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Ready-to-Eat Chutney Mix from Indian Pennywort (*Centella asiatica*) and its Quality Evaluation

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Abstract

Nutritionally enriched Ready to eat (RTE) chutney mix was explored by incorporating Indian pennywort (*Centella asiatica*) locally known as 'ondelga' in Kannada. Chutney mix was prepared using tamarind, bengal gram, cumin seeds, curry leaves, green chillies and turmeric along with *Centella asiatica* leaves in different proportions. The effect of adding Centella leaves to RTE chutney mix (10, 20, 30 and 40%) on sensory, nutritional and shelf-life quality was examined. The best accepted combination of chutney mix (30: Centella: 70 other ingredients) was dehydrated at 50 °C for 8 hours and stored at ambient temperature in Metallised Polyester Polyethylene (MPP) and Low Density Polyethylene (LDPE) pouches for a period of six months under ambient conditions. The colour and rehydration ratio of best accepted Centella chutney mix were 29.12(L*), 9.62 (a*), 43.06 (b* and 3.4 respectively. Enrichment of RTE chutney mix with Centella led to significant increase in Calcium (142 mg %), iron (4.58 mg %), phosphorus (169 mg %), zinc (1.82 mg %) and bioactive compounds such as total polyphenols (148 mg %), total flavonoids (142.24 mg %) and antioxidant capacity (349.28 mg %) compared to control. At the end of six months storage, the moisture (3.90 %), free fatty acid (0.44 %) and peroxide value (1.28 meq/ Kg of fat) were reported in Centella chutney mix and it was acceptable in sensory quality for six months.

Keywords : Ready-to-eat (RTE), *Centella asiatica*, Enrichment, Antioxidant, Flavonoids

Ready-to-eat (RTE) foods that are pre-cleaned, pre-cooked**,** mostly packaged and ready to eat without prior preparation or cooking (Huang *et al*., 2011). Indian pennywort (*Centella asiatica* - CA) is a perineal, herbaceous creeper belongs to the Apiaceae family (Amaravathi *et al*. 2020). It is found all over India growing in humid places up to an altitude of 1800 meters. It is seen in tropical and subtropical nations such as India, Pakistan, Sri Lanka, Madagascar, South Africa, South pacific and Eastern Europe. It has tiny fan shaped green leaves with one leaf per stem. The whole plant is utilized for medicinal purposes. Dietary quality should be taken into consideration in order to address the issue of deep rooted food insecurity and mal nutrition, which is considered as a barrier to national development (Shobha and Ravi shankar, 2017). CA is widely used for the treatment of high blood pressure, improving memory and promote longevity. It is one of the most important herbs used in Ayurveda to regenerate nerves and brain cells (Rao *et al.,* 2004). The primary bioactive compounds of the plant are saponins, commonly known as triterpenoids such asasiaticosides, asiatic acid, madecassoside and madasiatic acid. It is widely used traditionally for the treatments of wounds, cancer and depression due to its therapeutic properties (Rao *et al*., 2013).

In India, a variety of chutneys and pickles are based on vegetables, pulses and spices are consumed along with rice and breakfast items like *idly, dosa, chapatti* and *vada*. Literature is available on development and standardization of several food adjuncts namely traditional chutneys, instant chutneys and chutney powders based on the different raw materials available during different seasons (Balaswamy *et al*., 2004; Rao *et al*., 2005 and Jyothirmayi *et al*., 2006). The reviewed work showed that the many research workers utilized CA for the preparation of *noodles, paratha, chicken meat balls, herbal juice, ready to serve drink* (RTS), *health drink* and *soup mixes*. (Chandrika *et al*., 2015; Yashmin *et al*., 2020; Monica*et al*., 2018; Joshi *et al*., 2022 and Amravati *et al*., 2020). *Centella asiatica*, a locally grown herb, with its enormous health benefits can be utilized many ways in our daily diet in order to have dietary diversity and health benefits. Hence, study on *Centella asiatica* enriched RTE chutney mix was open for research which further expected to increase the use of *Centella asiatica* in the daily diet. Hence, the present study was formulated with an objective to develop RTE chutney mix enriched with functional ingredient *Centella asiatica* and to evaluate its acceptability in terms of nutritional, physicochemical and shelf-life quality.

Material and Methods

Procurement of Samples

The present study was carried out at Department of Post-harvest Engineering and Technology, University of Agricultural Sciences, GKVK, Bengaluru, Karnataka. The leaves of *Centella asiatica* were collected from Post-harvest Engineering and technology, garden, the other raw materials such as garlic, onion, coriander leaves, grated coconut, curry leaves, bengal gram, tamarind, salt, coriander seeds, bengal gram dhal and turmeric were purchased from local market in Bangalore in a single lot and refrigerated until further use.

Method of Preparation

Chutney was prepared by grinding different quantities of ingredients like garlic (5g), coriander leaves (7g), jeera (5g), grated coconut (6g), bengal gram (7g), tamarind (12g), salt (5g) and coriander seeds (5g). To this mixture blanched Centella leaves (10g) and green chillies (12g) were added and ground to a coarse consistency. Further, mixture was seasoned with oil (5ml), mustard (2g), bengal gram dhal (4g), onion (8g) and curry leaves (7g) and sauted for 4 to 5 minutes.

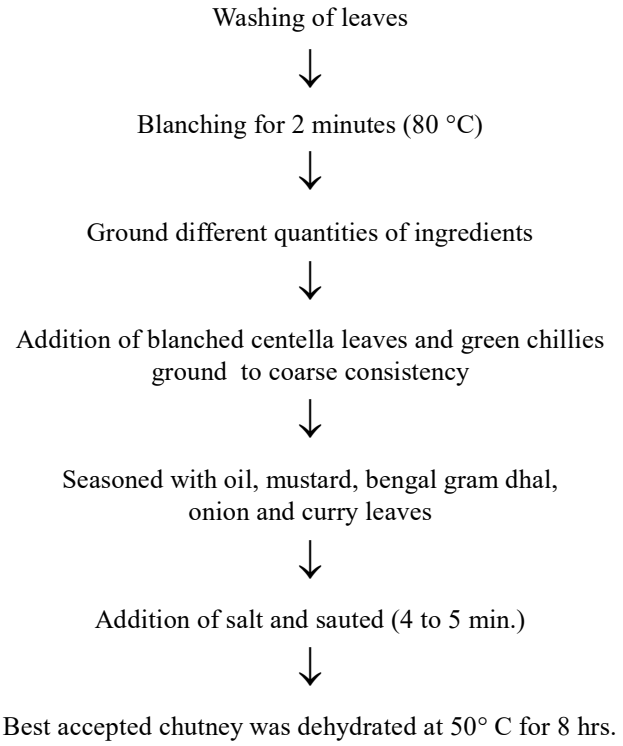


Fig. 1 : Flow chart for the preparation of RTE *Centella chutney mix*

The recipe for the preparation of *Centella chutney mix* was standardized in filler trials by varying the quantities of Centella leaves and other ingredients in various proportions (10:90, 20:80, 30:60 and 40:60) in order to develop palatable product.

Proximate and Physicochemical Estimation

Control (without addition of Centella) and Centella chutney mix were analysed for proximate composition namely moisture, ash, energy, crude fat and crude fiber according to the standard procedures described by Ranganna (1986). The carbohydrate content was calculated by difference method AOAC (2005). Estimation of minerals such as calcium, magnesium,

sodium, potassium, phosphorous, manganese, iron and zinc were estimated according to standard AOAC (2005) method.

Estimation of Total Phenolic Content

The total phenolic content in the ethanolic extract of chutney mix was determined spectrophotometrically using Folin-ciocalteu method as described by Onivogui *et al,* (2014) with slight modification. The amount of total phenol was expressed as gallic acid equivalent (GAE) in milligram per gram of sample.

Estimation of Total flavonoid

The total flavonoid content was determined from standard curve prepared using different concentrations of quercetin standard and expressed as mg quercetin equivalent (QE)/100g of the sample weight. The total flavonoid content (TFC) of the extract was determined according to Onivogui *et al,* (2014). The total flavonoid content was expressed as mg quercetin equivalents per 100 ml of chutney mix.

Total Antioxidant Activity by DPPH Assay

The ability of the different solvent extracts to scavenge free radicals was determined against a very stable free radical DPPH (1, 1-dipheny l-2-picrylhydrazyl) spectrometrically at the wavelength of 517 nm. The total antioxidant activity was determined from standard curve prepared using different concentrations of DPPH solution and expressed as percentage DPPH radical scavenging activity (RSA) in triplicates using ascorbic acid as the standard (AOAC, 2005).

Estimation of saponin content

The procedure for estimation of saponin was adopted from Hai *et al.* (2012). The absorbance of the mixture was measured by a spectrophotometer at a wavelength of 544nm. Diosgenin was used as a reference standard. Saponin concentration was obtained from the standard graph.

$$\text{Saponin content (mg/100 g)} = \frac{\textit{Absorbance of sample} \times \textit{gradient of graph}}{\textit{weight of the sample (g)}} \times 100$$

Estimation of Tannins

After dissolving the plant extract in 5 ml of distilled water, 1 per cent gelatin solution and 10 per cent Nacl were added. The presence of tannins was revealed by formation of white precipitate (Joshi and Awasthi 2022).

Colour Estimation

The colour of the best accepted chutney mix was carried out using spectrophotometer (Konica Minolta Instrument, Osaka, Japan; Model-CM 5). Sample colour was measured in terms of L*, a* and b* values as per Kabasa mary sally *et al.,* (2011).

Rehydration Ratio of Chutney Mix

Five grams of dehydrated sample was weighed accurately and taken in a 500mL beaker to which 50mL distilled water was added and covered with watch glass and brought to boil. It was boiled for five minutes and switched off. After half an hour the sample was filtered through Whatman No.1 filter paper. Gentle suck was applied and water was drained with careful stirring for 30 to 60 sec, until it drops from the funnel and the weight was recorded (Ranganna, 1986).

$$\textit{Rehydration ratio} = \frac{\textit{Weight of rehydrated sample}}{\textit{weight of dehyrated sample}}$$

Water Activity

Water activity of the chutney mixes was estimated by using Benchtop water activity meter (Hygrolab).

Storage Studies

The best accepted chutney mix (T_3 Centella chutney mix) and control (without Centella) were stored in MPP (Metalized polyster polyethylene) and LDPE (Low density polyethylene) pouches for a period of six months at ambient condition (24 ± 5°C). The samples were drawn every month and analysed for moisture, peroxide value and free fatty acid.

Sensory Evaluation of Developed Product

Sensory evaluation was carried out by a panel of 21 semi trained panel member using 9-point hedonic scale (Ranganna, 1986).

Statistical Analysis

The data was analysed with SAS software 9.3 using two-way analysis of variance. The difference between the means was tested using the least significant of difference at 5 per cent.

Results and Discussion

The mean sensory scores of chutney mixes at different levels of *Centella asiatica* incorporation is depicted in Table 1. Statistically significant scores were observed between Control and T_4. The chutney mix with 40 per cent incorporation scored lowest for all the sensory attributes due to increased concentration of centella which adversely affected the texture, taste, colour and overall acceptability (OAA). Between 20 and 30 per cent incorporation, as there was no significant difference for all sensory parameters. The OAA scores of 20 and 30 per cent incorporation were 8.96 and 8.91 respectively. Hence, looking into the nutritional benefits of Centella incorporation in the products, the 30 per cent (T_3) was taken for further studies.

Similar study conducted by Deepak (2016) determined the chutney powder prepared by incorporating tamarind leaves powder at different level (20, 30 and 40%) with that of the control (without incorporating tamarind leaves powder). The results revealed that the control chutney powder scored higher overall acceptability (8.1) scores.

The nutritional composition of control chutney mix and best accepted *Centella chutney mix* (T_3) were analysed and depicted in Table 2. The results revealed that the nutritional composition of chutney mixes varied statistically. Moisture content of control and *Centella chutney mix* was 3.79 and 3.98 per cent respectively. The *Centella chutney mix* had significantly more protein (4.98g), fat (3.34g), soluble fiber (3.25g) and insoluble fiber (11.30g), than control chutney mix. Minerals such as calcium (142 mg%), magnesium (72.42 mg%), phosphorous (142 mg%), sodium (17.02 mg%), potassium (179.36 mg%), iron (4.58 mg%) and zinc (1.82 mg%) were significantly higher in the *Centella chutney mix* than Control chutney mix. (Table 2). Even the study conducted by

Table 1

Mean sensory score of RTE *Centella chutney* mix

Products	Sensory attributes					
	Appearance	Colour	Texture	Aroma	Taste	Overall acceptability
Control	8.65 ± 0.00	8.94 ± 0.12	8.98 ± 0.23	8.97 ± 0.30	8.98 ± 0.31	8.98 ± 0.13
T_1	8.81 ± 0.4	8.76 ± 0.35	8.85 ± 0.21	8.86 ± 0.21	8.95 ± 0.22	8.94 ± 0.21
T_2	8.85 ± 0.35	8.86 ± 0.35	8.95 ± 0.32	8.95 ± 0.35	8.97 ± 0.31	8.96 ± 0.34
T_3	8.80 ± 0.21	8.69 ± 0.35	8.83 ± 0.49	8.82 ± 0.48	8.90 ± 0.48	8.91 ± 0.49
T_4	7.25 ± 0.43	6.98 ± 1.17	7.00 ± 0.91	6.96 ± 0.5	6.97 ± 0.9	6.65 ± 0.49
F value	*	*	*	*	*	*
S. Em±	0.204	0.176	0.212	0.219	0.224	0.220
CD at 5%	0.577	0.500	0.601	0.621	0.634	0.623

Values are mean ± standard deviation (n=3), * Significant at 5 %, S.Em± : standard error of mean.
CD : Critical difference, Control: Chutney mix without Centella, T_1 : Centella chutney mix (10 %),
T2 : Centella chutney mix (20 %), T_3 : Centella chutney mix (30 %), T_4 :Centella chutney mix (40 %)

TABLE 2
Proximate composition of RTE *Centella chutney mix* (100 g)

Nutrients	Control	T_3	t- value
Moisture	3.80 ± 0.2	3.98 ± 0.01	49.20 *
Protein	7.92 ± 0.12	8.02 ± 0.08	68.93 *
Fat	3.28 ± 0.01	3.34 ± 0.02	41.10 *
Ash	2.53 ± 0.01	2.89 ± 0.02	33.83 *
Carbohydrates	84.47 ± 0.08	86.17 ± 0.01	356 *
Crude fiber	4.98 ± 0.01	5.97 ± 0.01	104 *
Soluble fiber	2.25 ± 0.00	3.25 ± 0.01	212.13 *
Insoluble fiber	5.42 ± 0.00	11.30 ± 0.00	1763 *
Energy (kcal)	389.12 ± 0.08	391.29 ± 0.01	3257.82 *
Total dietary fiber	7.67 ± 0.00	14.55 ± 0.01	1975.13 *
Sodium (mg%)	15.23 ± 0.12	17.02 ± 0.21	379.716 *
Potassium (mg%)	158.25 ± 0.23	179.36 ± 0.26	466.69 *
Calcium (mg%)	128 ± 0.21	142 ± 0.31	8.485 *
Phosphorus (mg%)	148.32 ± 0.23	169.34 ± 0.24	99.702 *
Magnesium (mg%)	68.12 ± 0.21	72.42 ± 0.12	912.168 *
Iron (mg%)	1.93 ± 0.21	4.58 ± 0.31	562.15 *
Zinc (mg%)	0.91 ± 0.13	1.82 ± 0.12	274 *
Manganese (mg%)	1.38 ± 0.32	2.97 ± 0.24	328 *

Values are mean ± standard deviation (n=3).*- Significant at 5%, S.Em± - standard error of mean. CD - Critical difference, Control - Chutney mix without Centella, T_3 - *Centella chutney mix* (30 %)

Latharani and Jamuna (2023) reported improvement in nutritional content of Herbal *kasaya* drink prepared using herbs such as amruthaballi, clove, honagone, ginger and turmeric.

Balaswamy *et al*. (2004), evaluated the nutritional composition of curry leaves chutney powder, revealed that the 10 per cent incorporated curry leaves chutney mix contained moisture (5.0%), ash (4.0g), protein (16.4g), fat (14.2), crude fiber (7.0g), carbohydrates (44.3g) and minerals such as iron (9.3mg) and calcium (1.27mg). Similar results were also reported by Rao *et al.* (2004), Bidwe and khan (2017) and Jyothirmayi *et al*. (2006) for tamarind leaves chutney powder, drumstick leaves powder chutney and instant raw tamarind chutney powder respectively.

Phytochemical composition of the developed Centella chutney mix and control is depicted in Table 3. Significantly higher antioxidant activity (349.28 mg), Vitamin C (4.12 mg), phenols (148.27 mg), flavonoids (142.24 mg), oxalate (22.4 mg), tannins (36.74 mg) and saponins (2.48 mg) were noticed in *Centella chutney mix* compared to control. The addition of *Centella* in the chutney mix has led to increase in antioxidant (51.04 mg%) and other phytochemicals (Table 3) compared to control which is very much beneficial due to its nutraceutical properties.

Previous research by Ganesan *et al*. (2020), on curry leaves chutney powder revealed that, 10 per cent incorporated curry leaves chutney mix contained total polyphenol (146.36 mg) and antioxidant (35.33 %) content. Addition of curry leaves significantly increased the total polyphenol and antioxidant content of curry leaves chutney powder.

The physicochemical properties of Control and *Centella chutney mix* is presented in Table 4.

TABLE 3

Phytochemical composition of RTE *Centella chutney mix* (per 100 g)

Nutrients	Control	T_3	t- value
Antioxidant activity	298.24 ± 0.23	349.28 ± 0.41	10827.2 *
Vitamin C	1.24 ± 0.12	4.12 ± 0.23	610.94 *
Total phenols	96.32 ± 0.24	148.27 ± 0.31	11020.3 *
Total flavonoids	98.24 ± 0.13	142.24 ± 0.21	9333.81 *
Oxalate	18.24 ± 0.21	22.4 ± 0.24	123.285 *
Tannins	28.24 ± 0.21	36.74 ± 0.12	1803.12 *
Saponins (%)	1.08 ± 0.31	2.48 ± 0.32	296.985 *

Values are mean ± standard deviation (n=3).*- Significant at 5 %, S. Em± - standard error of mean. CD - Critical difference, Control - Chutney mix without Centella, T_3 - *Centella chutney mix* (30%)

Non-significant differences were observed with respect to titratable acidity in control (1.28 %) and *Centella chutney mix* (1.31 %). *Centella chutney mix* contained significantly higher pH (3.82) because of vitamin C content of Centella compared to control (Table 4). The TSS (2.13° brix), rehydration ratio (3.71) and water activity (0.51), were reported in *Centella chutney mix*. The low water activity is beneficial in preserving the product for longer period.

The L* values for control and *Centella chutney mix* was 45.06 and 29.12, respectively indicating that *Centella chutney mix* was darker than the control. This indicates that the incorporation of *Centella* has a pronounced effect on the lightness of chutney mix due to the dark green colour of leaves. Which gives natural green colour to the mix. Significantly difference ($p<0.05$) was observed with L*, a* and b* values of control and *Centella chutney mix* was due to the incorporation of *Centella* leaves.

Storage Studies

Perusal of (Table 5) Fig. 2, indicates the mean sensory scores of chutney mixes during six months storage period at ambient temperature. The sensory scores were found to be significantly more for control sample compared to *Centella* incorporated chutney sample (T_3). After one month of storage period, control chutney powder showed significantly decreasing trend

TABLE 4

Physicochemical properties of RTE *Centella chutney mix*

Parameter	Control	T_3	t- value
Titratable Acidity (%)	1.28 ± 0.00	1.31 ± 0.05	0.29 NS
pH	3.14 ± 0.00	3.82 ± 0.05	18.806 *
TSS (° brix)	1.68 ± 0.00	1.70 ± 0.00	31.81 *
Rehydration ratio	3.70 ± 0.00	3.71 ± 0.00	6.363 *
Water activity	0.51 ± 0.00	0.51 ± 0.00	4.242 *
Colour parameters			
L*	45.06 ± 0.00	29.12 ± 0.00	1952.24 *
a*	-7.57 ± 0.03	-9.62 ± 0.01	193.848 *
b*	24.46 ± 0.06	43.06 ± 0.12	2278.02 *

: Significant at 5% and NS: Non-significant, Values are mean ± standard deviation (n=3). S. Em± - standard error of mean. CD - Critical difference, L(*i.e.* [-] to [+] lightness coordinate), a*(*i.e.,* green [-] to red [+]) and b* (*i.e.,* blue [-] to yellow [+])

TABLE 5

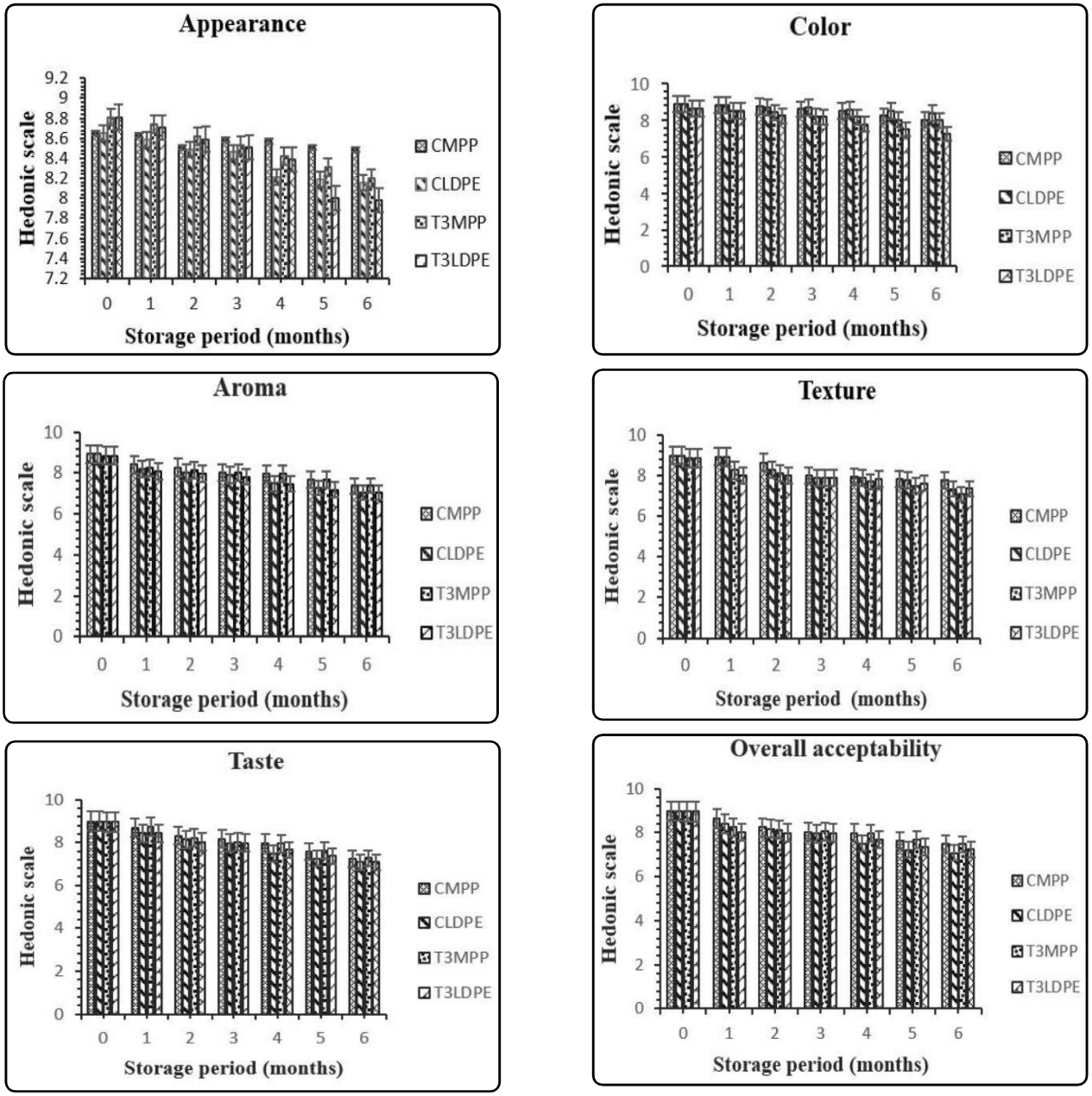
Effect of storage on sensory scores of RTE *Centella chutney mix* during storage

Storage Period (months)	Appearance				Color				Texture			
	CMPP	CLDPE	T_3MPP	T_3LDPE	CMPP	CLDPE	T_3MPP	T_3LDPE	CMPP	CLDPE	T_3MPP	T_3LDPE
0	8.65	8.65	8.81	8.81	8.91	8.91	8.63	8.63	8.98	8.98	8.83	8.83
1	8.63	8.59	8.74	8.71	8.84	8.81	8.52	8.51	8.92	8.89	8.25	8.00
2	8.51	8.49	8.62	8.59	8.75	8.71	8.43	8.23	8.62	8.28	8.09	7.99
3	8.50	8.46	8.53	8.51	8.61	8.69	8.20	8.19	7.98	7.9	7.89	7.87
4	8.49	8.21	8.42	8.39	8.53	8.60	8.17	7.78	7.92	7.87	7.68	7.81
5	8.48	8.19	8.41	8.00	8.24	8.50	8.04	7.53	7.81	7.76	7.49	7.61
6	8.47	8.16	8.40	7.98	8.02	8.39	8.03	7.25	7.76	7.32	7.09	7.36
	F-value		S.Em ±	CD at5%	F-value		S. Em ±	CD at5%	F-value		S.Em ±	CD at 5%
T	*		0.012	0.034	*		0.012	0.033	*		0.012	0.032
P	*		0.012	0.034	*		0.012	0.033	*		0.012	0.032
D	*		0.023	0.063	*		0.022	0.062	*		0.022	0.06
TX P	*		0.017	0.047	*		0.017	0.047	*		0.016	0.046
TX D	*		0.032	0.089	*		0.031	0.087	*		0.085	0.09
PXD	NS		0.032	-	NS		0.031	-	*		0.085	0.09
T X PXD	NS		0.045	-	NS		0.044	-	NS		-	-

Continued....

TABLE 5 Continued....

Storage Period (months)	Aroma				Taste				Over all acceptability			
	CMPP	CLDPE	T_3MPP	T_3LDPE	CMPP	CLDPE	T_3MPP	T_3LDPE	CMPP	CLDPE	T_3MPP	T_3LDPE
0	8.92	8.92	8.85	8.85	8.98	8.98	8.96	8.96	8.98	8.98	8.96	8.96
1	8.41	8.18	8.25	8.10	8.68	8.42	8.74	8.42	8.62	8.41	8.24	8.02
2	8.28	8.00	8.15	7.98	8.32	8.13	8.21	8.02	8.25	8.18	8.13	7.98
3	8.00	7.92	8.01	7.82	8.16	7.98	8.03	7.98	8.03	7.96	8.06	7.98
4	7.98	7.48	7.96	7.47	7.98	7.49	7.95	7.65	7.98	7.51	7.97	7.67
5	7.67	7.28	7.67	7.18	7.56	7.26	7.63	7.37	7.64	7.21	7.67	7.34
6	7.38	7.06	7.39	7.06	7.24	7.08	7.28	7.08	7.49	7.07	7.47	7.24
	F-value		S.Em ±	CD at 5%	F-value		S. Em ±	CD at 5%	F-value		S.Em ±	CD at 5%
T	*		0.013	0.035	*		0.012	0.033	*		0.011	0.032
P	*		0.013	0.035	*		0.012	0.033	*		0.011	0.032
D	*		0.023	0.065	*		0.022	0.061	*		0.021	0.059
TX P	NS		0.018	-	NS		0.017	-	NS		0.016	-
TX D	*		0.033	0.092	*		0.031	0.087	*		0.03	0.084
PXD	NS		0.033	-	NS		0.031	-	*		0.03	0.084
T X PXD	NS		0.047	-	NS		0.044	-	NS		0.043	-



CMPP - control chutney mix in MPP, CLDPE: Control chutney mix in LDPE, T_3MPP - Centella chutney mix in MPP, T_3LDPE : Centellachutney mix in LDPE,

Fig. 2 : Effect of storage on sensory scores of RTE *Centella chutney mix* during storage

compared to the Centella chutney sample. Further, as the months of storage increased, the scores for all the sensory attributes were decreased significantly in both the samples (Fig. 2). However, overall acceptability (OAA) scores were in the acceptance range up to six months of storage in both the packaging materials. There was slight decrease in the sensory scores of both the samples with increase in the storage days may be due to decline in colour and taste of the product. At the end of storage period, both control and *Centella chutney mix* stored in MPP packages retained significantly higher sensory scores of 8.47 and 8.40 respectively, which may be due to its enhanced oxygen and moisture barrier properties.

Analysis of variance indicated a non significant difference between the treatments, packaging materials and duration over six months of storage period. Though there was a slight changes observed in all sensory attributes over a period of six months, the products were stable up to six months due to low moisture (3.98%) and water activity (0.51), of the products.

The investigation by Rao *et al.* (2013) on storage of chutney powder prepared from flax seed (*Linum usitatissimum* L.). Stored in metalized polyester pouches at room temperature over period of six months revealed that there was a significant ($p<0.05$) difference in appearance (7.8), flavor (7.6) and overall acceptability (7.4) quality over six months period. Similar trend was noticed by Bidwe and khan (2017) and Jyothirmayi *et al*. (2006) for drumstick leaves powder chutney and instant raw tamarind chutney powder, respectively.

The changes in moisture, free fatty acid and peroxide value of control and *Centella chutney mix* is depicted in Table 6 (Fig. 3a, b & c). Increase in moisture content of chutney mixes in two types of packaging materials (MPP and LDPE) over six months of storage period was noticed. The results of Fig. 3a. Indicated that, significant difference was noticed with respect to changes in moisture in two types of packaging material. The LDPE pouches showed significantly higher moisture absorption over six months of storage in control chutney mix (3.79 to 3.94%) and *Centella chutney mix* (3.98 to 4.43%) while lesser value for the same was reported for MPP stored control chutney mix. The increase in moisture content may be due to storage condition or hygroscopic nature of the ingredients used in the product. MPP pouches retained better moisture and oxygen barrier properties.

The free fatty acids (FFA) content of control and *Centella chutney mix* were significantly increased with increase in storage period Fig. 3b. However, values remained in the acceptable range (<5%). FFA values were significantly high in LDPE pouch compared to MPP pouch both in control and *Centella chutney mix*. Analysis of data showed that interaction of treatments and packaging and treatments and duration, packaging and duration have a significant impact on FFA of chutney mixes ($p<0.05$). however, overall interaction between the treatments, packaging material and duration over six months of storage period was non-significant. Free fatty acids values were within the safe limits up to 60th day of storage period (BIS, 2006).

Peroxide value of control and *Centella chutney mix* stored in two types of packages (LDPE and MPP) is presented in Fig. 3c. In control chutney mix, peroxide value in MPP pouch increased significantly from 1.20 to 1.51, while in LDPE pouch it increased from 1.20 to 1.58. There was no significant difference observed between the products, duration and between the treatments, packaging materials over the six months storage period. Peroxide values were within the safe limits up to 60th day of storage period (BIS, 2006). However, 30 per cent Centella incorporated chutney mix (T_3) had less value for peroxides compared to control. This could be due to the presence of antioxidants in *Centella asiatica.*

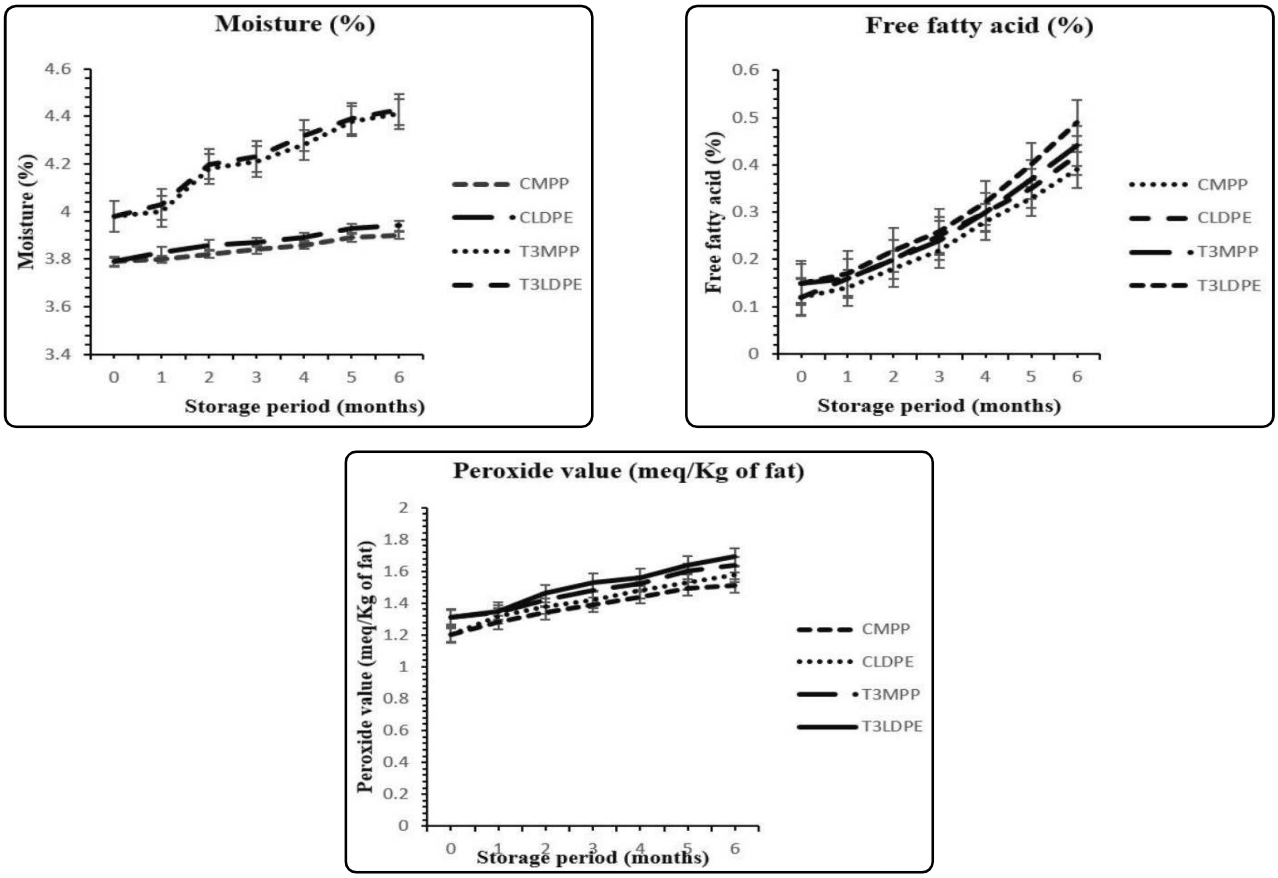
Rao *et al.* (2004), investigated the storage of standardised chutney powders with combination of dry tamarind leaves and protein rich oilseed powders of peanut and sesame packed in polyethylene and metallized polyethylene laminate pouches at ambient temperature. The results exhibited that; chutney powders stored in MPE pouches showed significantly lower FFA (2.02 to 2.73%), compared to PE pouches (1.81 to 3.20%). The similar trend was noticed by Shobha *et al.* (2021) on development of gluten free pasta using Quality Protein Maize (QPM) enriched with functional ingredients. The study revealed that the developed pasta had moisture (8.5 to 9.0%), free fatty acids (0.1 to 0.25%) and peroxide value (1.6 to 2.4 meq/Kg of fat) during the storage period of six months. However, the levels were within normal limits so that the taste, flavour and acceptability of the pasta were not affected. The similar results were observed by Satyanarayana *et al*. (2001) during the storage of instant chutneys from pudina (*Mentha spicata*) and gongura (*Hibiscus* sp.).

TABLE 6

Effect of storage on moisture (%), free fatty acids (%) and peroxide value (meq/Kg of fat) of RTE *Centella chutney mix*

Storage Period (months)	Moisture (%)				Freefatty acid (%)				Peroxide value (meq/Kg fat)			
	CMPP	CLDPE	T_3MPP	T_3LDPE	CMPP	CLDPE	T_3MPP	T_3LDPE	CMPP	CLDPE	T_3MPP	T_3LDPE
0	3.79	3.79	3.98	3.98	0.12	0.12	0.15	0.15	1.20	1.20	1.31	1.31
1	3.80	3.83	4.00	4.03	0.14	0.16	0.16	0.17	1.28	1.32	1.34	1.35
2	3.82	3.86	4.18	4.20	0.18	0.20	0.20	0.22	1.34	1.38	1.42	1.46
3	3.84	3.87	4.21	4.23	0.22	0.25	0.24	0.26	1.39	1.42	1.48	1.53
4	3.86	3.89	4.28	4.32	0.28	0.30	0.30	0.32	1.44	1.48	1.52	1.56
5	3.89	3.93	4.38	4.39	0.33	0.35	0.37	0.40	1.49	1.53	1.60	1.64
6	3.90	3.94	4.41	4.43	0.39	0.42	0.44	0.49	1.51	1.58	1.64	1.69
	F-value		S. Em ±	CD at 5%	F-value		S. Em ±	CD at 5%	F-value		S. Em ±	CD at 5%
T	*		0.081	0.229	*		0.004	0.013	*		0.034	0.096
P	NS		0.081	-	*		0.004	0.013	*		0.034	0.096
D	*		0.151	0.429	*		0.008	0.024	NS		0.048	-
TX P	NS		0.114	-	NS		0.006	-	*		0.063	0.179
TX D	NS		0.214	-	NS		0.012	-	*		0.089	0.253
PXD	NS		0.214	-	*		0.012	0.034	*		0.089	0.253
TX PX D	NS		0.303	-	NS		0.017	-	NS		0.126	-

*- Significant ($p<0.05$) and NS : non-significant, S. Em± - standard error of mean. CD - Critical difference, CMPP : control chutney mix in MPP, CLDPE : Control chutney mix in LDPE, T_3MPP - *Centella chutney mix* in MPP, T_3LDPE : *Centella chutney mix* in LDPE, T - Treatments, P - Packaging material, D - Duration



CMPP : control chutney mix in MPP, CLDPE : Control chutney mix in LDPE, T_3MPP - *Centella chutney mix* in MPP, T_3LDPE : *Centella chutney mix* in LDPE,

Fig. 3 : Effect of storage on (a) moisture (%), (b) free fatty acids (%) and (c) peroxide value (meq/Kg of fat) of RTE *Centella chutney mix*

From the study, it can be concluded that Chutney mix prepared with incorporation of *Centella asiatica* at 30 per cent level was organoleptically superior along with nutritional quality (protein, dietary fiber, calcium, phosphorous, zinc and iron) and bioactive compounds such as antioxidant, polyphenols and flavonoids compared to control. The product was stable up to six months with respect to sensory and biochemical quality. Study revealed that Ready to eat (RTE) chutney mix from centella will provide diversity in the diet along with the nutritional advantage.

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