

# DEVELOPMENT AND QUALITY CHARACTERISTICS OF *CORCHORUS OLITORIUS* LEAVES INCORPORATED INSTANT CHUTNEY POWDERS

## Abstract:

*Corchorus olitorius*, is a popular nutrient dense and multipurpose traditional wild green leafy vegetable of Nalgonda district, Telangana state. Due to its short shelf life and the limited harvesting time, processing such as drying techniques permit to preserve and provide it throughout the year. Till date not much research was done to develop value added products with the *Corchorus olitorius* leaves. Therefore, in the present investigation, a ready-to-use instant chutney powder was developed with the most organoleptically acceptable formulation of 33% *Corchorus olitorius* leaves powder and physicochemical, nutritional and phytonutrient properties were determined. The developed instant chutney powder found good amount of ash (15.33%), crude fiber (13.04%), protein (19.63%), beta-carotene (82.18 $\mu$ g/100g), total carotenoids (763.1 $\mu$ g/100g), calcium 632.7mg/100g), iron (13.40mg/100g), zinc (2.51mg/100g), copper (1.03mg/100g), manganese (3.83mg/100g) and potassium (757.7mg/100g) compared to control. As green leaves are good source of phytonutrients, incorporation of *Corchorus olitorius* leaves significantly ( $p < 0.01$ ) improved the total phenols (28.7%) and total antioxidant capacity (99.09%) of developed chutney powder. The results of the study also found high bioavailable calcium (84.44%) and iron (64.21%) content in the leaf powder incorporated chutney powder than the control. The developed product can be readily eaten with rice, idli or dosa, which could serve as a healthy addition to one's daily diet. The developed instant chutney powder could enhance the utilization of locally available seasonal traditional green leafy vegetables and promote dietary diversification.

**Key words:** Antioxidant activity, *Corchorus olitorius*, Traditional green leafy vegetable

## Introduction

Now a days, there is an increasing incidences of many life style disorders like obesity, cardiovascular and diabetes problems are coupled with consumption of high energy high fat and high refined foods with low nutrient density. These increased life style disorders creating health concerns among the consumers and so, currently food choices of customers have significantly changed towards looking for and choosing nutritious, healthy and tasty alternatives. Thus, it drives the attention of the researchers, food scientists, technologists, and nutritionists towards development of tasting, healthy, therapeutic and functional foods with added nutritional benefits (Dega and Barbhai, 2023).

*Corchorus olitorius* is commonly called as a Tossa jute or Nalta jute in English. About 90% of this plant cultivated South Asia specially India and Bangladesh (Parvin *et al.*, 2015; Ghellam *et al.*, 2022). This plant belongs to family Tiliaceae, it is also known as bush or wild okra, Jew's mallow, long fruited jute, Meloukia, Moroheia, Moroheiya, Mulukhiya (Abdel-Razek *et al.*, 2022). The plant is consumed in Nigeria, Bangladesh, Philippines, Malaysia, Egypt, Sudan, India and Japan (Isuosuo *et al.*, 2019; Loumerem and Alercia, 2016; Baiyeri *et al.*, 2022). The plant is cherished for its huge food, nutritional, nutraceuticals, economic and climatic resilient plant (Baiyeri *et al.*, 2022). It is a rich source of protein, dietary fiber, beta carotene, chlorophylls, vitamins, minerals, phenols and other bioactive compounds. It is a traditional medicinal plant possesses antitumour, anti-pyretic, decrease serum and liver cholesterol, anti-inflammatory, anticonvulsive, antioxidant, gastroprotective, diuretic, anticarcinogenic, treatment of anemia, diabetes and hypertension management properties (Youssef *et al.*, 2014; Biswas *et al.*, 2020; Baiyeri *et al.*, 2022). Different parts of *C. olitorius* are also used in folk medicine notably, leaves to relieve stomach pains, seeds as laxative and roots for treating toothache and the stems for treating cardiovascular disorder (Loumerem and Alercia, 2016).

Though it is a popular green leafy vegetable globally, countries like India, it is mainly cultivated for the jute purpose. But it is naturally grown in the field areas during rainy season. Still people in rural areas are consuming this as traditional wild green leafy vegetable. But the main drawback is this leafy vegetable is seasonal and perishable. Therefore, one way to preserve this kind of the seasonal traditional green leafy vegetable is dehydration. Dehydration is one the most commonly used method for preservation of leafy vegetables. Nowadays, market value of dehydrated vegetables has increased. As it increases the variety in the diet, reduces the wastage and also provides long-shelf-life products which are easy to store, handle and can also be used in the formulation of functional and nutraceutical products (Joshi and Mathur, 2010; Youssef *et al.*, 2014).

In India, a variety of traditional preparations like chutneys, pickles and chutney powders are available in large volumes based on the spices, pulses and vegetables are consumed with rice, breakfast items such as vada, idly, dosa, chapathi, upma, samosa as a side dish and as sprinklers on various snack foods such as potato chips and extruded products as a side dish, which also increase appetite (Jyothirmayi *et al.*, 2006; Balaswamy *et al.*, 2004; Rao *et al.*, 2013; Rao *et al.*, 2017). Green leafy vegetables are good source of protein, vitamins, mineral and antioxidants, their application in chutney powders were found to be stable and

acceptable (Rao et al., 2017). Many studies are available on the development and standardization of several traditional instant chutney powders based on the different raw materials (Balaswamy et al. 2004; Jyothirmayi et al. 2006; Devi et al., 2023; Rao et al., 2017; Kumar et al., 2023; Mummaleti and Beera, 2019; Sarkar et al., 2018; Rao et al., 2004; Rao et al., 2008; Prasoon, et al., 2020; Ganesan et al., 2014, 48-50). Interestingly, though abundant studies available on the instant chutney powders, instant chutney powder based on *Corchorus olitorius* leaves was not reported. Hence, present study was taken up to standardise nutri dense chutney powder and evaluated for its physicochemical and phytonutrient properties.

### **Materials and methods**

The present study was conducted at Department of Foods and Nutrition, Post Graduate and Research Center (PGRC), Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad (India).

### **Procurement of raw materials**

The fresh leaves of *Corchorus olitorius* was collected from the farming areas of Nalgonda district, Telangana state. The edible portions of selected leaves were washed, and blanched, shade dried until samples became crisp and brittle to the touch. After drying the samples were powdered and used for product development. All the raw materials required for the product are procured from the local markets of Hyderabad, India.

### **Process description of *Corchorus olitorius* incorporated instant chutney powders:**

Five formulations of instant chutney powders were prepared from dried *Corchorus olitorius* (5%, 10%, 15%, 20% and 25%) leaves. Control chutney powder (CCP) and instant chutney powders different formulations of *Corchorus olitorius* leaves were prepared using ingredients given in Table-1. All the ingredients weighed separately and roasted ingredients (black gram, bengal gram, cumin seeds, coriander seeds, garlic, tamarind, chili powder and salt) were powdered and mixed together in blender, with salt and five different proportions of leaf powder is added.

**Table-1 Proportions of the ingredients used in standardization of *Corchorus olitorius* leaves incorporated chutney powder**

<b>Ingredients</b>	<b>Control</b>	<b>F1</b>	<b>F2</b>	<b>F3</b>	<b>F4</b>	<b>F5</b>
<i>Corchorus olitorius</i> powder	0.0	5.0	10.0	15.0	20.0	25.0

Black gram dhal	6.5	6.5	6.5	6.5	6.5	6.5
Bengal gram dhal	5.0	5.0	5.0	5.0	5.0	5.0
Cumin powder	3.5	3.5	3.5	3.5	3.5	3.5
Coriander seeds	6.5	6.5	6.5	6.5	6.5	6.5
Garlic	5.5	5.5	5.5	5.5	5.5	5.5
Tamarind powder	7.0	7.0	7.0	7.0	7.0	7.0
Chili powder	10.0	10.0	10.0	10.0	10.0	10.0
Common salt	6.0	6.0	6.0	6.0	6.0	6.0

**Note:** All formulae were repeated three times.

All ingredients were measured in grams

### **Sensory evaluation of instant chutney powders and murukku**

The sensory assessments were conducted in a sensory evaluation laboratory. Semi trained panel members (15) from the Foods and Nutrition Department at Post Graduate and Research Centre, PJTSAU, Rajendranagar, Hyderabad, were selected as panellists for the study. They were given written instructions and asked to evaluate the products for acceptability in terms of appearance, color, texture, taste, flavour, crispness and overall acceptability using a 9-point hedonic scale, where 1= dislike extremely, 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like, nor dislike; 6 = like slightly; 7 = like moderately and 8 = like very much 9= Like extremely (Meilgaard *et al.*, 1999). The samples were presented in plates coded with three-digit numbers in individual booths in sensory evaluation lab. Panelists rinsed their mouth with water after testing each sample.

**Physico-chemical properties of developed products:** Bulk density (Stojceska *et al.* 2008), tapped density (Narayana and Narasinga Rao 1984), flowability and cohesiveness (Jinapong *et al.* 2008), titratable acidity (Ranganna 2017), color (Hunter Lab 2013), chroma and hue (Pathare *et al.* 2012), total color difference (Martins and Silva 2002) and water activity (Abramovie *et al.* 2008) was estimated for both test and the control sample.

**Nutritional composition:** Moisture, ash, protein (AOAC, 2005), fat (AOAC, 1997), crude fiber (AOAC, 1995), carbohydrate and energy (AOAC, 1980), total carotenoids (Zakaria *et al.*, 1979),  $\beta$ - carotene (Srivastava and Kumar, 1993), ascorbic acid (Ranganna, 2017), Calcium, iron, magnesium, manganese, copper, zinc, sodium, potassium, phosphorus was analyzed by

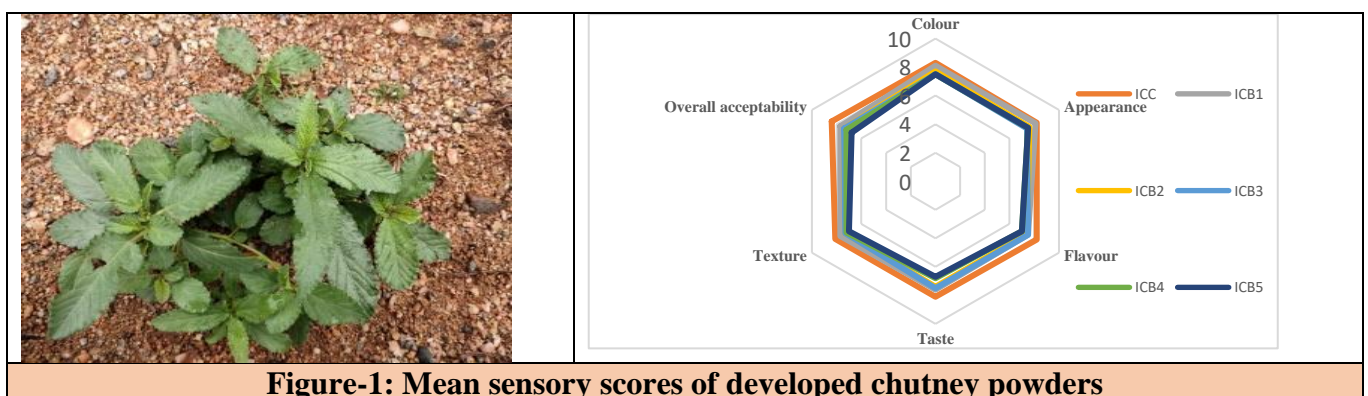
the standard procedures (AOAC, 2012) bioavailable calcium, zinc (Kim and Zemel, 1986) and iron (Narasinga and Prabhavathi, 1978) content was analyzed.

**Phytonutrient properties:** Antioxidant screening (Harbourne, 1993), flavonoid content (Zhishen *et al.*, 1999), total phenols (Slinkard and Slingleton, 1997), antioxidant activity by DPPH (2,2-diphenyl-1-picrylhydrazyl) (Dorman *et al.*, 2004; Tadhani *et al.*, 2007), tannins (AOAC, 2005).

**Statistical analysis:** All experiments were performed three times. All data were presented as mean  $\pm$  standard deviation of the mean.

## Results and discussion

**Sensory quality characteristics of *Corchorus olitorius* leaves incorporated chutney powders:** Evaluation of sensory attributes like color, appearance, taste and aroma are important for consumer's acceptance or rejection of any food (Kumar and Devi, 2023). It provides both qualitative and quantitative data that aids in the product development (Devi *et al.*, 2023). The mean sensory scores of developed products were represented in Figure-1. The results for sensory analysis of developed instant chutney powders showed that a significant difference was observed for sensory attributes of *Corchorus olitorius* leaves incorporated chutney powders ( $p < 0.05$ ). The control sample found highest scores for all sensory attributes. as the percentage incorporation of leaf powder increases, decrease in overall acceptability was observed. The results of the ICO1 (5% leaf powder incorporated chutney powder) were closer to the control. Even though scores were decreased as the percentage of incorporation increases, but up to 25% incorporation of leaf powder also shows the good overall acceptability score. Therefore, ICO5 (25% leaf powder incorporated instant chutney powder) was selected for the further analysis.



**Figure-1: Mean sensory scores of developed chutney powders**

## Physical properties of instant chutney powders

The bulk and tapped density of developed chutney powder was decreased by 1.86% and 18.07% than the control sample due to incorporation of leaves. Flowability percentage of ICO was less whereas its was found highest in ICC. According to Carr index, ICO (25% leaf powder incorporated chutney powder) had fair flowability. Flowability is the ability of the powder to flow. According to husner ratio (HR) based on bulk and tapped densities, ICO (1.29) has intermediate cohesiveness, whereas ICC (control instant chutney powder) (1.57) had high cohesiveness. Titratable acidity of chutney powders was 0.003 (ICO) and ICC (0.014). When compared to ICC, titratable acidity of ICO, was decreased by 78.57% respectively. Due to addition of leaves P<sup>H</sup> of chutney powders was increased by 16.21% in ICO, when compared to ICC.

The results of colour scores of chutney powders were presented as L\*, a\*, b\*, C\* and h\* values and mentioned in Table-2. L\* values of chutney powders were -61.16±0.88 (ICC) and -59.88±0.49 (ICO). The a\* and b\* values of ICO were 5.21±0.19 and 23.71±0.24 (ICO) respectively. The L\* values of chutney powders were decreased by 2.09% in ICO than the control sample. It was found that a\* and h\* values of ICO was increased when compared to control sample. The E\* and C\* values of ICO was decreased by 2.48 and 10.584% respectively then ICC. There was no significant difference was found between the control and ICO5 for the L\* and E\* values. Hunter colour values L\*, a\* and b\* indicates that ICO possessed green colour. The water activity is inversely proportional to shelf life of the products. The water activity of *Corchorus olitorius* incorporated chutney powder was less than 0.5 and so the product can be best stored at room temperature.

**Table-2 Physical properties of *Corchorus olitorius* incorporated instant chutney powders**

Physical properties of developed products						
Sample	BD (g/cm <sup>3</sup> )	TD (g/cm <sup>3</sup> )	CI (%)	HR	TA (%)	P <sup>H</sup>
ICC	0.53 <sup>a</sup> ±0.00	0.83 <sup>b</sup> ±0.00	36.10 <sup>b</sup> ±0.06	1.57 <sup>b</sup> ±0.00	0.014 <sup>b</sup> ±0.00	4.07 <sup>a</sup> ±0.00
ICO	0.52 <sup>a</sup> ±0.00	0.68 <sup>a</sup> ±0.00	22.15 <sup>a</sup> ±0.07	1.29 <sup>a</sup> ±0.00	0.003 <sup>a</sup> ±0.00	4.73 <sup>b</sup> ±0.00
t-value	3.40	320.32	28.99	34.08	14.86	88.55
p value	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**
Colour values of developed products						
Sample	L*	a*	b*	E*	C*	H*
ICC	-61.16 <sup>b</sup> ±0.88	9.63 <sup>b</sup> ±0.51	25.59 <sup>b</sup> ±0.05	67.61 <sup>b</sup> ±0.85	27.35 <sup>b</sup> ±0.18	58.50 <sup>a</sup> ±0.69
ICO	-59.88 <sup>a</sup> ±0.49	5.21 <sup>a</sup> ±0.19	23.71 <sup>a</sup> ±0.24	65.93 <sup>a</sup> ±0.49	24.28 <sup>a</sup> ±0.25	64.90 <sup>b</sup> ±0.36
t-value	1.26	8.14	7.58	1.71	9.78	8.21
p value	0.28NS	0.00**	0.00**	0.16NS	0.00**	0.00**

(BD: Bulk density, TD: Tapped density, CI: Carr index, HR: Hausner ratio, TA: Titratable acidity, L\*- lightness, a\*- green to red, b\*- blue to yellow, E\*- total colour difference, H\*- hue angle, C\*- chroma)

**Note:** Values are expressed as mean  $\pm$  standard deviation of three determinations; Means within the same column followed by a common letter do not differ significantly at ( $p \leq 0.01$ ) NS: not significant; \*\* significant at ( $p \leq 0.01$ ); \* significant at ( $p \leq 0.05$ )

ICC: Instant chutney powder control

ICO: *Corchorus olitorius* leaves incorporated instant chutney powder

**Nutritional composition *Corchorus olitorius* leaves incorporated instant chutney powders:** The results of the nutritional composition of the developed products were reported in Table-3. Moisture content was high in ICO and low in ICC. Ash, crude fiber, and protein content of ICC and ICO was 14.48% and 15.33%, 12.29% and 13.04%, 15.32% and 19.63% respectively. Previous studies reported that *Corchorus olitorius* leaves are good sources of protein, ash and crude fiber (Ukom and Obi, 2018; Yakoub *et al.*, 2018; Yekeen *et al.*, 2013). Incorporation of *Corchorus olitorius* leaves powder significantly ( $p < 0.01$ ) increased the ash, crude fiber and protein content by 5.87%, 6.1%, and 28.13% respectively due incorporation of leaf powder. As greens are low in fat and energy, ICO fat, carbohydrate and energy content was decreased by 2.25, 6.54 and 3.24% respectively when compared to the control sample.

Vitamin C, beta carotene and total carotene of ICC and ICO was 1.07mg/100g to 14.73mg/100g, 150.3 $\mu$ g-82.18 $\mu$ g/100g and 13.87 $\mu$ g/100g-763.18 $\mu$ g/100g respectively. Incorporation leaf powder increased the vitamin C, beta carotene and total carotenoid content of ICO by 1276.63%, 492.5% and 407.72% respectively. Green leafy vegetables are the source of plenty of essential nutrients like ascorbic acid, carotenoids, chlorophyll, polyphenols and other phytochemicals (Rodriguez-Amaya *et al.* 2007). The study found that leaf powder incorporated chutney powder found more vitamin content than the control.

Dehydrated greens are the concentrated source of minerals. Both macro and micro minerals crucial for the normal body functions. Mineral content of ICC and ICO per 100g were calcium-486.3mg and 632.7mg, iron-7.22mg 13.4mg, zinc-1.44mg and 2.51mg, copper-0.74mg and 1.03mg, manganese-1.87mg and 3.83mg respectively. There was significant difference found between the mineral content of ICC and ICO. Addition of *Corchorus olitorius* leaf powder increased the calcium, iron, zinc, copper, manganese and potassium content of

ICO was enhanced by 30.1, 85.59, 74.3, 39.19, 104.81 and 27.86% respectively. The term bioavailability goes beyond absorption from the gut and also includes the use and retention in body tissue (Melse-Boonstra, 2020). The study found that ICO had high available calcium content than ICC. Bioavailable iron and zinc content of ICO was 84.9% and 48.27% respectively.

**Table-3: Nutritional composition of developed products (100g)**

Proximate composition of developed products								
Sample	Moisture (%)	Ash (g)	Fat (g)	Crude fiber(g)	Protein (g)	Carbohydrate (g)	Energy (kcal)	
ICC	7.43 <sup>a</sup> ±0.03	14.48 <sup>a</sup> ±0.14	8.41 <sup>b</sup> ±0.071	12.29 <sup>a</sup> ±0.01	15.32 <sup>a</sup> ±0.00	40.47 <sup>b</sup> ±0.01	298.8 <sup>b</sup> ±0.00	
ICO	9.22 <sup>b</sup> ±0.04	15.33 <sup>b</sup> ±0.08	6.61 <sup>a</sup> ±0.005	13.04 <sup>b</sup> ±0.00	19.63 <sup>b</sup> ±0.00	37.82 <sup>a</sup> ±0.04	289.1 <sup>a</sup> ±0.00	
t-value	33.87	5.30	25.18	57.08	1085.15	22.89	878.30	
p value	0.00**	0.01*	0.00**	0.00**	0.00**	0.00**	0.00**	
Mineral content of developed products (mg/100g)								
Sample	Calcium	Iron	Zinc	Copper	Manganese	Phosphorus	Sodium	Potassium
ICC	486.3 <sup>a</sup> ±0.20	7.22 <sup>a</sup> ±0.09	1.44 <sup>a</sup> ±0.00	0.74 <sup>a</sup> ±0.00	1.87 <sup>a</sup> ±0.00	207.1 <sup>b</sup> ±0.00	5830 <sup>b</sup> ±0.00	592.6 <sup>a</sup> ±0.00
ICO	632.7 <sup>b</sup> ±0.20	13.40 <sup>b</sup> ±0.11	2.51 <sup>b</sup> ±0.00	1.03 <sup>b</sup> ±0.00	3.83 <sup>b</sup> ±0.01	200.1 <sup>a</sup> ±0.10	3619 <sup>a</sup> ±1.00	757.7 <sup>b</sup> ±0.10
t-value	486.27	42.62	15413.15	332.20	1226.69	83.76	2523.61	1162.31
p value	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**	0.00**

**Note:** Values are expressed as mean ± standard deviation of three determinations; Means within the same column followed by a common letter do not differ significantly at ( $p \leq 0.01$ ) NS: not significant; \*\* significant at ( $p \leq 0.01$ ); \* significant at ( $p \leq 0.05$ )

ICC: Instant chutney powder control; ICO: *Corchorus olitorius* leaf powder incorporated instant chutney powder

**Table-4: Vitamin composition of developed products (100g)**

Sample	Vitamin C (mg)	Beta carotene (µg)	Total carotenoids(µg)
ICC	01.07 <sup>a</sup> ±0.01	13.87 <sup>a</sup> ±0.01	0150.3 <sup>a</sup> ±0.20
ICO	14.73 <sup>b</sup> ±0.08	82.18 <sup>b</sup> ±0.00	0763.1 <sup>b</sup> ±0.10
t-value	1505.89	741.80	3289.11
p value	0.00**	0.00**	0.00**

**Note:** Values are expressed as mean ± standard deviation of three determinations; Means within the same column followed by a common letter do not differ significantly at (p ≤ 0.01) NS: not significant; \*\* significant at (p≤0.01); \* significant at (p≤0.05)

ICC: Instant chutney powder control; ICO: *Corchorus olitorius* leaf powder incorporated instant chutney powder

**Table-5. Bioavailable mineral content of instant chutney powders**

Sample	Calcium		Iron		Zinc	
	mg/100g	%	mg/100g	%	mg/100g	%
ICC	325.3 <sup>a</sup> ±0.20	66.89	5.23 <sup>a</sup> ±0.01	72.43	0.58 <sup>a</sup> ±0.00	40.27
ICO	406.3 <sup>b</sup> ±0.20	64.21	11.45 <sup>b</sup> ±0.11	84.44	0.86 <sup>b</sup> ±0.00	34.26

ICC: Instant chutney powder control

ICO: *Corchorus olitorius* leaf powder incorporated instant chutney powder

**Phytonutrient composition of developed products:** Various types of photochemicals are present in green leafy vegetables such as polyphenols, phenolic acids, flavonoids, carotenoids, glucosinolates, isothiocyanate, phytosterols, and monoterpenes (Aslam *et al.*, 2020). Phytonutrients are naturally occurring plant secondary metabolites which helps to prevent and protect against several infections, diseases and useful for human health and wellbeing (Chukwuebuka and Chinenye, 2015). These phytochemicals possess medicinal properties such as anti-diabetic properties, prevents cardiovascular diseases, anti-hypertensive, anti-carcinogenic, anti-anemic, and improves gut health (Aslam *et al.*, 2020).

The screening of methanolic extracts of chutney powders identified the presence of proteins, amino acids, carbohydrates, phenols, flavonoids, tannins, alkaloids, saponins, glycosides, phlobatinins, steroids. Phenolic compounds are the major antioxidant constituents of fruits and vegetables. There is a direct relationship between their antioxidant activity and total phenolic compounds (Arasaretnam *et al.*, 2018). The total phenol content of chutney powder was increased by 28.7% due to incorporation of leaf powder. The flavonoid and tannins content of ICC and ICO was 8.44mg RE/gm-90.71mg RE/gm and 16.27mg TAE/100g-27.29mg

TAE/100g respectively. Total antioxidant activity of ICC and ICO was 31.09% and 50.81% respectively. Overall incorporation of *Corchorus olitorius* leaves powder significantly ( $p < 0.01$ ) improved the phytonutrient composition of developed chutney powder.

**Table-6: Phytonutrient composition of developed products**

Sample	Phenols (mg GAE/100g)	Flavonoids (mg RE/gm)	Tannins (mg TAE/100g)	Antioxidant activity (%)
ICC	203.1 <sup>a</sup> ±0.00	8.44 <sup>a</sup> ±0.06	16.27 <sup>a</sup> ±0.01	31.09 <sup>a</sup> ±0.00
ICO	261.4 <sup>b</sup> ±0.00	90.71 <sup>b</sup> ±0.14	27.29 <sup>b</sup> ±0.01	50.81 <sup>b</sup> ±0.00
t-value	745.48	536.37	896.90	15968.61
p value	0.00**	0.00**	0.00**	0.00**

**Note:** Values are expressed as mean ± standard deviation of three determinations; Means within the same column followed by a common letter do not differ significantly at ( $p \leq 0.01$ ) NS: not significant; \*\* significant at ( $p \leq 0.01$ ); \* significant at ( $p \leq 0.05$ )

ICC: Instant chutney powder control; ICO: *Corchorus olitorius* leaf powder incorporated instant chutney powder

### Conclusion

Natural plant-based foods are the need of the hour. Being low in calories, green leafy vegetables have immense nutritional and therapeutic benefits. Drying and value addition of traditional green leafy vegetables in the commonly consumed foods like instant chutney powders have significantly increased the protein, crude fiber, ash, vitamin, mineral and phytonutrient content. The developed product using *Corchorus olitorius* leaf powder could be one of the novel food items with nutrient density and also provides variety in the daily diet. It can be concluded that this product can be promoted as a functional food has the potential to prevent certain diseases associated with hidden hunger and oxidative stress.

**Conflict of interest:** We have no conflict of interest to declare.

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### References

1. Abdel-Razek, M.A.M., Abdelwahab, M.F., Abdelmohsen, U.R and Hamed, A.N.E. 2022. Pharmacological and phytochemical biodiversity of *Corchorus olitorius*. RSC Advances. 12: 35103–35114.

2. Abramovic, H., Jamnik, M., Burkan, L and Kac, M. 2008. Water activity and water content in Slovenian honeys. *Food control*. 19(11): 1086-1090.
3. AOAC, Official method of analysis for fiber, *Association of Official Analysis Chemists*. 14<sup>th</sup> Edition. Washington DC. USA, (1995).
4. AOAC, Official Methods of Analysis for ash in flour. *Association of Official Analytical chemists*, (2005a).
5. AOAC, Official Methods of Analysis for fat (crude) or ether extract in flour, *Association of Official Analytical Chemists*, 16<sup>th</sup> Ed. 3<sup>rd</sup> Revision. Gaithersburg, Maryland, 20877-2417. AOAC 920.85, chap 32 (1997) 05.
6. AOAC, Official Methods of Analysis for moisture in flour, *Association of Official Analytical Chemists*. 18<sup>th</sup> Ed, Arlington VA 2209, USA. AOAC 929.03, 32 (2005b) 02.
7. AOAC, Official Methods of Analysis for PH in fruits leather rolls. AOAC international 19th Edition. Volume II. *Association of Official Analytical Chemists*. Gaithersburg (2012).
8. AOAC, Official Methods of Analysis for protein. *Association of Official Analytical Chemists*. 18<sup>th</sup> Ed, Arlington VA 2209, USA. AOAC 984.13, (2005c) chap 04, pp 31.
9. AOAC, Official methods of analysis, Association of Official Analytical Chemists. Washington, D.C. USA (1980).
10. Arasaretnam, S., Kiruthika, A and Mahendran, T. 2018. Nutritional and mineral composition of selected green leafy vegetables. *Ceylon Journal of Science*. 47(1):35-41.
11. Aslam, T., Maqsood, M., Jamshaid, I., Ashraf, K., Zaidi, F., Khalid, S., Shah, F.U.H., Noureen, S and maria. 2020. Health Benefits and Therapeutic importance of green leafy vegetables (GLVs). *European Academic Research*. 8(7): 4213-4229.
12. Baiyeri, S.O. and Samuel-Baiyeri, C.C.A. 2022. Evaluation of the Minerals, Proximate, Viscosity and Antinutrients of the Fruits of *Corchorus olitorius* Accessions. *Journal of the Austrian Society of Agricultural Economics*. 18(7): 1163-1171.
13. Biswas, A., Dey, S., Li, D., Liu, Y., Zhang, J., Huang, S., Pan, G and Deng, Y. 2020. Comparison of Phytochemical Profile, Mineral Content, and In Vitro Antioxidant Activities of *Corchorus capsularis* and *Corchorus olitorius* Leaf Extracts from Different Populations. *Journal of Food Quality*. 1-14.
14. Dega, V and Barbhai, M.D. 2023. Exploring the underutilized novel foods and starches for formulation of low glycemic therapeutic foods: A review. *Frontiers in Nutrition*. 10(1162462.): 1-16.

15. Dorman, H.J.D., Bachmayer, O., Kosar, M and Hiltunen, R. 2004. Antioxidant properties of aqueous extracts from selected La-miaceae species grown in Turkey. *Journal of Agricultural and Food Chemistry*. 52(4): 762–770.
16. Ghellam, M., Fatena, B and Koca, I. 2022. Physical and chemical characterization of *Corchorus olitorius* leaves dried by diferent drying techniques. *Discover Food*. 2(14): 1-16.
17. Harbourne, J.B. 1993. *Phytochemistry*. Academic press, London. 89-131.
18. Hunter lab. 2013. Hunter Assosiate Labaratory. Manual version-2.1. 60: 1014-323.
19. Jinapong, N., Suphantharika, M and Jamnong, P. 2008. Production of instant soymilk powders by ultrafiltration, spray drying and fluidized bed agglomeration. *Journal of Food Engineering*. 84: 194-205.
20. Loumerem, M and Alercia, A. 2016. Descriptors for jute (*Corchorus olitorius* L.). *Genet Resour Crop Evol*. 63:1103–1111.
21. Martins, R.C and Silva, C.L.M. 2002. Modelling colour and chlorophyll losses of frozen green beans (*Phaseolus vulgaris*, L.). *International Journal of Refrigeration*. 25(7): 966-974.
22. Meilgaard, M., Civile, G.V and Carr, B.T. 1999. *Sensory Evaluation Technique*. 3<sup>rd</sup> Edition. CRC press, Boca Raton.
23. Melse-Boonstra, A. 2020. Bioavailability of Micronutrients From Nutrient-Dense Whole Foods: Zooming in on Dairy, Vegetables, and Fruits Alida Melse-Boonstra. *Frontiers in Nutrition*. 7(101): 1-12.
24. Narasinga Rao, B.S and Prabhavathi, T. 1978. An *in vitro* method for predicting the bioavailability of iron from foods. *American Journal Clinical Nutrition*. 31: 169–175.
25. Pathare, P.B., Opara, U.L and Al-said, F.A.J. 2012. Colour measurement and analysis in fresh and processed foods. A Review. *Food and Bioprocess Technology*. 6(1): 36-60.
26. Ranganna, S. 2017. *Handbook of analysis and quality control for fruits and vegetable products*. Second edition. McGraw Hill Education (India) Private Limited, Chennai, Tamil Nadu. 105-110.
27. Slinkard, K and Slingleton. 1997. Total phenolic analyses: Automation and comparison with manual method. *American Journal Enology and Viticulture*. 28: 49-55.
28. Srivastava, R.R and Kumar, S. 1993. Important methods for analysis of fruits / vegetables and their products. *Fruit and Vegetable preservation Principles and Practices 2nd Edition*. 321-339.

29. Stojceska, V., Ainsworth, P., Plunkett, A and Ibanoglu, S. 2008. The advantage of using extrusion processing for increasing dietary fiber level in gluten free products. *Food chemistry*. 121: 156-164.
30. Tadhani, M.B., Patel, V.H and Subhash, R. 2007. In vitro antioxidant activities of Stevia rebaudiana leaves and callus. *Journal of Food Composition and Analysis*. 20: 323-329.
31. Youssef, Kh. M., Mokhtar, S.M and Morsy, N.E. 2014. Effect of Hot Air Drying Variables on Phytochemicals and Antioxidant Capacity of Jew's Mallow (*Corchorus olitorius* L.) Leaves. *Journal of Food Sciences, Suez Canal University*. (2): 11-18.
32. Zakaria, M., Simpson, K., Brown, P and Krstulovic, A. 1979. Use of reverse phase HPLC analysis for the determination of provitamin A carotenes in tomatoes. *Journal of Chromatography*. 176: 109-117.
33. Rao, N.G., Balaswamy, K., Srinivasulu, K., Sulochanamma, G., Venkateswaran, G and Rao, P.G.P. 2017. Development of an instant spice mix from gongura (*Hibiscus cannabinus* L.) for deep fat fried snacks and evaluation of its antioxidant activity. *Indian Journal of Traditional Knowledge*. 16(3): 490-497.
34. Zhishen, J., Mengcheng, T and Jianming, W. 1999. The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. *Food Chemistry*. 64(4): 555-559.
35. Balaswamy, K., Jyothirmayi, T and Rao, D.G. 2004. Studies on Preparation of Curry leaf (*Murraya Koenigil* L.) Chutney Powder. *Foodservice Research International* 14: 175-187.
36. Devi, R., Devi, T.S., Kuna, A., Reddy, M.V., Chary, D.S and Babu, K.M. 2023. Formulation and Sensory Evaluation of Fenugreek Microgreens Incorporated Instant Chutney Powders. *Environment and Ecology*. 41(1B): 486-491.
37. Kumar, V and Devi, M.K. 2023. Impact of different drying methods on sensory and physicochemical analysis of instant green bell pepper chutney mix. *Measurement: Food*. 9(100077): 1-8.
38. Mummaleti, G and Beera, V. 2019. Formulation and Sensory Evaluation of Flax Seed Chutney Powder. *The Indian Journal of Nutrition and Dietetics*. 56(3): 243-248.
39. Sarkar, B.R., Awasthi, P and Joshi, H. 2018. Physical properties and nutritional composition of tamarind kernel powder and quality evaluation of instant chutney mix prepared incorporating tamarind kernel powder. *Journal of Pharmacognosy and Phytochemistry*. 7(6): 1342-1346.

40. Rao, P.G.P., Rao, G.N., Satyanarayana, A and Rao, D.G. 2004. Studies on chutney powders based on tamarind (*Tamarindus indica L.*) leaves. *Foodservice Research International*. 15: 13–24.
41. Rao, N., Rao, G.P., Jyothirmayi, T and Rao, D.G. 2008. Chemical composition, standardisation and storage studies on raw mango chutney powder. *Journal of Food Science Technology*. 45(5): 436-438.
42. Prasoon, J., Kumari, B.A., Sarkar, S., Kiran, K.V and Swamy, R. 2020. Development of instant chutney powder with incorporation of cabbage and green leafy vegetable. *Journal of Pharmacognosy and Phytochemistry*. 9(4): 3275-3278.
43. Ganesana, P., Murugana, Y., Phaiphana, A and Baharin, B.S. 2014. Physicochemical and antioxidant properties of curry leaves (*Murraya koenigii*) chutney powder. *International Bioscience Conference and the 5th International PSU-UNS Bioscience Conference (IBSC2014)*. 167-171.
44. Rodriguez-Amaya DB, Porcu OM, Azevedo-Meleiro CH (2007). Variation in the carotenoid composition of fruits and vegetables along the food chain. *Acta Hort.* 746 : 265—271.
45. Ukom, A.N and Obi, J.A. 2018. Comparative Evaluation of the Nutrient Composition and Phytochemical Content of Selected Vegetables Consumed in Nigeria. *International Letters of Natural Sciences*. 71: 43-50.
46. Yakoub, A.R.B., Abdehedi, O., Jridi, M., Elfalleh, W., Nasri, M and Ferchichi, A. 2018. Flavonoids, phenols, antioxidant, and antimicrobial activities in various extracts from Tossa jute leaf (*Corchorus olitorus L.*). *Industrial Crops and Products*. 118: 206-213.
47. Yekeen, T.A., Akintaro, O.I and Azeez, M.A. 2013. Evaluation of cytogenotoxic and nutrient composition of three commonly consumed vegetables in south western Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*. 13(2): 7452-7466.
48. Mishra S, Mishra S, Kumari S, Bharali D. Evaluation of Nutritional and Microbial Properties of Bread Developed by Incorporating Moringa oleifera Leaves and Fenugreek Leaves. *AFSJ* [Internet]. 2021 Jun. 22 [cited 2024 May 21];20(7):93-101. Available from: <https://journalafsj.com/index.php/AFSJ/article/view/441>
49. Fred Coolborn A, Bolatito B, Victoria Omolara A, C. Adetuyi F. Phytochemical and Antioxidant Effect of Spathodea campanulata leaf Extracts. *Int. J. Biochem. Res. Rev.*

[Internet]. 2015 May 4 [cited 2024 May 21];7(3):148-59. Available from: <https://journalijbcrr.com/index.php/IJBCRR/article/view/341>

50. Raja KS, Taip FS, Azmi MM, Shishir MR. Effect of pre-treatment and different drying methods on the physicochemical properties of *Carica papaya* L. leaf powder. *Journal of the Saudi Society of Agricultural Sciences*. 2019 Apr 1;18(2):150-6.