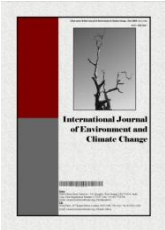

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Standarsidation, Nutritional and Phytonutrient Composition of *Aerva lanata* Incorporated Product

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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

Nutritionally rich snack item was developed by the incorporation of a wild green leafy vegetable powder-*Aerva lanata*. The plant has good nutritional, cultural and medicinal value. The present study evaluated and compared the nutritional and phytonutrient composition of value-added snack along with its control. It was found the increase in protein (18.24g/100g), ash (3.34g/100g), crude fiber (2.65g/100g), vitamin C (2.86mg/100g), total carotenoid (233.21µg/100g) and beta carotenoid (34.14µg/100g) content of the leaf incorporated murukku than its control. The minerals like the calcium, iron, zinc, copper, manganese, phosphorus, potassium was increased by 159.47, 121.73, 20.12, 25.0, 42.7, 2.55, 6.58% whereas sodium content was decreased by 15.54% in the product then the control sample. The qualitative analysis of methanolic extracts of products identified the presence of proteins, amino acids, carbohydrates, phenols, flavonoids, tannins, alkaloids, glycosides, phlobatinins and steroids. The phenolic, flavonoid and tannic acid content of product was increased by 96.52, 842.99 and 64.02% respectively. The study concluded that the product was best accepted than the control sample in all organoleptic properties. In addition, incorporation of leaf powder increased the nutritional, mineral and antioxidant activity of the product. Value addition of the wild green leafy vegetable in traditional food products improves the palatability, dietary diversity and improves the nutritional status.

Keywords: Aerva lanata; jowar murukku; antioxidant activity; value addition.

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1. INTRODUCTION

United Nations sustainable development goals namely no poverty, zero hunger, good health and wellbeing are difficult to achieve simply by maximizing the food production with the limited natural resources [1]. In order to meet the demands of increasing population we need to improve food production to 70% by 2050. So, there is growing demand for the cultivation of high resilient, low resource intensive and nutritionally rich crops which are important for the environmental sustainability and human wellbeing. In this view, domestication and exploitation of uncultivated crops with efficient utilisation of natural resources provide a promising future food security with high nutritional value [2].

Nutrition security is achieved "when all people at all times consume food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care" (FAO, 2012).

There were at least 3000 wild edible plant species known to man and almost 1532 wild species are available in India, mostly from Western Ghats and Himalayan regions. Tribal people had great knowledge about wild species and used them for many purposes [3]. Indigenous vegetables supply certain hormone precursors in addition to proteins, energy, vitamins and minerals. Some studies reported that consumption of indigenous species was less expensive and more nutritious than normal cultivated species [4].

Aerva lanata is a traditional green leafy vegetable with cultural, medicinal and nutritional importance. In traditional medicinal system, the plant is used to treat various diseases such as diuretic, anthelmintic, antidiabetic, treatment in lithiasis, to arrest haemorrhage during pregnancy and for uterus clearance after delivery. Nasal bleeding, cough and fractures was treated by plant extracts. Leaves were used as antimalarial, to expel kidney stones and other antirheumatic conditions [5]. The present is aimed to study the feasibility of incorporation of *Aerva lanata* into jowar based murukku and analysed for its nutritional and phytonutrient composition.

2. MATERIALS AND METHODS

The fresh leaves of *Aerva lanata* was collected from the fields of Nalgonda district, Telangana state. The edible portions of selected leaves were washed, blanched, 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 form the local markets of Hyderabad, India. To the jowar murukku dough, different proportions of leaf powder (0,5,10 and 15%) was added and pressed to desired shape by using murukku pressor.

2.1 Sensory Evaluation

The developed products were analysed for organoleptic characteristics by 15 selected semi trained panel members from PGRC, PJTSAU using 9-point hedonic scale and evaluated for colour, texture, flavour, taste and overall acceptability. Scores were based on a hedonic scale of 1 to 9 where: 1=I dislike extremely (very bad) and 9= I like extremely (excellent). 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 [6].

2.2 Physical Properties

Titratable acidity [7], Color [8], chroma and hue [9], total color difference [10].

2.3 Nutritional Profiling

2.3.1. Proximate analysis

Moisture, ash, protein [11], fat [12], crude fiber [13], carbohydrate and energy [15], free fatty acids [15] and starch [16].

2.3.2 Vitamin analysis

Total carotenoids [17], β- carotene [18] and ascorbic acid [7].

2.3.3 Mineral analysis

Calcium, iron, magnesium, manganese, copper, zinc, lithium, sodium, potassium and phosphorus was analysed by the standard procedures [19]. Bioavailable calcium, zinc [20] and iron [21] content was analysed.

2.3.4 Antioxidant properties

Antioxidant screening [22], flavonoid content [23], total phenols [24], antioxidant activity by DPPH [25, 26], tannins [27], oxalate content [28].

3. RESULTS AND DISCUSSION

3.1 Sensory Evaluation

Even though sensory characteristics are subjective, the colour and flavour of food play an important role not only in the selection, but also in the determination of consumption, satiation, and ingestion [29].

Based on the sensory evaluation scores, JMP2 (10% leaf powder incorporated jowar murukku) was found best in all attributes like colour, appearance, flavour, taste, texture, overall acceptability than control and other samples. The study selected 10% *Aerva lanata* leaves incorporated jowar murukku for the further analysis.

3.2 Physical Properties

Both titratable acidity and pH are two interrelated concepts that deal with acidity in food analysis. These two parameters are analysed in separate ways and each provides its own particular insights on food quality. The analysis of pH value determines the ability of a microorganism to grow in a specific food whereas titratable acidity is a better predictor than pH of how organic acids in the food impact flavour. Titratable acidity is the measure of total acid concentration in a food [30]. The titratable acidity and PH of JMP2 was increased by 0.004% and 6.11% respectively due to addition

Colour lab scale values were determined by using hunter colorimeter. L* indicates lightness and extends from 0.0 (black) to 100.0 (white). The other two coordinates a* and b* represent redness (+a*value) to greenness (-a*value) and yellowness (+b*value) to blueness (-b*value) respectively (Hunter Lab, 2013). Colour values of jowar murukku were analysed and presented in Table-2. It was found that the L*, a*, E* of JMP was increased by 36.2, 44.09 and 2.53% respectively. Whereas b*, C* and h* of JMP was decreased by 37.67, 38.77 and 1.09% when compared to the control sample. colour is an important quality parameter of food and influences preference and choice of the consumers.

3.3 Nutritional Composition of *Aerva lanata* Incorporated Jowar Murukku

The proximate and vitamin composition of the products was analysed and present in Table-3. The percentage change in nutritional composition of value added murukku when compared to its control was presented in Fig. 3. The addition leaf powder increased the moisture content of the product (3.13%). The ash (4.27g), fat (25.96g), crude fiber (4.42g), protein (13.75g) of the product than the control sample. As leaves have less amount of carbohydrates, energy, starch and so, addition of greens decreased its content by 11.99, 1.73 and 30.14% respectively in the jowar murukku.

Vitamin composition of developed products per 100gm were: vitamin C (JMC-0.23mg; JMP-2.86mg), total carotenoids (JMC-10.55µg; JMP-233.21µg) and beta carotenoids (JMC-5.02µg; JMP-34.14µg). Value addition of *Aerva lanata* improved the vitamin content by 1143.47 (vitamin C), 580.07 (total carotenoid) and 211.46% (Beta carotenoid) above the control sample.

3.4 Mineral Content of *Aerva lanata* Incorporated Jowar Murukku

Minerals are micronutrients which are required in small quantities in for normal physiological functions. The mineral content of developed products per 100gm were: calcium (JMC-200.6mg; JMP-520.5mg), iron (JMC-6.67mg; JMP-14.79mg), zinc (JMC-2.84mg; JMP-20.12mg), copper (JMC-0.48mg; JMP-0.60mg), phosphorus (JMC-168.1mg; JMP-2.55mg), sodium (JMC-1113mg; JMP-940mg), potassium (JMC-405.5mg; JMP-432.2mg) and lithium (JMC-0.01mg; JMP-0.17mg).

The calcium, iron, zinc, copper, manganese, phosphorus, potassium 159.47, 121.73, 20.12, 25.0, 42.7, 2.55, 6.58% was increased whereas sodium content was decreased by 15.54% respectively when compared to the control sample.

The amount of minerals available to the body after digestion and absorption is known as mineral bioavailability. The bioavailable calcium content of chutney powders increased to 105.56 (JMP) when compared to control sample because of incorporation of leafy vegetables. It was found that high bioavailable percentage of iron was seen in JMP (81.33%) than JMC. The bioavailable zinc content of JMP (24.48%) was increased when compared to control sample.

Table 1. Mean sensory scores of *Aerva lanata* kura leaves incorporated jowar murukku

Sample	Colour	Appearance	Flavour	Taste	Texture	Overall acceptability
JMC	8.13^{c}±0.16	8.00^{c}±0.24	7.73^{c}±0.18	7.60^{c}±0.19	7.73^{c}±0.18	7.87^{d}±0.16
JMP1	8.67^{d}±0.13	8.67^{d}±0.13	8.40^{d}±0.19	8.40^{d}±0.21	8.53^{d}±0.13	8.53^{c}±0.16
JMP2	7.40^{b}±0.16	7.13^{b}±0.19	7.27^{b}±0.21	7.07^{b}±0.25	7.27^{b}±0.21	7.20^{b}±0.22
JMP3	6.73^{a}±0.15	6.87^{a}±0.24	6.20^{a}±0.20	6.20^{a}±0.20	6.80^{a}±0.26	6.40^{a}±0.21

***Note**: Values are expressed as mean ± standard deviation of fifteen determinations; Means within the same column followed by a common letter do not differ significantly at (p≤0.05). **JMC**: Control murukku; **JMP_1**: 5% Aerva lanata leaves incorporated jowar murukku; **JMP_2**: 10% Aerva lanata leaves incorporated jowar murukku; **JMP_3**: 15% Aerva lanata leaves incorporated jowar murukku*

Table 2. Physicochemical properties of *Aerva lanata* incorporated jowar murukku

Sample	L*	a*	b*	E*	C*	h*
JMC	-46.65^{a}±0.26	20.48^{b}±0.33	44.06^{b}±1.07	67.17^{a}±0.58	48.59^{b}±0.90	57.77^{b}±2.54
JMP	-63.54^{b}±0.57	11.45^{a}±0.11	27.46^{a}±0.66	68.87^{b}±0.45	29.75^{a}±0.62	57.14^{a}±0.32

(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 ≤ 0.05); JMC: Jowar murukku control; JMP: Jowar murukku with 10% incorporation of Aerva lanata*

Table 3. Nutritional composition of *Aerva lanata* incorporated jowar murukku per 100g

Sample	JMC	JMP	Sample	JMC	JMP
Moisture (%)	3.86b±0.03	3.13a±0.04	Energy (Kcal)	483.6^{b}±0.10	475.2^{a}±0.00
Ash (g)	3.34^{a}±0.03	4.27^{b}±0.02	CHO (g)	51.77^{b}±0.01	43.99^{a}±0.01
Fat (mg)	24.65^{a}±0.32	25.96^{b}±0.00	Starch (g)	36.22^{b}±0.16	25.30^{a}±0.13
Free fatty acids (g)	0.34^{b}±0.00	0.15^{a}±0.00	Vitamin C (mg)	0.23^{a}±0.00	2.86^{b}±0.00
Crude fiber (g)	2.65^{a}±0.00	4.42^{b}±0.00	Total carotenoids(µg)	10.55^{a}±0.06	233.21^{b}±0.72
Protein (g)	13.75^{a}±0.00	18.24^{b}±0.00	Beta carotenoids(µg)	5.02^{a}±0.00	34.14^{b}±0.01

***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 ≤ 0.05); JMC: Jowar murukku control; JMP: Jowar murukku with 10% incorporation of Aerva lanata leaves*

Table 4. Mineral and bioavailable mineral content of *Aerva lanata* incorporated jowar murukku (mg/100g)

Sample	JMC	JMP	Sample	JMC	JMP
Calcium	200.6[a]±0.30	520.5b±0.20	Potassium	405.5[a]±0.30	432.2b±0.00
Iron	6.67[a]±0.12	14.79b±0.12	Lithium	0.01a±0.00	0.17b±0.00
Zinc	1.54[a]±0.00	1.85[b]±0.00	Sodium	1113b±0.00	940[a]±0.00
Copper	0.48[a]±0.00	0.60b±0.00	Phosphorus	168.1[a]±0.00	172.4b±0.10
Manganese	2.43b±0.00	1.39[a]±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 ($p \leq 0.05$); JMC: Jowar murukku control; JMP: Jowar murukku with 10% incorporation of Aerva lanata leaves*

Table 5. Bioavailable mineral content of *Aerva lanata* incorporated jowar murukku

Sample	Bioavailable calcium		Bioavailable iron		Bioavailable zinc	
	mg/100g	%	mg/100g	%	mg/100g	%
JMC	156.4[a]±0.20	77.96	4.57[a]±0.01	68.51	0.49a±0.00	31.81
JMP	321.5b±0.10	61.76	12.03b±0.03	81.33	0.61b±0.00	32.97

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 ($p \leq 0.05$); JMC: Jowar murukku control; JMP: Jowar murukku with 10% incorporation of Aerva lanata leaves*

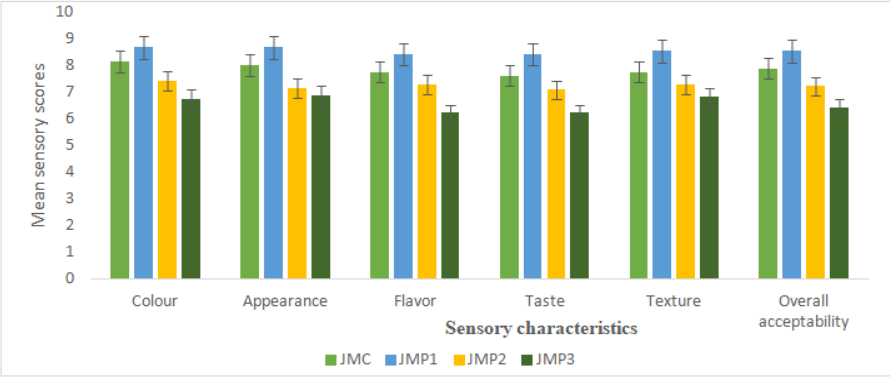

Fig. 1. Mean sensory scores of *Aerva lanata* incorporated jowar murukku

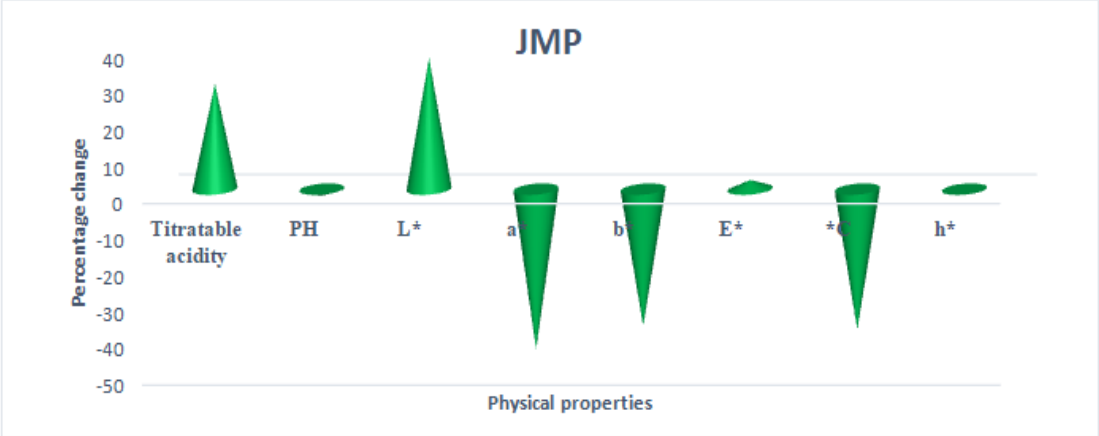

Fig. 2. Percentage change in physical properties of *Aerva lanata* incorporated jowar murukku

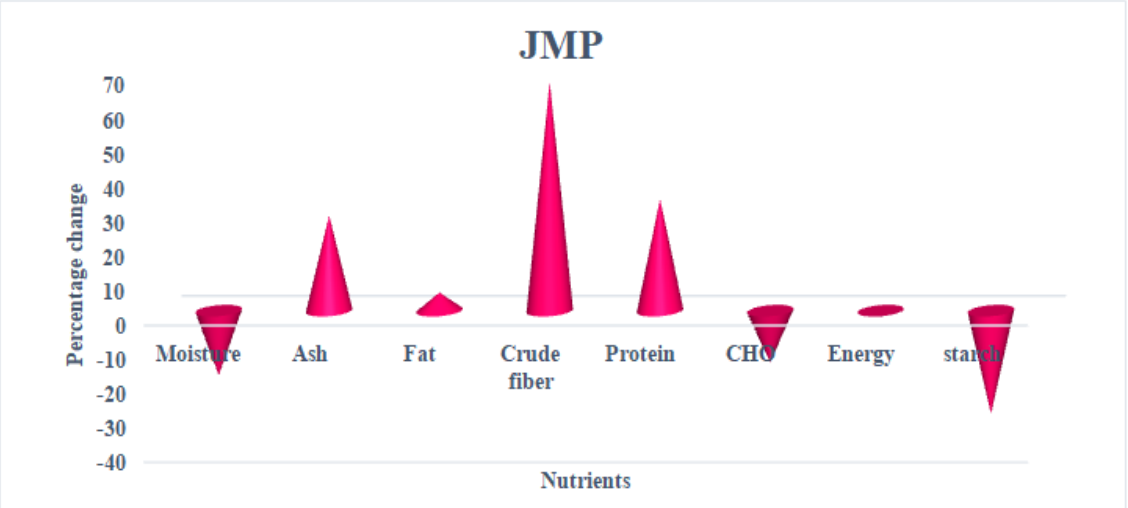

Fig. 3. Percentage change in nutrient composition of *Aerva lanata* incorporated jowar murukku

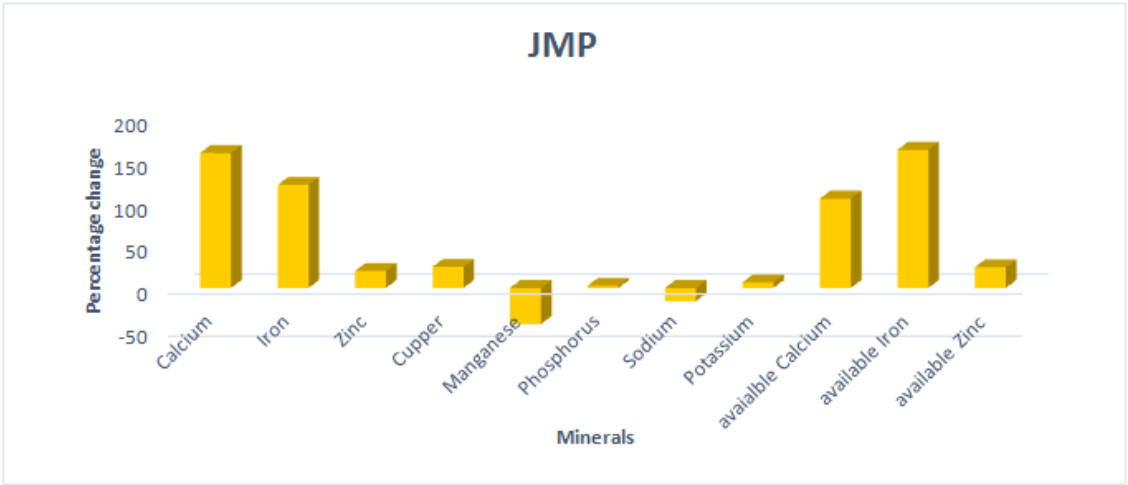

Fig. 4. Percentage change in mineral composition of *Aerva lanata* incorporated jowar murukku

Table 6. Phytonutrient composition of *Aerva lanata* incorporated jowar murukku

Sample	Phenols (mg GAE/100g)	Flavonoids (mg RE/g)	Tannins (mg TAE/100g)	Oxalates (mg/100g)	Antioxidant activity (%) per 0.5ml of extract (mg/l)	IC_{50}
JMC	78.04a±0.03	5.35[a]±0.06	11.09[a]±0.00	1866[a]±0.00	1.86[a]±0.00	13.51mg/l
JMP	153.37b±0.00	50.45[b]±0.01	18.19b±0.00	2884b±0.00	2.55b±0.00	09.8mg/l

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 ($p \leq 0.05$). JMC: Jowar murukku control; JMP: Jowar murukku with 10% incorporation of Aerva lanata leaves*

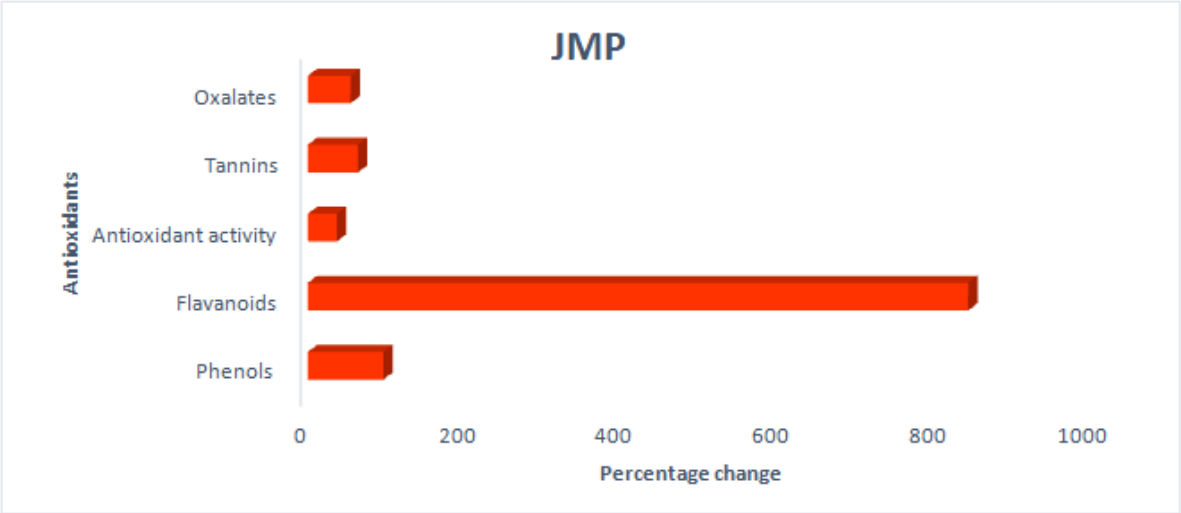

Fig. 5. Percentage change in phytonutrient of *Aerva lanata* incorporated jowar murukku

3.5 Antioxidant Screening of Developed Products

Green leafy vegetables are rich sources of antioxidant vitamins. The ascorbic acid, total carotene, β-carotene, total flavonoid and total phenolic compounds are found high in green leafy vegetables [31]. Phytochemical screening of *Aerva lanata* incorporated chutney powders and murukku was carried out by standard methods. The methanolic extracts of murukku were identified the presence of proteins, amino acids, carbohydrates, phenols, flavonoids, tannins, alkaloids, glycosides, phlobatinins and steroids.

The quantitative analysis of methanolic extract of the developed products improved the total phenolic, total flavonoid and tannic acid content by 96.52, 842.99 and 64.02% respectively due to incorporation of green leafy vegetable powder.

Antioxidant activity and IC_{50} values of murukku were determined with DPPH by spectrophotometric method. The antioxidant activity was found high for JMP (2.55) than JMC (1.86). The IC_{50} values calculated and 50% inhibition was seen at 13.51mg/l (JMC), 9.8mg/l (JMP) concentration of the samples.

4. CONCLUSION

The study developed traditional green leaf vegetable leaf powder incorporated jowar based murukku and analysed for its chemical composition. The study conclude that the developed products have good sensory, nutritional and antioxidant properties.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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