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Development and Quality Characteristics of *Corchorus olitorius* Leaves Incorporated Instant Chutney Powders

Kanneboina Soujanya [a*], B. Anila Kumari [a] and E. Jyothsna [b]

[a] Department of Food and Nutrition, Post Graduate & Research Centre, PJTS Agricultural University, Rajendranagar, Hyderabad (500 030), India.
[b] Krishi Vigyan Kendra, PJTSAU, Palem, Nagar Kurnool District – 509215, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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 25% *Corchorus olitorus* leaves powder and physicochemical, nutritional and phytonutrient properties were determined. The

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**Corresponding author: E-mail: Kanneboinasoujanya16@gmail.com;*

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developed instant chutney powder found good amount of ash (15.33%), crude fiber (13.04%), protein (19.63%), beta-carotene (82.18µg/100g), total carotenoids (763.1µg/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 phenol content (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 power 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.

Keywords: Antioxidant activity; Corchorus olitorius; traditional green leafy vegetable.

1. 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 tasty, healthy, therapeutic and functional foods with added nutritional benefits [1].

Corchorus olitorius is commonly called as a Tossa jute or Nalta jute in English. About 90% of this plant is cultivated in South Asia specially in India and Bangladesh [2]. 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 [3]. The plant is consumed as leafy vegetable in Nigeria, Bangladesh, Philippines, Malaysia, Egypt, Sudan, India and Japan [4,5]. The plant is cherished for its huge food, nutritional, nutraceuticals, economic and climatic resilient plant [5]. 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 [6,7,5]. 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 disorders [4].

Though it is a popular green leafy vegetable globally, in India, it is mainly cultivated for the jute purpose. It is also available naturally in the field areas during rainy season. Still many people in rural areas are consuming this as a traditional wild green leafy vegetable during its availability. 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 [6].

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, which also increases the appetite [8,9]. Green leafy vegetables are good source of protein, vitamins, mineral and antioxidants, their application in chutney powders were found to be stable and acceptable [9]. Many studies are available on the development and standardization of several traditional instant chutney powders based on the different raw materials [8,10,9,11,12,13,14,15,16,17,18-20].
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.

2. MATERIALS AND METHODS

The present study was conducted at Department of Foods and Nutrition, Post Graduate and Research Centre (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. Collected leaves were washed, blanched (2 min) and shade dried until samples became crisp and brittle to 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 different formulations of instant chutney powders were prepared from dried *Corchorus olitorius* (5%, 10%, 15%, 20% and 25%) leaves. Control chutney powder (ICC) 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.

Sensory evaluation of instant chutney powders: 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 [21]. 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.

Physicochemical properties of developed products: Bulk density [22], tapped density [23], flowability and cohesiveness [24], titratable acidity [25], color [26], chroma and hue [27], total color difference [28] and water activity [29] was estimated for both test and the control sample.

Nutritional composition: Moisture, ash, protein [30], fat [31], crude fiber [32], carbohydrate and energy [33], total carotenoids [34], β- carotene [35], ascorbic acid [24], calcium, iron, magnesium, manganese, copper, zinc, sodium, potassium, phosphorus was analyzed by the standard procedures [36]. Bioavailable calcium, zinc [37] and iron [38] content was analyzed for both control and the selected formulation.

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

Ingredients	Control	F1	F2	F3	F4	F5
Corchorus olitorius 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 formulations were repeated three times.
All ingredients were measured in grams

Phytonutrients content: Antioxidant screening [39], total flavonoid content [40], total phenol content [41], antioxidant activity by DPPH (2,2-diphenyl-1-picrylhydrazyl) [42,43] and, tannins [44] were analyzed.

Statistical analysis: All experiments were performed three times. All the data were presented as mean ± standard deviation of the mean.

3. 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 [11]. It provides both qualitative and quantitative data that aids in the product development [10]. The mean sensory scores of developed products were represented in Fig. 1b. The results of sensory analysis of developed products showed significant difference for sensory attributes of chutney powders ($p<0.05$). The control sample found highest scores for all sensory attributes. As the percentage of 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.

Physicochemical properties of instant chutney powders: The bulk and tapped density of ICO (25% leaf powder incorporated 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 had fair flowability. Flowability is the ability of the powder to flow. According to Hausner 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 0.014% (ICC). Due to addition of leaves P^H 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 (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 and 23.71 respectively. The L* values of chutney powders were decreased by 2.09% in ICO than the control sample. There was no significant difference was found between the control and ICO 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.

Fig: 1a Corchorus olitorius

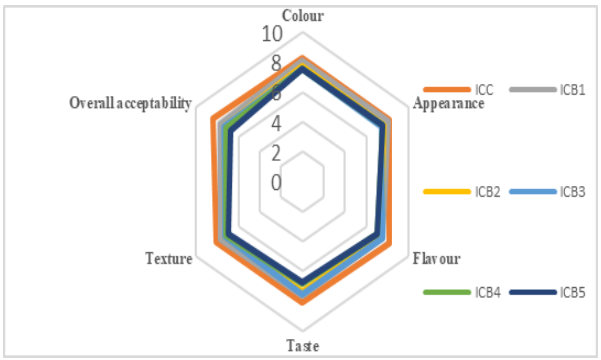

Fig:1b Mean sensory scores of developed chutney powders

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

Physical properties of developed products						
Sample	**BD (g/cm^3)**	**TD (g/cm^3)**	**CI (%)**	**HR**	**TA (%)**	**P^H**
ICC	0.53^a±0.00	0.83^b±0.00	36.10^b±0.06	1.57^b±0.00	0.014^b±0.00	4.07^a±0.00
ICO	0.52^a±0.00	0.68^a±0.00	22.15^a±0.07	1.29^a±0.00	0.003^a±0.00	4.73^b±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^b±0.88	9.63^b±0.51	25.59^b±0.05	67.61^b±0.85	27.35^b±0.18	58.50^a±0.69
ICO	59.88^a±0.49	5.21^a±0.19	23.71^a±0.24	65.93^a±0.49	24.28^a±0.25	64.90^b±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 ± 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 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 1304%, 15.32% and 19.63% respectively. Previous studies also reported that *Corchorus olitorius* leaves are good sources of protein, ash and crude fiber [45,46,47]. 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. 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 content of ICC and ICO was 1.07mg/100g and 14.73mg/100g, 150.3µg/ 100g and 82.18µg/100g and 13.87µg/100g and 763.18µg/100g respectively. Incorporation leaf powder significantly 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 [48].

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 and 13.4mg, zinc-1.44mg and 2.51mg, copper-0.74mg and 1.03mg, managanese-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 [49]. 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.

Phytonutrient content of developed products: Various types of phytochemicals are present in green leafy vegetables such as polyphenols, phenolic acids, flavonoids, carotenoids, glucosinolates, isothiocyanate, phytosterols, and monoterpenes [50]. Phytonutrients are naturally occurring plant secondary metabolites which helps to prevent and protect against several infections, diseases and useful for human health and wellbeing [51]. These phytochemicals possess medicinal properties such as anti-diabetic properties, prevents cardiovascular diseases, anti-hypertensive, anti-carcinogenic, anti-anemic, and improves gut health [50].

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^{a}±0.03	14.48^{a}±0.14	8.41^{b}±0.071	12.29^{a}±0.01	15.32^{a}±0.00	40.47^{b}±0.01	298.8^{b}±0.00
ICO	9.22^{b}±0.04	15.33^{b}±0.08	6.61^{a}±0.005	13.04^{b}±0.00	19.63^{b}±0.00	37.82^{a}±0.04	289.1^{a}±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^{a}±0.20	7.22^{a}±0.09	1.44^{a}±0.00	0.74^{a}±0.00	1.87^{a}±0.00	207.1^{b}±0.00	5830^{b}±0.00	592.6^{a}±0.00
ICO	632.7^{b}±0.20	13.40^{b}±0.11	2.51^{b}±0.00	1.03^{b}±0.00	3.83^{b}±0.01	200.1^{a}±0.10	3619^{a}±1.00	757.7^{b}±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[a]±0.01	13.87[a]±0.01	0150.3[a]±0.20
ICO	14.73[b]±0.08	82.18[b]±0.00	0763.1[b]±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[a]±0.20	66.89	5.23[a]±0.01	72.43	0.58[a]±0.00	40.27
ICO	406.3b±0.20	64.21	11.45b±0.11	84.44	0.86b±0.00	34.26

ICC: Instant chutney powder control

ICO: Corchorus olitorius leaf powder incorporated instant 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[a]±0.00	8.44a±0.06	16.27[a]±0.01	31.09[a]±0.00
ICO	261.4[b]±0.00	90.71[b]±0.14	27.29[b]±0.01	50.81[b]±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 ≤ 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

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 [52]. 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.

4. 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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