0.59</td>
</tr>
</tbody>
</table>

*Values are average of triplicate analysis with ± SD; L*: Lightness; a*: Redness; b*: Yellowness, GP: Gongura powder; IGSM: instant gongura spice mix

Fig. 1—Photographs of (a) Fresh gongura leaves (b) Gongura powder (c) Instant gongura spice mix (IGSM) (d) Deep fat fried corn chips (e) Deep fat fried corn chips applied with IGSM

The crude fibre of 29.61 % and crude protein content 12.40 % in H. cannabinus were reported25. The yields of gongura and pudina leaves during dehydration in a tray drier were 16.6 and 15.4 %, respectively14 are comparable with the present work. The crude fibre content in instant gongura and pudina chutney powders were reported as 5.1 and 6.38 %, respectively17. Similarly, a crude fibre content of 7.0 % was reported in instant curry leaf chutney powder3. Hunter colour values are L* 66.42, a* -0.19 and b* 18.08 for IGSM, which indicated that the product possessed green colour. Colour value of L* (22.07) and negative a* value were reported for tray dried curry leaf with good retention of chlorophyll during drying26.

Moisture sorption isotherm

Moisture sorption isotherm of IGSM is presented in Fig. 2. Initial moisture content (IMC) of 3.39 %, which equilibrated at 37 % RH. The sample picked up moisture very fast above 56 % RH, which indicated that the sample is non-hygroscopic in nature. The CMC equilibrated at 56 % RH. Earlier studies showed IMC of instant gongura and pudina chutney powders were 4.9 and 4.0%, which equilibrated at 42 and 43% RH, respectively14. They reported these instant mixes were hygroscopic in nature. Similarly, the CMCs of 8.5 and 9.2 % for pudina and gongura instant chutneys were reported to equilibrate at 63 and 52 % RH, respectively.

Active components

The data on pigments and active components of GP and IGSM such as polyphenols, ascorbic acid, β-carotene, lycopene and chlorophyll is presented in Table 2. Higher amount of total polyphenols 1644
mg/100 gm were observed in IGSM. Similarly, ascorbic acid (9.4 mg), β-carotene (4 mg), lycopene (36 mg) and total chlorophyll (152 mg/100 gm) were also found in IGSM. Fresh gongura leaves possessed total polyphenol content 318.59 mg, β-carotene 124 mg chlorophyll a (39.16 mg) and chlorophyll b (9.33 mg/ 100 gm). Total carotenoid content of 68 mg/100 gm and total chlorophyll of 838 mg/100 gm in instant curry leaf chutney was reported in literature. Premavalli et al.27 noticed 60 % retention of carotenoids in dehydrated leafy vegetable and combinations of acidulants and antioxidant spices also improved the retention of b-carotene during cooking. This effect seemed to be additive in the case of processing of amaranth by boiling.28 The total phenolic content of the methanolic fraction of Momordica cymbalaria was found to be 132 mg/gm on dry matter.29 Polyphenols such as rutin, kaempferol, quercetin, etc., are some important plant flavonoids known for their anti-inflammatory, anti-allergic, antithrombitic, hepatoprotective, antispasmodic and anticancer properties reported in the literature.30

**Amino acid composition**

The protein content was found to an extent of 20.86 and 12.11 % in gongura leaf powder and IGSM, respectively. Amino acid composition of the dehydrated GP and IGSM is presented as gm/100 gm protein in Table 3. Total essential amino acids except tryptophan were found to an extent of 42.12 and 42.62 gm/100 gm protein in gongura leaf powder and IGSM, respectively. Among the essential amino acids, leucine (8.91 and 9.71 gm/100 gm); lysine (6.19 and 6.17 gm/100 gm); phenylalanine (6.01 and 5.95 gm/100 gm) were found in higher amounts. Methionine was observed to an extent of 1.53 and 1.15 gm/100 gm protein of gongura leaf powder and IGSM, respectively. Glutamic acid (12.40 and 12.98 gm/100 gm) and aspartic acid (13.94 and 13.96 gm/100 gm) were found to be major non essential amino acids in gongura leaf powder and GSM, respectively. The ratio of essential to non essential amino acids was found to be 0.72 and 0.74 in gongura leaf powder and GSM, respectively. FAO/WHO31 recommended values of essential amino acids (mg/kg body weight per day) for adult humans are isoleucine (20), leucine (39), lysine (30), methionine and cysteine (15), phenylalanine and tyrosine (25), threonine (15), tryptophan (4) and valine (26). Earlier reports on H. cannabinus indicated that the leaf powder is found to be a good source of essential amino acids, which can supplemented in processed food products as a nutraceutical additive. Cysteine and methionine contents were found to be slightly below 50 % of the WHO/ FAO requirements in Hibiscus cannabinus.25

**Antioxidant activity of ethanolic extracts of IGSM**

Data on DPPH radical scavenging activity ABTS assay and ferric ion reducing power of IGSM was presented in Table 4. In all the methods the activity of extracts was dose dependent. The activity was found to be higher in ABTS assay, when compared to that of DPPH. IC50 value of DPPH radical scavenging activity was found to be 0.6 mg/ml (51.23 %), when compared to 57.38 % inhibition at 0.4 mg/ml in the ABTS assay. It was observed that the inhibition was 35.34 % with

<table>
<thead>
<tr>
<th>Amino acid</th>
<th>GP</th>
<th>IGSM</th>
</tr>
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<tbody>
<tr>
<td>Asx*</td>
<td>13.94±0.60</td>
<td>13.56±0.40</td>
</tr>
<tr>
<td>Glx**</td>
<td>12.40±0.30</td>
<td>12.98±0.71</td>
</tr>
<tr>
<td>Ser</td>
<td>3.20±0.13</td>
<td>4.35±0.20</td>
</tr>
<tr>
<td>Gly</td>
<td>5.74±0.32</td>
<td>5.97±0.22</td>
</tr>
<tr>
<td>His</td>
<td>2.51±0.11</td>
<td>2.32±0.09</td>
</tr>
<tr>
<td>Arg</td>
<td>5.69±1.99</td>
<td>4.77±1.4</td>
</tr>
<tr>
<td>Thr</td>
<td>3.92±1.50</td>
<td>4.66±1.64</td>
</tr>
<tr>
<td>Ala</td>
<td>8.68±0.63</td>
<td>7.60±0.08</td>
</tr>
<tr>
<td>Pro</td>
<td>6.99±0.79</td>
<td>7.03±0.26</td>
</tr>
<tr>
<td>Tyr</td>
<td>0.31±0.11</td>
<td>0.29±0.02</td>
</tr>
<tr>
<td>Val</td>
<td>7.50±0.45</td>
<td>7.18±0.24</td>
</tr>
<tr>
<td>Met</td>
<td>1.53±0.22</td>
<td>1.15±0.06</td>
</tr>
<tr>
<td>Cys</td>
<td>0.92±0.13</td>
<td>0.85±0.19</td>
</tr>
<tr>
<td>Ile</td>
<td>5.55±0.13</td>
<td>5.47±0.17</td>
</tr>
<tr>
<td>Leu</td>
<td>8.91±0.27</td>
<td>9.71±0.28</td>
</tr>
<tr>
<td>Phe</td>
<td>6.01±0.45</td>
<td>5.95±0.15</td>
</tr>
<tr>
<td>Lys</td>
<td>6.19±0.05</td>
<td>6.17±0.11</td>
</tr>
</tbody>
</table>

*Values are average of triplicate analysis with ± SD, Amino acid composition is expressed as gm/100 gm protein.
0.2 mg/ml of extract, which increased to 69.05% with 1.2 mg/ml. Similarly, ferric ion reducing power, the increase in optical density was 0.084 to 0.356, when increased the concentration from 0.2 mg/ml to 1.2 mg/ml, respectively. The activity, when compared to standard antioxidant at varying concentrations of 5-30 μg/ml showed an activity in the range of 37.12 to 84.62% inhibition by DPPH assay, 56.88-99.14% inhibition by ABTS assay and optical density values of 0.047-0.152 by ferric ion reducing power. The DPPH activity of ethanolic extract and aqueous extract of Stevia (20 - 200 μg/ml) leaf increased from 36.93 - 68.76% and 40 - 72.37% in a dose dependent manner and the total phenolic contents were measured as 6.15 and 5.67%. The higher total phenol (131 μg) content in Stevia leaf extract showed greater antioxidant activity than Stevia callus extract (44 μg/ml)\(^{12,33}\). The anti-radical power value of DPPH IC 50% at 0.41 mg/ml extract was observed in ethanolic extract of Hibiscus sabdariffa leaves\(^{11}\). Amla, a rich source of ascorbic acid and polyphenols was evaluated for antioxidant activity of the methanolic extract. A very high DPPH inhibition was reported with an IC 50 value of 22.07 μg/ml when compared to 16.41 μg/ml for standard ascorbic acid (Singh et al., 2015)\(^{34}\). Shade dried spinach leaf powder showed DPPH inhibition of 42.57% at a concentration of 10 μg/ml\(^{35}\). Spinach (Spinacia oleracea) powder in flour dough as a natural antioxidant was investigated and oxidation of frying soybean oil and the lipid in fried products during frying was studied\(^{13}\). They reported that addition of spinach powder helped to reduce the lipid content of fried samples. Spinach in the dough decreased the accumulation of the polar compounds in soybean oil during frying and also reduced conjugated diene and aldehyde formation. Improvement in lipid oxidative stability of fried products is higher than in oil, presumably due to pigments of spinach. The jam prepared using seabuckthorn fruit pulp was found to be rich in vitamin C (504 mg/100 gm), carotenoids (6.85 mg/100 gm) and anthocyanins (1.85 mg/100 gm) which in turn exhibited good antioxidant activity (89%) based on DPPH assay when compared to commercial pineapple (8.16%) or papaya (6.19%) jams (Selvamuthukumaran et al., 2014)\(^{36}\).

### Organoleptic quality

The organoleptic scores namely appearance, colour, crispiness, taste, and overall acceptability of coated snacks with IGSM are presented in Table 5. Panelists liked the standardized IGSM applied at 5% level on deep fat fried snacks during sensory analysis. The overall acceptability scores are 8.64 ± 0.45 which reduced to 7.27 ± 0.47 after six months storage at room temperature in MPE pouches, which is due to loss of flavour. Earlier Balaswamy et al.\(^{3}\) reported a overall sensory quality score of 7.6 (good) for instant curry leaf chutney powder after 3 months of storage at room temperature.

### Traditional significance of the study to the society/researchers

The instant gongura spice mix is a novel concept to utilise the acidulant property from natural sources whereas commercial spice formulations apply synthetic citric acid. The formulation is rich in fibre, essential amino acids and pigments, which are health promoting.
Conclusion
Preparation of instant gongura spice mix is a convenient and economical process. IGSM was rich in protein and bioactive components and possessed good antioxidant activity, which was confirmed by the presence of bioactive components such as polyphenols and ascorbic acid. Sorption studies indicated that the IGSM was non-hygroscopic in nature and stable at room temperature. The overall sensory quality of IGSM on deep fat fried snacks was well accepted by panellists even after storage for six months at room temperature. The study shows, the highly perishable gongura leaf can be converted in to commercially viable value-added stable instant spice powder suitable for breakfast, snack and meal preparations.

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