STANDARSIDATION, NUTRITIONAL AND PHYTONUTRIENT COMPOSITION OF AERVA LANATA INCORPORATED PRODUCT

ABSTRACT

Nutritionally rich snack item was developed by the incorporation of leaf powder of a wild green leafy vegetable-*Aerva lanata*. The physical, functional, nutritional, antinutritional properties of snack was evaluated and compared between the test and the control sample. The test sample reported high protein (18.24g/100g), ash (3.34g/100g), crude fiber (2.65g/100g), vitamin C (2.86mg/100gm), total carotenoid (233.21 µg/100g) and beta carotenoid content (34.14 µg/100g). The mineral composition of the developed product like 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%. The methanolic extracts of murukku were identified the presence of proteins, amino acids, carbohydrates, phenols, flavonoids, tannins, alkaloids, glycosides, phlobatinins and steroids. the phenolic, flavonoid and tannic acid content by 96.52, 842.99 and 64.02% respectively. The study concluded the product was best accepted than the control sample. Also, the product has reported good nutritional, mineral and antioxidant activity. Value addition of the traditional leaf powder improved the palatability, diversity and improves the nutritional status.

Key words: *Aerva lanata*, jowar murukku, antioxidant activity, value addition

INTRODUCTION

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 (Reddy *et al*., 2007). 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 (Ndlovu and Afolayan, 2008). *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 (Omotoso *et al*., 2017). 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.

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.

Sensory evaluation

A semi-trained panel of 15 members from PGRC, PJTSAU using 9-point hedonic scale evaluated the developed instant chutney powder 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.

Physical-functional properties

Rehydration capacity (Quintero-Ramos et al. 1992), rehydration ratio (Sheshma and Raj 2014), bulk density (Stojceska et al. 2008), tapped density (Narayana and Narasinga Rao 1984), flowability and cohesiveness (Jinapong et al. 2008), titratable acidity (Ranganna 2017), total soluble solids (Kathiravan et al. 2014), color (Hunter Lab 2013), chroma and hue (Pathare et al. 2012), total color difference (Martins and Silva 2002),

Functional properties

water solubility and water absorption index (WAI; Anderson et al. 1969), water retention and oil-retention capacities (Beugre et al. 2014), hydrophilic lipophilic index (Njintang et al. 2001), and water activity (Abramovie et al. 2008).

Nutritional profiling:

Proximate analysis

Moisture, ash, protein (AOAC, 2005), fat (AOAC, 1997), crude fiber (AOAC, 1995), carbohydrate and energy (AOAC, 1980), free fatty acids (Sadasivam and Manickam, 2018) and starch (Southgate, 1976).

Vitamin analysis:

Total carotenoids (Zakaria *et al*., 1979), β- carotene (Srivastava and Kumar, 1993) and ascorbic acid (Ranganna, 2017).

Mineral analysis

Calcium, iron, magnesium, manganese, copper, zinc, lithium, sodium, potassium and phosphorus was analysed by the standard procedures (AOAC, 2012). Bioavailable calcium, zinc (Kim and Zemel, 1986) and iron (Narasinga and Prabhavathi, 1978) content was analysed.

Antioxidant properties:

Antioxidant screening (Harbourne, 1993), flavonoid content (Zhishen *et al*., 1999), total phenols (Slinkard and Slingleton, 1997), antioxidant activity by DPPH (Dorman *et al*., 2004; Tadhani *et al*., 2007), tannins (AOAC, 2005), oxalate content (Mishra *et al*., 2017).

RESULTS AND DISCUSSION

Sensory evaluation

Based on the sensory evaluation, it was observed that JMP_1 was found best in all attributes like colour, appearance, flavour, taste, texture, overall acceptability than control and other samples. Based on the scores obtained 10% *Aerva lanata* leaves incorporated jowar murukku was selected for the further study.

Chart 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 ($p \leq 0.05$)

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

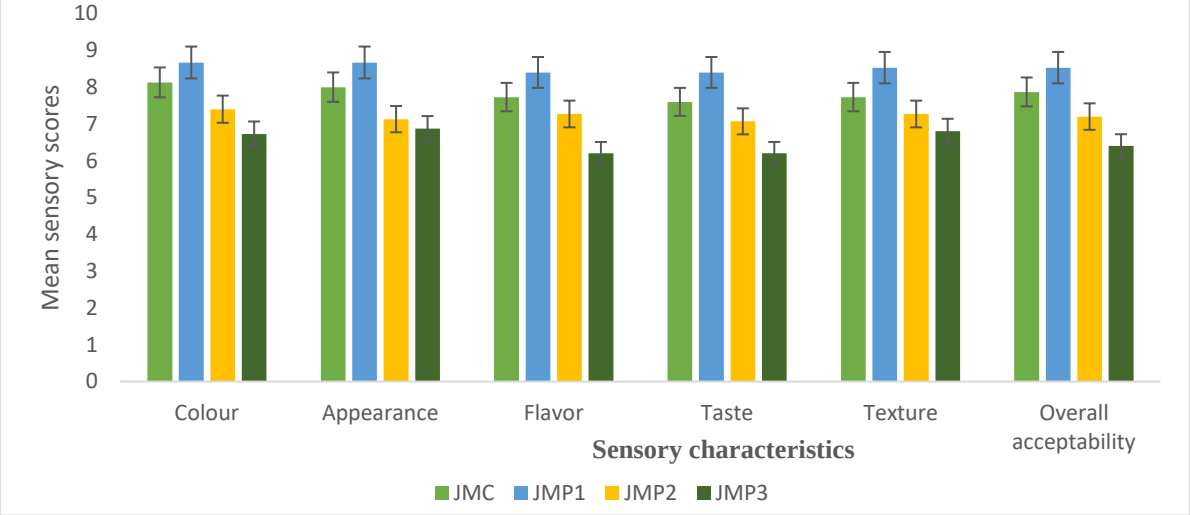

Figure 1: Mean sensory scores of *Aerva lanata* incorporated jowar murukku

Physical properties of *Aerva lanata* incorporated jowar murukku:

The bulk and tapped density of *Aerva lanata* incorporated jowar murukku was decreased in experimental sample when compared to control sample. The cohesiveness of JMP (1.76) was less and according to hunser ratio of cohesiveness, the cohesiveness of JMP has high cohesiveness. Whereas it has very bad flowability. The titratable acidity and PH of JMP was 0.004% and 6.11 respectively.

Colour is an important quality parameter of food and influences preference and choice of the consumers. Colour values of jowar murukku were analysed and presented in Table-1. 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.

Table-1 **Physicochemical properties of *Aerva lanata* incorporated jowar murukku**

Sample	**BD** (g/cm^2)	**TD** (g/cm^2)	**CI**	**HR (%)**	**TA (%)**	**P^H**
JMC	$0.69^{b}\pm0.00$	$1.26^{b}\pm0.00$	$1.83^{b}\pm0.01$	$45.52^{b}\pm0.01$	$0.0031^{a}\pm0.00$	$6.22^{b}\pm0.01$
JMP	$0.59^{a}\pm0.00$	$1.04^{a}\pm0.00$	$1.76^{a}\pm0.00$	$43.45^{a}\pm0.03$	$0.0040^{b}\pm0.00$	$6.11^{a}\pm0.00$
Sample	**L***	**a***	**b***	**E***	**C***	**h***
JMC	$-46.65^{a}\pm0.26$	$20.48^{b}\pm0.33$	$44.06^{b}\pm1.07$	$67.17^{a}\pm0.58$	$48.59^{b}\pm0.90$	$57.77^{b}\pm2.54$
JMP	$-63.54^{b}\pm0.57$	$11.45^{a}\pm0.11$	$27.46^{a}\pm0.66$	$68.87^{b}\pm0.45$	$29.75^{a}\pm0.62$	$57.14^{a}\pm0.32$

(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 ($p \leq 0.05$)

JMC: Jowar murukku control

JMP: Jowar murukku with 10% incorporation of *Aerva lanata*

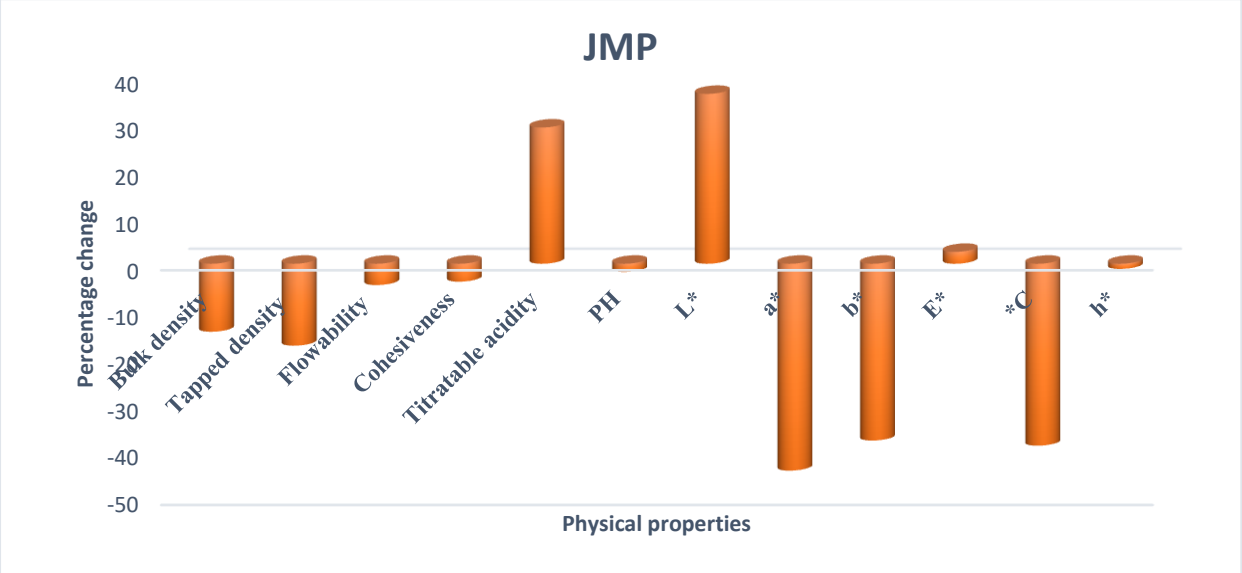

Figure 2: Percentage change in physical properties of *Aerva lanata* incorporated jowar murukku

Functional properties of *Aerva lanata* incorporated jowar murukku

The water absorption index (1.38) of of *Aerva lanata* incorporated murukku was decreased whereas water solubility index (1.23), oil retention capacity (1.93), rehydration capacity (6.18) and water retention capacity (2.31) were increased than the control sample. However, no significant difference was found in the hydrophilic-lipophilic index of control and test sample. The water activity of experimental and control was less than 0.5 which indicates good storage stability of the products.

Table-2 **Functional properties of *Aerva lanata* incorporated jowar murukku**

Sample	**WAI**	**WSI**	**HLI**	**WRC**	**ORC**	**RC**	**a_w**
JMC	1.32^{a}±0.00	1.21^{a}±0.00	0.73^{a}±0.00	2.23^{a}±0.00	1.81^{a}±0.00	5.08^{a}±0.00	0.26^{a}±0.00
JMP	1.38b±0.01	1.23^{a}±0.00	0.71^{a}±0.00	2.31^{b}±0.00	1.93^{b}±0.00	6.18^{b}±0.00	0.29^{a}±0.00

(WAI- water absorption index, WSI- water solubility index, HLI- hydrophilic lipophilic index, ORC-oil retention capacity, WRC- water retention capacity, RC-rehydration capacity, AW- water activity)

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

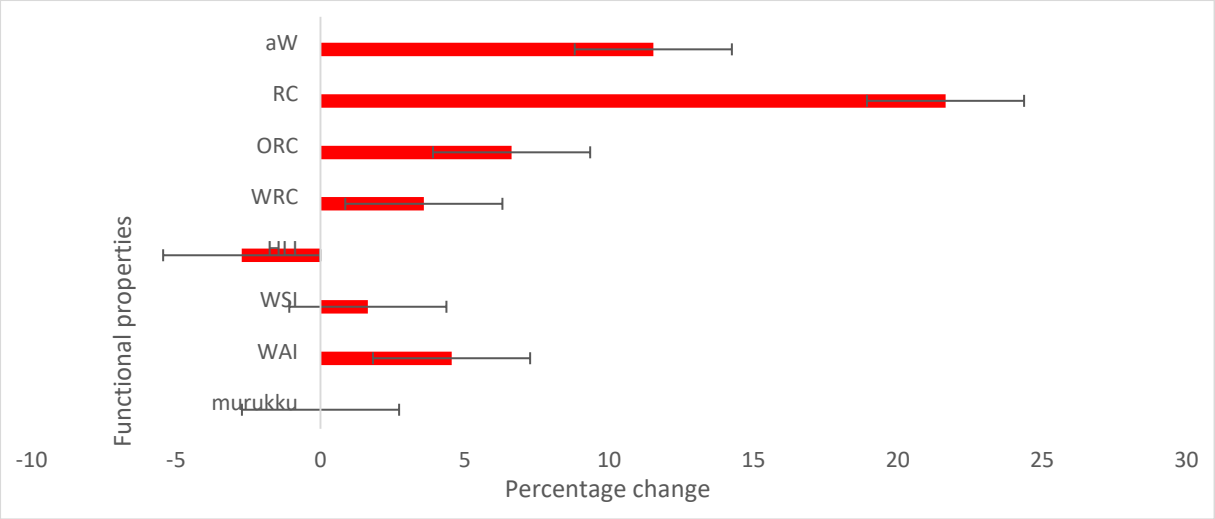

Figure 3: Percentage change in functional properties of *Aerva lanata* incorporated jowar murukku

Proximate composition of *Aerva lanata* incorporated jowar murukku

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) was found high in test sample 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.

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, 580.07 and 211.46% respectively.

Table-3 Proximate 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 ($p \leq 0.05$)

JMC: Jowar murukku control

JMP: Jowar murukku with 10% incorporation of *Aerva lanata* leaves

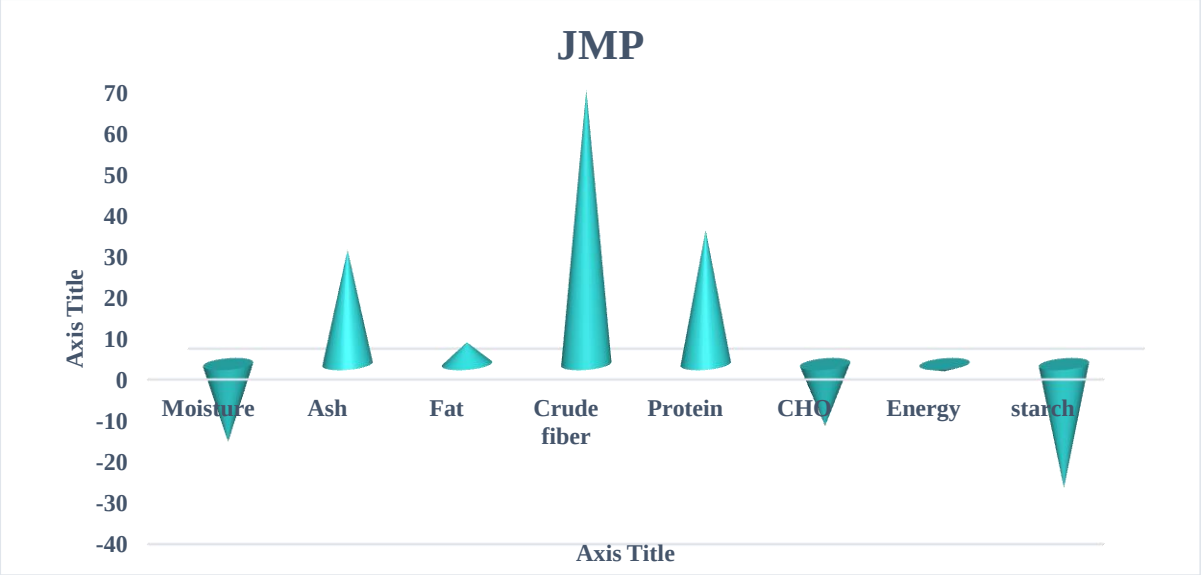

Figure 4: Percentage change in nutrient composition of *Aerva lanata* incorporated jowar murukku

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%.

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

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 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

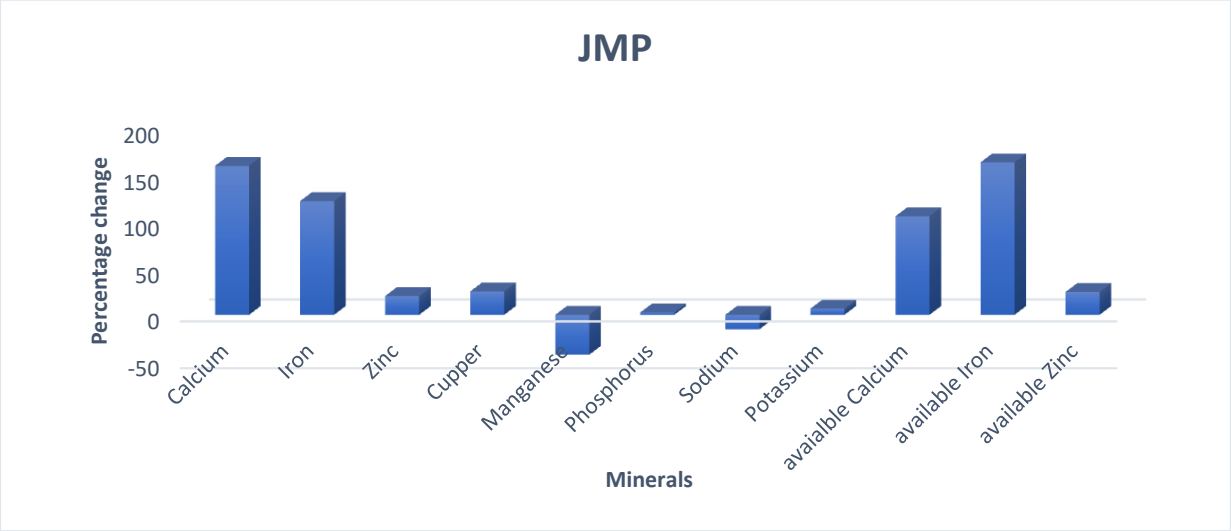

Figure 5: Percentage change in mineral composition of *Aerva lanata* incorporated jowar murukku

Antioxidant screening of developed products

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.

As leaves are the important sources of antioxidants and helps to prevent oxidative stress and many degenerative diseases. The methanolic extract of the developed products improve the phenolic, flavonoid and tannic acid content by 96.52, 842.99 and 64.02% respectively.

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 13.51 (JMC), 9.8ml (JMP) concentration of the samples.

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**	**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	13.51ml
JMP	153.37b±0.00	50.45^{b}±0.01	18.19b±0.00	2884b±0.00	2.55b±0.00	09.8ml

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

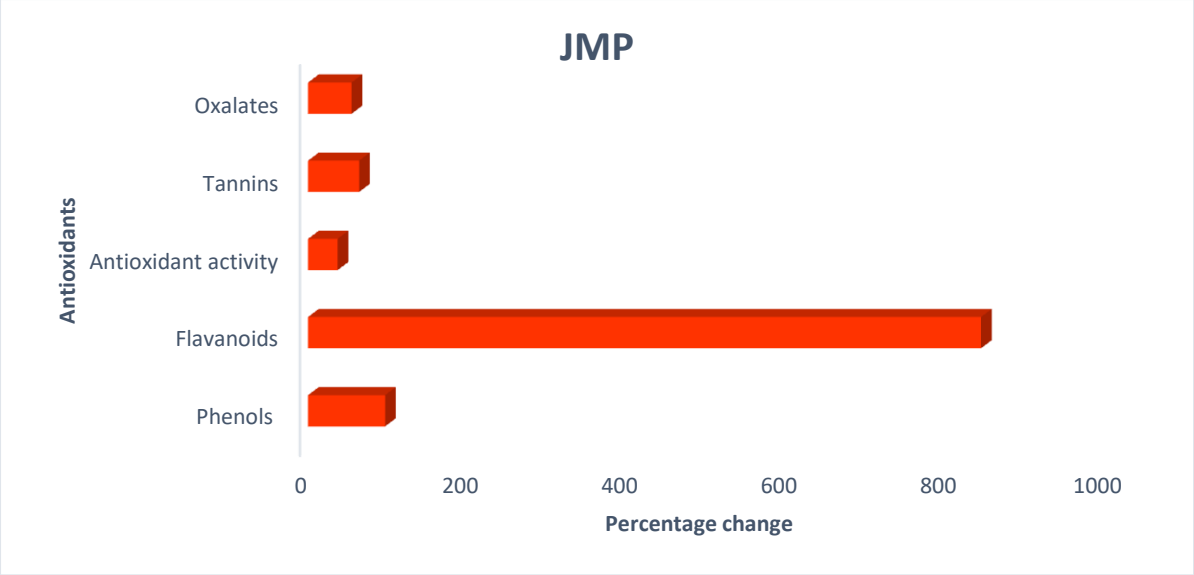

Figure 6: Percentage change in phytonutrient of *Aerva lanata* incorporated jowar murukku

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 has good sensory, nutritional and antioxidant properties.

References

1. Abramovie, H.; Jamnik, M.; Burkan, L and Kac, M. (2008). Water activity and water content in Slovenian honeys. *Food control*, 19(11): 1086-1090.
2. Achikanu, C.E., Eze-Steven, P.E., Ude, C.M and Ugwuokolie, O.C. 2013. Determination of the vitamin and mineral composition of common leafy vegetables in south eastern Nigeria. *International Journal of Current Microbiology and Applied Sciences*. 2(11): 347-353.
3. Anderson, R.A.; Conway, H.F.; Pfeifer, V.F and Griffin, E.L. (1969). Gelatinization of corn grits by roll and extrusion cooking. *Cereal Science Today*, 14: 4-12.
4. AOAC, Official method of analysis for fiber, *Association of Official Analysis Chemist.* (1995). 14th Edition. Washington DC. USA.
5. AOAC, Official Methods of Analysis for ash in flour. *Association of Official Analytical chemists.* (2005).

6. AOAC, Official Methods of Analysis for fat (crude) or ether extract in flour, *Association of Official Analytical Chemists.* (1997). 16th Ed. 3rd Revision. Gaithersburg, Maryland, 20877-2417. AOAC 920.85, chap 32-05.

7. AOAC, Official Methods of Analysis for moisture in flour, *Association of Official Analytical Chemists.* (2005). 18th Ed, Arlington VA 2209, USA. AOAC 929.03, 32-02.

8. AOAC, Official Methods of Analysis for PH in fruits leather rolls. AOAC international 19th Edition. Volume II. *Association of Official Analytical Chemists*. Gaithersburg (2012).

9. AOAC, Official Methods of Analysis for protein. *Association of Official Analytical Chemists. (2005).* 18th Ed, Arlington VA 2209, USA. AOAC 984.13, chap 04, pp 31.

10. AOAC, Official methods of analysis, Association of Official Analytical Chemists. (1980). Washington, D.C. USA.

11. Beugre, G.A.M.; Yepo, B.M.; Ble, S.H and Gnakri, D. (2014). Effect of fermentation time on the physico-chemical properties of maize flour. *International Journal of Research Studies in Biosciences.* 2(8): 30-38.

12. Chew, A.L,; Jessica, J.J.A and Sasidharan, S. (2016). Antioxidant and antibacterial activity of different parts of *Leucas aspera, Asian Pacific Journal of Tropical Biomedicine,* 2(3):176-180.

13. David, O,; Arthur, E,; Kwadwo, S.O,; Badu, E and Sakyi, P. (2015). Proximate Composition and Some Functional Properties of Soft Wheat Flour, International *Journal of Innovative Research in Science, Engineering and Technology*, 4(2): 753-758.

14. 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.

15. Godswill, A.C., Somtochukwu, I.V and Kate, E.C. 2019. The functional properties of foods and flours. International *Journal of Advanced Academic Research Sciences, Technology and Engineering*. 5(11): 139-160

16. Harbourne, J.B. (1993). Phytochemistry, Academic press, London, 89-131.

17. Hunter lab. (2013). Hunter Assosiate Labaratory. Manual version-2.1. 60: 1014-323.

18. Jayakumar, K,; Kannan, T. M .S and Vijayarengan, P. (2015). *Leucas aspera L*. – Medicinal Herb, *International Journal of Traditional and Natural Medicines,* 5(1): 1-5.

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. Kakade, S.B and Neva, V.S. 2014. Dehydration of Green Leafy Vegetable: Review. International journal of innovative research in technology. 1(8): 58-64.

21. Kathiravan, T.; Nadanasabapathi, S and Kumar, R. (2014). Standardization of process condition in batch thermal pasteurization and its effects on antioxidant, pigment and microbial inactivation of ready to drink (RTD) beetroot (*Beta vulgaris L*.) juice. *International Food Research Journal*, 21(4): 1305-1312.

22. Kim, H and Zemel, M.B. (1986). *In vitro* estimation of potential bioavailability of calcium for sea mustard, milk and spinach under stimulate normal and reduce gastric condition, *Journal of Food Science,* 51: 957-963.

23. 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.

24. Mishra, D.P,; Mishra, N,; Musale, H.B,; Samal, P,; Mishra, S.P and Swain, D.P. (2017). Determination of seasonal and developmental variation in oxalate content of *Anagallis arvensis* plant by titration and spectrophotometric method, *The Pharma Innovation,* 6(6):105-111.

25. 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.

26. Narayana, K and Narasinga Rao, M.S. (1984). Effect of partial hydrolysis on winged Bern (*Psophocarpus tetragonolobus*) flour. *Journal of food science*, 49: 944 -947.

27. Njintang, N.Y.; Mbofung, C.M.F and Waldron, K.W. (2001). *In vitro* protein digestibility and physicochemical properties of dry red bean (*Psophocarpus tetragonolobus*) flour. *Journal of Food Science*, 47(5): 1534-11538.

28. 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.

29. Prajapati, M.S.; Patel, J.B,; Modi, K and Shah, M.B. (2010). *Leucas aspera*: A review, *Pharmacognosy Reviews*, 4(7): 85-87.

30. Quintero-Ramos, A.; Bourne, M.C and Anzaldfia-Morales, A. (1992). Texture and rehydration of dehydrated carrots as affected by low temperature blanching. *Journal of Food Science*, 57: 1127- 1128.

31. 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.

32. 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.

33. Sadasivam, S and Manickam, A. (2018). Biochemical methods. Third edition. New Age International Pvt Ltd Publishers, 21-22.

34. Salvi J & Katewa S S, A review: Underutilized wild edible plants as a potential source of alternative nutrition, *International Journal of Botany Studies*, 1(4):32-36.

35. Sheshma, J and Raj, J.D. (2014). Effect of pre drying treatments on quality characteristics of dehydrated tomato powder. *International Journal of Research on Engineering and Advanced Technology*, 2(3): 1-7.

36. Slinkard, K and Slingleton. (2004). Total phenolic analyses: Automation and comparison with manual method, *American Journal Enology and Viticulture*, 28: 49-55.

37. Southgate D A T, Determination of food carbohydrates. (1976). 108, 109, Appiled Science Publishers Ltd. London.

38. 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.

39. 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.

40. 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.

41. 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.

42. 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.