



DEVELOPMENT OF VALUE-ADDED FOOD PRODUCTS INCORPORATING DEHYDRATED CURRY LEAVES (*Murraya koenigii*)

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ABSTRACT

Curry Leaf (*Murraya koenigii*) is an important leafy vegetable, that belongs to the family Rutaceae consisting 150 genera and 1600 species. Curry leaves is the best complete nutritional source of Calcium, Iron, Fibre, Vitamins and Antioxidant as well as supplies many bioactive components which have several health benefits. The purpose of the study was development of value-added food products incorporating dehydrated curry leaves such as Cookies, Nachos and Noodles and to assess the sensory properties and nutritional composition of prepared products. Along with control (T₀), three variations (treatment) T₁, T₂ and T₃ were prepared which contains 2%, 3% and 5% of Curry leaves flakes respectively. The sensory attributes of products were analysed organoleptically by the panel of judges using 9-point hedonic scale score card. The nutritional composition of value-added food products was calculated using the food composition table given by C. Gopalan et al., 2010. Appropriate statistical methods were used to analyse the data. Among all the treatments, average sensory and nutrient score was significantly high in various treatments as compared to control products. Hence it can be concluded that Curry leaves flakes contains good amount of macro and micro nutrients which can be utilized as functional ingredients to develop different products.

Keywords- Curry Leaf, *Murraya koenigii*, value-added products, Curry-leaf flakes, organoleptic analysis, antioxidants, bio-active compounds, Statistical Analysis, Nutritive value

1. INTRODUCTION

Curry Leaf (*Murraya koenigii*) is an important leafy vegetable, that belongs to the family Rutaceae consisting 150 genera and 1600 species (Sangam et al., 2015). Curry leaf tree, is a native to India, Sri Lanka and Southeast Asian region (Kumar and Reddy 2013). Curry leaves are also known as Mithi neem in India. Curry leaves are very popular as a spice which used in small quantities for aroma and flavouring of food products due to presence of volatile oil.

The curry leaves contain several medicinal properties such as anti-diabetic, antioxidant, antimicrobial, anti-fungal, anti-inflammatory, anticarcinogenic and hepato-protective properties. The various notable pharmacological activities of the plant include activity on heart, anti-diabetic and cholesterol reducing property, antimicrobial activity, antiulcer activity, antioxidative property, cytotoxic activity, antidiarrheal activity, phagocytic activity. The chemical composition of the fresh leaves of *Murraya koenigii* consists of volatile oil. (Bhandari, 2012 and Disegha, et al.,)

In curry leaves found the carbozole alkaloids that are recently isolated are of mahanimbine and koenigine, which showed higher antioxidant activities. The curry leaves are rich in fibres, minerals and vitamins such as calcium, carotene, nicotinic acid and vitamin A and phosphorous, calcium, iron, vitamin B₂, niacin and vitamin C. There are three antimicrobial alkaloids isolated from the curry leaves which are mahanine, mahanimbicine and mahanimbine, showed potent antimicrobial effect on the growth of antibiotic resistant bacteria. In the curry leaves are of Mahanimbine which involves either increasing the secretion of insulin or by increasing the utilization of the glucose. Hypercholesterolemia is the major factor to many serious illnesses includes, hypertension, heart attack and cancer. Preventive measures depend on the dose level; the dose of 500 mg/kg was found to be highly efficient in reducing the blood cholesterol level in aged mice.

The curry leaves are showed potential anticancer effect on the human cell lines like human breast, human cervical HeLa and murine leukaemia cell lines. Girinimbine, an active compound isolated from the curry plant was shown to have in vitro antitumor activity of the Raji cells.

Curry leaves may offer antibacterial, antidiabetic, pain-relieving, and anti-inflammatory effects. The abundance of health benefits is due to the presence of antioxidants in plant compounds.

Antioxidants play an essential role in keeping your body healthy and free from disease.

2. REVIEW OF LITERATURE

Pagthinathan et al., (2020) conducted a study to assess the different concentrations of curry leaf extract on the shelf life of paneer for a storage period of 28 days at refrigeration temperature ($7\pm 1^\circ\text{C}$). In this study, paneer was developed with five different concentration of curry leaves extract viz. 0.0% (control), 0.2%, 0.4%, 0.6% and 0.8%. The prepared samples of paneer were analysed for chemical, physical and sensory evaluation at day 1, day 7, day 14, day 21 and day 28 storage at $7^\circ\pm 1^\circ\text{C}$. At the day one, the chemical attributes, such as ash (1.66 ± 0.02), dry matter (49.60 ± 1.85), acidity (0.20 ± 0.02) and antioxidant activity at 593 absorbance (0.292) showed higher value in paneer treated with 0.8% curry leaves extract added paneer. On the other hand, pH (5.88 ± 0.01) and free fatty acid (0.21 ± 0.02) were higher in paneer made without curry leaves extract. At the day 7 of storage period, paneer treated with 0.8% curry leaves extract showed higher mean value for dry matter (51.28 ± 1.52), ash (1.73 ± 0.01), pH (5.85 ± 0.01) and antioxidant activity at 593nm (0.295). While paneer treated without curry leaves extract showed higher mean value for titratable acidity (0.27 ± 0.01) and free fatty acid (0.23 ± 0.00). At the day 28 of storage period, paneer treated with 0.8% curry leaves extract received higher mean value for ash (1.96 ± 0.01), dry matter (54.69 ± 0.30), pH (6.10 ± 0.02).

Similarly, paneer made without curry leaves extract received higher mean value for titratable acidity (0.44 ± 0.00) and free fatty acid (0.45 ± 0.21). Both mineral content and antioxidant activity were increasing during storage period and increased with increasing of concentration of curry leaves. Sensory attributes were changed among the all types of paneers and paneer made from 0.6% curry leaves extract showed the highest preference of sensory attributes at day 14 and day 21 of storage.

Sharma et al., (2021) stated that curry leaves are a miracle plant that had been used in Indian kitchens from ancient times to enhance flavour and aroma of the food. But apart from their appetite tickling flavour, these leaves are known to have essential nutrients like copper, calcium, phosphorus, fibre, carbohydrates, energy, magnesium and iron. However, the crop is highly perishable and susceptible to microbial contamination. The shelf life of the leaves can be increased by using different drying techniques. In this study, control and pre-treated curry leaves were dried under various drying techniques i.e., open sun drying, solar drying, solar tunnel drying and mechanical drying at 50°C , 55°C and 60°C . The quality was determined on the basis of moisture content, time of drying, colour, chlorophyll content, rehydration ratio and sensory attributes. Among all the drying techniques, solar tunnel drying and mechanical drying at 55°C gave best results for pre-treated curry leaves witnessing total drying time of 3.5 hours and 4.5 hours, respectively. The green colour of the leaves was retained better in mechanical drying system.

Gahtori et al., (2022) demonstrated that *Murraya koenigii* (Curry tree) is a common culinary plant, its leaves are used from ancient times as a spice or merely as garnishing or seasoning and they not only enhance the flavour but also increase the nutritional value of food. Besides being a valuable ingredient curry plant has high medicinal value, it is being used since ancient times to treat various diseases, heal wounds, and also has cosmetic uses. This review highlights the morphological and taxonomical status of the curry plant along with its phytochemicals, pharmacological activity, medical importance, and ethno botanical uses.

3. MATERIAL AND METHODS

The study entitled “Development of value-added products with incorporating dehydrated curry leaves (*Murraya koenigii*)” was conducted in the department of Food and Nutrition, EraUniversity, Lucknow.

The details of methods and materials experiment, techniques followed during the course of study have been discussed in this chapter under the following subheadings:

- Study area
- Procurement of raw material
- Dehydration of curry leaves
- Processing technique of curry leaves
- Development of value -added products
- Organoleptic Analysis
- Determination of nutritive value
- Statistical Analysis

3.1 PROCUREMENT OF RAW MATERIAL

The raw material was collected from local market nearby area of Era university Lucknow. The raw materials, for preparation of curry flakes cookies, curry flakes nachos, curry flakes noodles.i.e., (for curry flakes cookies – refined flour, sugar, butter, baking powder), (for curry flakes nachos- maize, wheat flour, salt and edible oil), (for curry flakes noodles- wheat flour and salt) was purchased from local market of Lucknow for the preparation of curry flakes cookies, curryflakes nachos, and curry flakes noodles.

3.2 DEHYDRATION OF CURRY LEAVES

The curry leaves flakes were prepared in the Lab by dehydration techniques. First of all, curry leaves were procured, washed, and leave for 5 min. for moisture dry, leaves were subjected to dry in the hot air oven dry at 50-60⁰c for 15-30 minutes. After drying, the leaves were subjected for cooling and after that flakes were prepared with handpress and packed in the air tight container for experimental work.

3.3 PROCESSING TECHNIQUE OF CURRY LEAVES



Plate 3.1 Processing steps of *M. Koenigii*

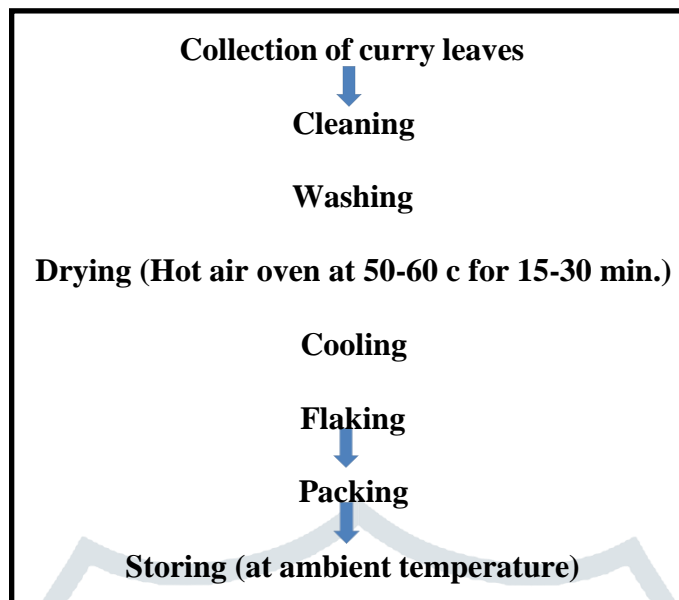


Figure:3.1 Flow diagram of processing of *M. koenigi*.

3.4 Development of value- added product with incorporating dehydrated curry leavesflakes:

The value- added product were developed such as *Curry flakes Cookies*, *Curry flakes Nachos*, *Curry flakes Noodles* with incorporating of curry flakes at different levels as follows

1. *Curry flakes Cookies*: - Dehydrated curry flakes zeera *Cookies*.

The curry flakes zeera cookies were developed with incorporating dehydrated curry leaves at different variations (2%, 3% & 5% respectively). For product formulation following procedure was Followed as:

T0: - Control (No incorporation of curry leaves)

T1: - 2% =dehydrated curry leaves 2 gm. & refined flour 98 gm. T2: - 3% =dehydrated curry leaves 3 gm. & refined flour 97 gm. T3: - 5% =dehydrated curry leaves 5 gm. & refined flour 95 gm.

2. *Curry flakes Nachos*: -The nachos were developed with incorporating dehydrated curry leaves at different variations like (2, 3 & 5%). For product formulation following procedure was followed as-

T0: - Control (no incorporation of curry leaves).

T1: -2% =dehydrated curry leaves 2 gm. & corn flour and wheat flour 98 gm. T2: -3% =dehydrated curry leaves 3 gm. & corn flour and wheat flour 97 gm. T3: -5% =dehydrated curry leaves 5 gm. & corn flour and wheat flour 95 gm.

3. *Curry flakes Noodles*- The noodles were developed with incorporating dehydrated curry leaves at different variations like (2, 3 & 5%). For product formulation following procedure was followed as-

T0: - Control (no incorporation of curry leaves).

T1: -2% =dehydrated curry leaves 2 gm. & wheat flour 98 gm. T2: -3% =dehydrated curry leaves 3 gm. & wheat flour 97 gm. T3: -5% =dehydrated curry leaves 5 gm. & wheat flour 95 gm.



Plate 3.2 *Curry flakes zeera Cookies* with their treatments



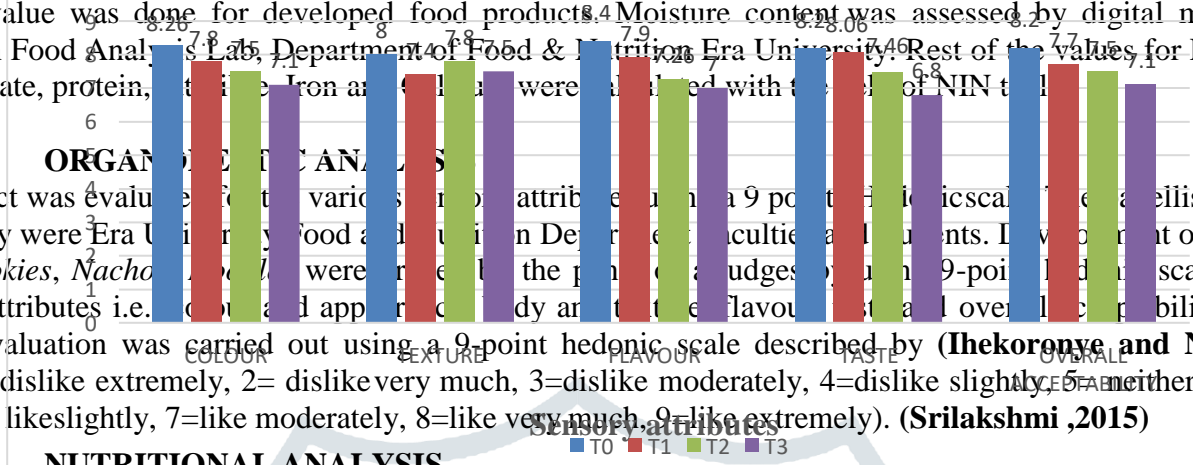
Plate 3.2 *Curry flakes Nachos* with their treatments



Plate 3.2 *Curry flakes Noodles* with their treatments

3.5 NUTRITIVE VALUE ASSESSMENT

For assessing the nutritive value of developed food products like *Curry flakes Zeera Cookies* Calculation method was used. With the help of NIN table, (Nutritive value of Indian foods by C.Gopalan) calculation for nutritive value was done for developed food products. Moisture content was assessed by digital moisture analyser in Food Analysis Lab, Department of Food & Nutrition, Era University. Rest of the values for Energy, Carbohydrate, protein, Fat, Dietary fibre, Iron and Calcium were analysed with the help of NIN table.



3.6 ORGANOLEPTIC ANALYSIS

The product was evaluated for various sensory attributes using a 9-point hedonic scale. The panelists used in the study were Era University students in the Department of Food and Nutrition. Development of *Curry flakes Cookies, Nachos* were made by the panel of judges using a 9-point hedonic scale with different attributes i.e. colour and appearance, texture, flavour, taste and overall acceptability. The sensory evaluation was carried out using a 9-point hedonic scale described by (Ihekoronye and Ngoddy 1985). (1=dislike extremely, 2= dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like or dislike, 6= likeslightly, 7=like moderately, 8=like very much, 9=like extremely). (Srilakshmi ,2015)

3.7 NUTRITIONAL ANALYSIS

The nutritional analysis such as Energy, Carbohydrate, Protein, and Fat, Dietary fibre, Iron and Calcium were determined by NIN table (C. Gopalan). Various value- added food products macronutrient and micronutrient were analysed by Gopalan et al., 2010

3.8 STATISTICAL ANALYSIS

Appropriate statistical techniques were adopted to analyse the data. The data provides the acceptability of products which was analyse by panel member. (Gupta and Kapoor, 2002).

4 RESULT AND DISCUSSION

The value-added food products like *Curry flakes Cookies, Nachos* and *Noodles* were prepared using curry leaves flakes, in different proportions i.e., T₁-2%, T₂-3%, T₃-5% respectively. The value -added food product were subjected for sensory evaluation by expert panel members from the Department of Food and Nutrition with the help of 9-point hedonic scale. The results obtained from the analysis were presented and discussed in the following table:

4.1 SENSORY EVALUATION PARAMETERS OF DEVELOPED CURRY FLAKES COOKIES:

Table 4.1 Average sensory score of value -added curry flakes cookies

TREATMENT	COLOUR	TEXTURE	FLAVOUR	TASTE	OVERALL ACCEPTABILITY
T ₀	8.26±0.24	8±0.23	8.4±0.22	8.2±0.18	8.2±0.20
T ₁	7.8±0.12	7.4±0.22	7.9±0.14	8.06±0.18	7.7±0.15
T ₂	7.5±0.12	7.8±0.13	7.26±0.14	7.46±0.16	7.5±0.10
T ₃	7.1±0.12	7.5±0.21	7±0.18	6.8±0.21	7.1±0.13
S.E.	0.12	0.14	0.12	0.13	0.10

Mean ± Standard Deviation
Figure 4.1

Average sensory score of *Curry flakes Cookies*

4.2 NUTRITIVE VALUE OF *CURRY FLAKES COOKIES* PER 100 gm: -Table 4.2 Nutritive value of *Curry flakes Cookies*.

Treatment	Energy(Kcal)	CHO (gm.)	Protein (gm.)	Fat (gm.)	Ca (mg.)	Fe (mg.)	Fibre(gm.)
T0	458.56±0.20	50.20±0.16	4.8±0.19	26.45±0.14	11.96±0.17	2.4±0.21	0.1±0.29
T1	454.06±0.12	49.35±0.14	4.56±0.17	26.45±0.27	22.38±0.23	3.2±0.23	0.14±0.11
T2	453.5±0.25	49.6±0.12	4.53±0.19	26.47±0.11	34.5±0.15	4.8±0.17	0.32±0.14
T3	450.5±0.28	48.4±0.27	4.47±0.23	26.50±0.13	45.87±0.12	9.23±0.15	0.5±0.19

4.3 SENSORY EVALUATION PARAMETERS OF DEVELOPED *CURRY FLAKES NACHOS*

Table 4.3 Average sensory score of different sensory parameters of control and treatments

TREATMENT	COLOUR	TEXTURE	FLAVOUR	TASTE	OVERALL ACCEPTABILITY
T ₀	7.5±0.20	7.37±0.14	7.25±0.22	7.3±0.20	7.35±0.18
T ₁	7.87±0.17	7.9±0.16	7.5±0.19	7.75±0.18	7.75±0.14
T ₂	8.4±0.15	8.4±0.17	8.5±0.16	8.56±0.12	8.5±0.11
T ₃	7.37±0.23	7.5±0.25	7.06±0.16	7±0.29	7.23±0.20
S.E.	0.14	0.14	0.14	0.13	0.12

Mean ± Standard Deviation

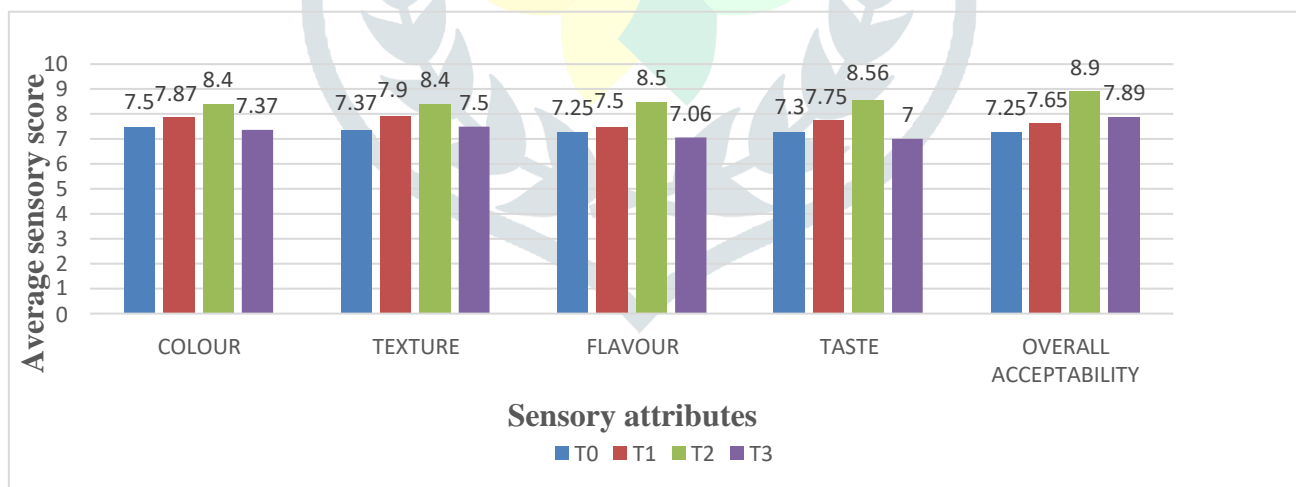


Figure 4.2 Average sensory score of *Curry flakes Nachos*.

4.4 Nutritive value of Curry flakes Nachos / 100 gm.

Table 4.4 Nutritive value of Curry flakes Nachos

Treatment	Energy (Kcal)	CHO (gm.)	Protein (gm.)	Fat(gm.)	Ca (mg.)	Fe (mg.)	Fibre (gm.)
T₀	409.8±0.18	81.5±0.22	13.92±0.20	3.18±0.25	34.8±0.16	3.32±0.16	2.76±0.09
T₁	400.5±0.12	79.44±0.23	13.7±0.14	3.06±0.25	67.6±0.14	4.56±0.13	5±0.13
T₂	395.76±0.17	78.38±0.19	13.6±0.21	3±0.11	84±0.21	6.22±0.18	6.96±0.25
T₃	386.4±0.24	76.5±0.15	13.4±0.24	2.92±0.13	116.8±0.17	11.5±0.12	8.13±0.22

4.4 SENSORY EVALUATION PARAMETERS OF DEVELOPED CURRY FLAKES NOODLES

Table 4.5 Average sensory score of Noodles

TREATMENT	COLOUR	TEXTURE	FLAVOUR	TASTE	OVERALL ACCEPTABILITY
T₀	7.5±0.20	7.37±0.14	7.25±0.22	7.3±0.20	7.35±0.18
T₁	7.87±0.17	7.9±0.16	7.5±0.19	7.75±0.18	7.75±0.14
T₂	8.4±0.15	8.4±0.17	8.5±0.16	8.56±0.12	8.5±0.11
T₃	7.37±0.23	7.5±0.25	7.06±0.16	7±0.29	7.23±0.20
S.E.	0.14	0.14	0.14	0.13	0.12

Mean ± Standard Deviation

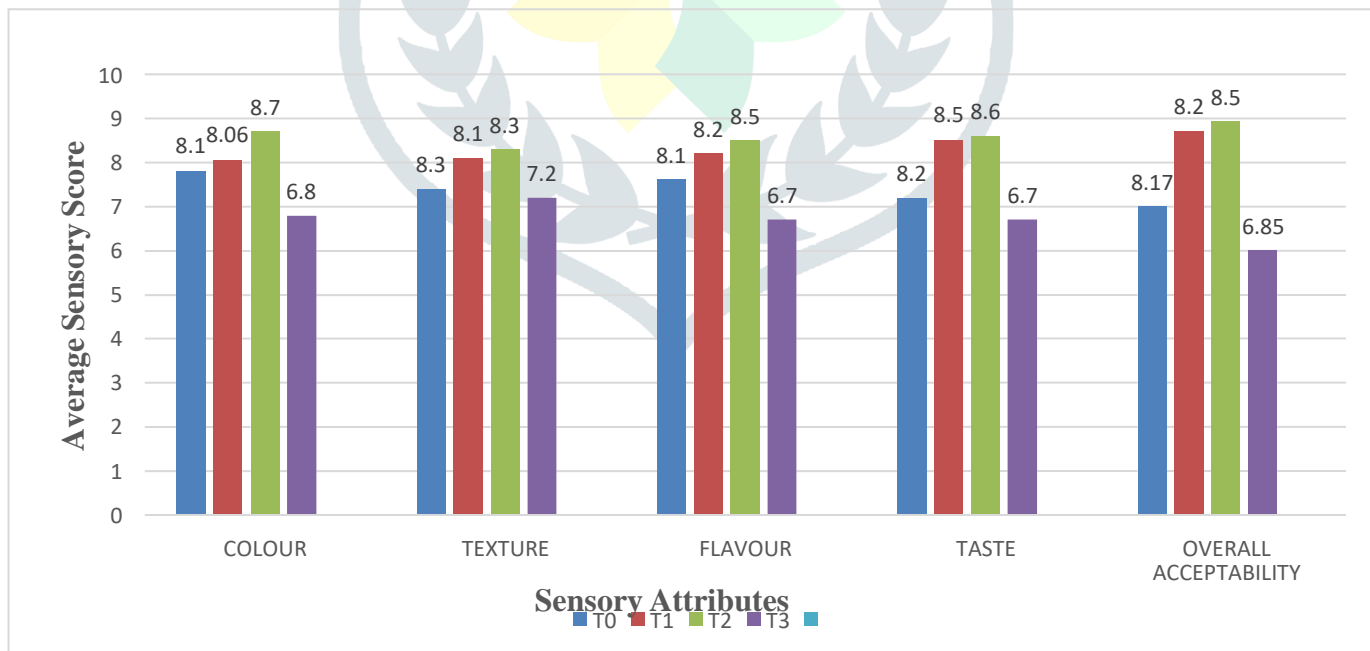


Figure 4.3 Average sensory score of Curry flakes Noodles.

4.5 Nutritive value of *Curry flakes Nachos* / 100 gm.

Table 4.6 Nutritive value of *Curry flakes Nachos*

Treatment	Energy (Kcal)	CHO (gm.)	Protein (gm.)	Fat (gm.)	Ca (mg.)	Fe (mg.)	Fibre (gm.)
T0	272.8±0.14	55.52±0.25	9.68±0.20	1.6±0.10	38.4±0.21	3.5±0.15	1.52±0.24
T1	269.6±0.14	54.7±0.12	9.56±0.13	1.34±0.18	50.9±0.16	4.9±0.23	1.59±0.27
T2	268.5±0.22	54.25±0.15	9.53±0.18	1.35±0.12	67.128±0.22	5.1±0.26	1.7±0.21
T3	280.76±0.13	56.34±0.21	10.39±0.13	1.5±0.16	202.5±0.10	11.5±0.13	2.72±0.17

5. SUMMARY AND CONCLUSION

The present research work has summarized here and it was concluded that developed food products by incorporating curry leaves flakes like *Cookies*, *Nachos* and *Noodles* provides concentrated form of nutrients (Carbohydrate, Energy, Protein, Fat, Calcium, Iron, and crude fibre) in comparison to standard recipe. The prepared products were accepted with regard to sensory characteristics.

The curry flakes product was more nutritious as the addition of curry flakes increases calcium, iron and fibre content of the products. The sensory parameters i.e., colour & appearance, body & texture, flavour, taste and overall acceptability of the curry flakes incorporated *Cookies*, *Nachos*, *Noodles* were found highly acceptable by consumers. It can be concluded that addition of curry flakes adds a fragrance, taste and it also enhanced the quality of *Curry flakes Cookies*, *Nachos*, and *Noodles*.

According to the sensory scores, the T₂ was the most acceptable among all the treatments.

The present investigation was undertaken to study the utilization of curry flakes for the development of value-added food products.

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