Annals. Food Science and Technology
2020

DEVELOPMENT OF NOVEL FOODS USING BETEL LEAVES

M Sindhuja[1], Rajkala **A**[2]
[1]Ethiraj College for Women (Autonomous), No.70, Ethiraj Salai, Chennai-600008, India
[2]Ethiraj College for Women (Autonomous), No.70, Ethiraj Salai, Chennai-600008, India
Email: sindhuja.m9@gmail.com, rajkaladinakaran@gmail.com

Abstract
The betel leaves are scientifically known as Piper betle L. and belong to the Black Pepper familyi.e. Piperaceae. They are commonly known as Paan in most parts of India and have deep greenheart shaped leaves. India is the inhabitant of forty varieties of betel leaves amongst the abouthundred varieties found in the world. These betel leaves have effective neutraceutical properties,anti-ulcer, anti-malarial, anti-filarial, anti-asthamatic, anti-cancer, cyto-toxic, wound healing,radioprotective and platelet inhibition activities. The betel leaf extract is known to beantioxidant, anticancer, anti-allergic etc. Owing to these properties, a study was conductedinvolving the development of novel foods with the incorporation of betel leaves, the organolepticproperties were evaluated and nutritive value of the food products was determined. Five recipeswere developed with three variations each in terms of the amount of betel leaves added. Theorganoleptic analysis revealed the acceptability of each variation for the five recipes in terms ofappearance, colour, flavour, taste and texture. The nutrient content of the betel leaf incorporatedrecipes was studied in terms of carbohydrate, protein, fat, ascorbic acid (24.5mg/100mg), β-carotene (4676µg/100µg), calcium (196mg/100mg) and potassium (678mg/100mg). The presentstudy aimed to branch out the association of betel leaves with nutrition in order to increase itsutility in everyday meal pattern and to combat malnutrition. As it is quite affordable, itsacceptance and utility would be more with the vulnerable population, which in turn would aid inhaving a better health status index in the country.
Key Words: nutritious; ascorbic acid; β-carotene; calcium; potassium; carbohydrate; protein; fat

Received: 19.01.2020 Reviewed: 20.03.2020 Accepted: 28.04.2020

1. INTRODUCTION

Betel leaves (*Piper betle L.);* popularly known as *Paan* in India, are the deep green heart shaped leaves of betel vine. Other common names are Nagaballi, Nagurvel, Saptaseera, Sompatra, Tamalapaku, Tambul, Tambuli, Vaksha Patra, Vettilai, Voojangalata etc in different parts of the country. The betel vine is diocious (male and female species are different), shade loving perennial root climber.
Piper betle L. has a great nutraceutical potential. It belongs to the piperacae family which has a long standing history dating back 5500- 7000BC. These heart shaped leaves are aromatic in nature and due to the presence of essential oils it tastes sweet to pungent (Pradhan et al., 2013)
About 100 varieties of betel vines are found in the world, around 40 are found in India and 30 in West Bengal. Due to its antiquity, betel vines are more popular in India than in other countries. Various citations in the ancient Indian literature and scriptures are an evidence of this. The most probable place of their origin is Malaysia (Guha, 2014).
Both male and female betel vines are cultivated in India. The male betel vines are cultivated throughout India except the dry northwestern parts. The female plants rarely produce any flower or fruit in the Indian climate. Yet the vines are cultivated for harvesting the heart shaped green leaves. It grows best under the shaded, tropical forest ecological conditions with a rainfall of about 2250-4750 mm, relative humidity and temperature ranging from 40-80% and 15-40°C, respectively. A well-drained fertile sandy or sandy loam or sandy clay soil with pH range of 5.6 –8.2 is considered suitable for its cultivation (Guha, 2014). However, in the areas with lower rainfall (1500- 1700 mm) the crop is cultivated with small and frequent irrigations, i.e. every day in summer and every 3-4 days in winter, whereas adequate drainage is required during the rainy season (Guha, 2014).
The annual yield of a good crop is about 60-70 leaves/ plant and 6-7 million leaves/ ha. The

gross production of the leaves constitutes to about Rs 9000 million every year in the country; on about 55,000 ha of land. On an average about 66% of such production is contributed by the state of West Bengal where it is cultivated on about 20,000 ha of land (Guha, 2014).

Piper betel leaves; also known as 'green gold' are widely consumed in Africa and Asia (especially India and Taiwan) as a condiment. These are rich in phenols and exhibit antioxidant, anti-inflammatory, immunomodulatory and antitumor activities (Paranjpe et al., 2013). Further, the leaves are very nutritive containing substantial amount of vitamins and minerals and therefore, six leaves with a little bit of slaked lime is said to be comparable to about 300 ml of cow milk particularly for the vitamin and mineral nutrition. The leaves also contain the enzymes like diastase and catalase besides a significant amount of all the essential amino acids except lysine, histidine and arginine, which are found only in traces (CSIR, 1969; Guha, 2014). However, relevant data from a complete biochemical analysis is not available from any single source.

Chewing of betel leaves produce a sense of well-being, increased alertness, sweating, salivation, hot sensation and energetic feeling with exhilaration. It also increases the capacity to exercise physical and mental functions more efficiently for a longer duration but it may produce a kind of psychoactive effect causing a condition of mild addiction leading to habituation and withdrawal symptoms (Guha, 2014).

Nutritional composition of *Piper betle* as given by the Indian Food Composition Tables published by the National Institute of Nutrition in 2017 is as follows:

Table1: Nutritional composition of*Piper betle*

Proximate Principles and Dietary Fibre (per 100g edible portion)	
Moisture (g)	85.92± 0.16
Protein (g)	2.62± 0.28
Ash(g)	2.59± 0.18
Total Fat (g)	0.75± 0.04
Dietary Fibre (g)	
Total (g)	1.97± 0.13
Insoluble (g)	1.17± 0.12
Soluble (g)	0.80±0.09
Carbohydrate (g)	6.16±0.33
Energy (KJ)	183±2
Water Soluble Vitamins (per 100g edible portion)	
Thiamin (B1) (mg)	0.02± 0.010
Riboflavin (B2) (mg)	0.70± 0.009
Niacin (B3) (mg)	0.47± 0.07
Pantothenic Acid (B5) (mg)	0.47± 0.04
Total B6 (mg)	0.04± 0.005
Biotin (B7) (µg)	1.28± 0.15
Total Folates (B9) (µg)	16.56± 2.67
Total Ascorbic Acid (mg)	24.51± 8.66
Fat Soluble Vitamins (per 100g edible portion; All blank space in the table represent below detectable limit)	
Ergocalciferol (D2) (µg)	2.27± 0.25
Tocopherols	
Alpha (mg)	0.02± 0.01
Beta (mg)	
Gama (mg)	0.05± 0.00

Delta (mg)	
Tocotrienols	
Alpha (mg)	0.02± 0.00
Beta (mg)	
Gama (mg)	
Delta (mg)	
α – Tocopherol equivalent	0.03± 0.01
Phylloquinones (K1) (µg)	204± 4.9
Carotenoids (per 100g edible portion; All blank space in the table represent below detectable limit)	
Lutein (µg)	5783± 460
Zeaxanthin (µg)	79.80± 13.41
Lycopene (µg)	
β- Cryptoxanthin (µg)	
γ- Carotene (µg)	
α- Carotene (µg)	427± 64.0
β- Carotene (µg)	4676± 622
Total Carotenoids (µg)	16563± 1292
Minerals and Trace Elements Carotenoids (per 100g edible portion; All blank space in the table represent below detectable limit)	
Aluminuim (mg)	1.85± 0.43
Arsenic (µg)	1.68± 0.00
Cadmium (mg)	
Calcium (mg)	196± 13.7
Chromium (mg)	0.019± 0.005
Cobalt (mg)	0.002± 0.001
Copper (mg)	0.29± 0.02
Iron (mg)	2.87± 0.29
Lead (mg)	0.004± 0.003
Lithium (mg)	0.005± 0.006
Magnesium (mg)	89.94± 14.98
Manganese (mg)	1.79± 0.62
Mercury (µg)	
Molebdeum (mg)	0.002± 0.002
Nickel (mg)	0.043± 0.017
Phosphorous (mg)	55.72± 3.36
Potassium (mg)	678± 5.2
Selenium (µg)	5.40± 1.71
Sodium (mg)	14.04± 2.32
Zinc (mg)	0.39± 0.06

Need for the study

The *Piper betle L.* posses a lot of therapeutic values. The leaf has the great potency to act as natural antioxidant. The anti-oxidant property is correlated with different biological activities like hepatoprotective, antidiabetic and anticancer properties, since free radicals are involved in all these diseases. The leaf poses the broad spectrum antimicrobial activity against various bacterial strains including Bacillus cereus, Pseudomonas Aeruginosa, Escherichia coli, Micrococcus luteus, Staphylococcus aureus, Aeromonas hydrophila, etc. The leaf extract shows the Gastroprotective activity by enhancing the mucus rather than decrease the acid production.

Piper betle have a tremendous potential as a potent source for novel therapeutic usage. The pharmacological profile reveals it to be fit for its future usage as a promising source for treating various conditions. Therefore, in the near future the standardization and stabilization studies on the leaf extract can be carried out which can help in improving its usage for varied medicinal usage (Rekha, Kollipara, & Gupta, 2014).

Formulation of novel value added products using betel leaves would be beneficial for the

food industry as well. The use of betel leaves in the food industry would create new opportunities for bringing in new ways of consuming the leaf. The betel leaf in itself is very nutritious but is often used only as a mouth-freshener since the olden days. With the advancement in technology and the gap between generations, the utility of betel leaf is restricted to being an ornamentation during traditional ceremonies, to be discarded later. Hence initiating the use of betel leaves in everyday recipes would help in the utilization of its nutritive value in this era of malnutrition.

Betel leaves are available at an affordable cost in local markets all over India. Hence it will be considered a prominent option during cooking if its nutritive value and the possibility of crafting dishes with the same are made familiar within the population.

Thus betel leaf place its position in nature same as our heart in our body and role the same with lots of biological activities and has a tremendous strength to come out as a future green medicine, hence *Piper betle. L.* leaf is regarded as "Green heart"(Dwivedi & Tripathi, 2014).

General objectives of the study

1. Recipe development and standardization of recipes.

2. Organoleptic analysis of formulated recipes.

3. Nutritional analysis of formulated recipes.

2. MATERIALS AND METHODS

The sample size for the present study was of 30 panelists in the age group of 18-25years of age in good health. It was conducted at Ethiraj College for Women, Egmore, Chennai, India,from January-March 2019. Due to convenience and accessibility of young adult population, the college was selected as the place of study.The panelists were invited for the tasting of the samples from 11a.m. to 12:30p.m. to ensure that they do not have any after-taste in their palettes from eating any other food product. Most panelists arrive at the college campus around 11 a.m. and may start having their lunch around 12:30-1p.m., hence the time frame of 11a.m to 12:30p.m. was considered to be ideal as the time of evaluation.

Standard and betel leaf incorporated recipes namely; standard parupu podi (pulse powder, usually consumed with rice) and betel leaf parupu poodi, standard moore (buttermilk) and betel leaf moore, standard stuffed paratha and betel leaf stuffed paratha, standard cutlet and betel leaf cutlet and standard coconut ladoo and betel leaf coconut ladoo were prepared.Standardized recipes were prepared after three trails of each individual recipe. The best quality of Vallaikodi betel leaves were purchased from a reputed local merchant in Mylapore (Chennai, India) for the preparation of betel leaf incorporated recipes. The incorporation of betel leaves was made in three different variations. The three different variations were 8g, 11g and 15g of betel leaves in powdered or liquid form. In the first variation, 1.5tsp of powdered betel leaves were used and have been converted to 8g; in the second variation, 2.25tsp of powdered betel leaves were used and have been converted to 11g; in the third variation, 3tsp of powdered betel leaves were used and have been converted to 15g.

A score card of nine point hedonic rating scale which assessed the following attributes: appearance, colour, flavour, taste and texture in the range of like extremely to dislike extremely was used to analyze the acceptability of the study.

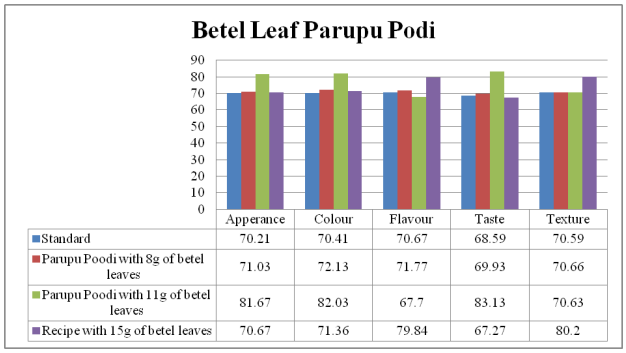
The nutrients present in the betel leaf incorporated recipes in three variations were assessed using the Indian Food Composition Tables published by the National Institute of Nutrition in 2017. The following nutrients were analyzed: carbohydrate, protein, fat, ascorbic acid, β-carotene, calcium and potassium.

The data collected was classified, tabulated and analyzed. The following are the statistical measures used in this study.

a) Arithmetic mean
b) Standard Deviation
c) ANOVA

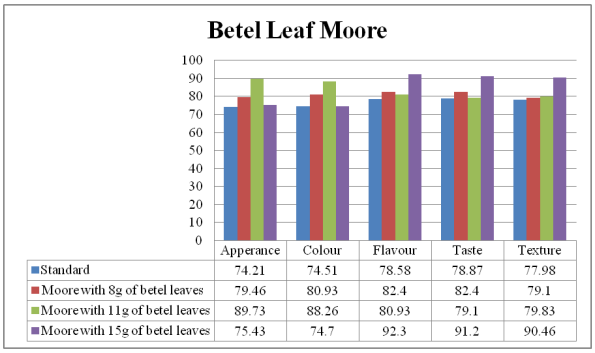
3. RESULTS AND DISCUSSION

The present study was carried out to standardize and formulate the recipes with the incorporation of betel leaves, to conduct a sensory evaluation and to compare the nutrients of the betel leaf incorporated recipes in different variations.The parameters evaluated were appearance, colour, flavour, taste and texture. The results were recorded and statistically tested for their significance. The level of significance considered for the study was $p<0.01$ and $p<0.05$.



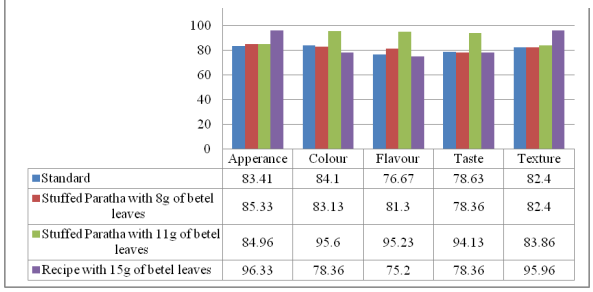
	Apperance	Colour	Flavour	Taste	Texture
Standard	70.21	70.41	70.67	68.59	70.59
Parupu Poodi with 8g of betel leaves	71.03	72.13	71.77	69.93	70.66
Parupu Poodi with 11g of betel leaves	81.67	82.03	67.7	83.13	70.63
Recipe with 15g of betel leaves	70.67	71.36	79.84	67.27	80.2

Figure 1: Acceptability of standard paruppu poodi with betel leaf paruppu poodi incorporated with 8g, 11g and 15g of betel leaves



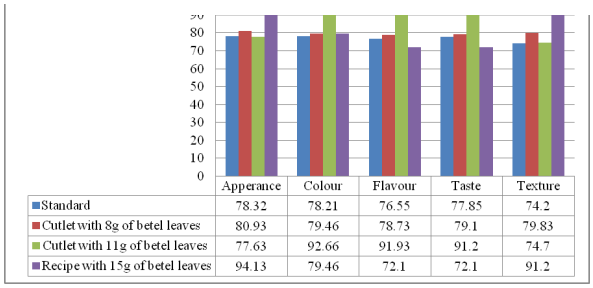
	Apperance	Colour	Flavour	Taste	Texture
Standard	74.21	74.51	78.58	78.87	77.98
Moore with 8g of betel leaves	79.46	80.93	82.4	82.4	79.1
Moore with 11g of betel leaves	89.73	88.26	80.93	79.1	79.83
Moore with 15g of betel leaves	75.43	74.7	92.3	91.2	90.46

Figure 2: Acceptability of standard moore with betel leaf moore incorporated with 8g, 11g and 15g of betel leaves



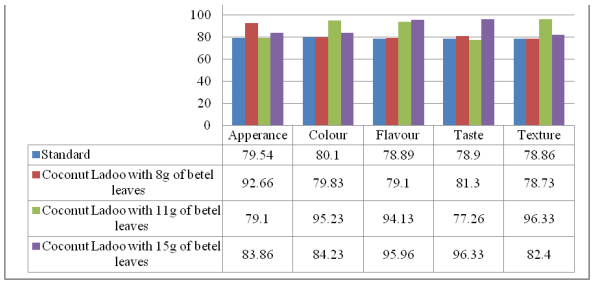
	Apperance	Colour	Flavour	Taste	Texture
Standard	83.41	84.1	76.67	78.63	82.4
Stuffed Paratha with 8g of betel leaves	85.33	83.13	81.3	78.36	82.4
Stuffed Paratha with 11g of betel leaves	84.96	95.6	95.23	94.13	83.86
Recipe with 15g of betel leaves	96.33	78.36	75.2	78.36	95.96

Figure 3: Acceptability of standard stuffed paratha with betel leaf stuffed parathaincorporated with 8g, 11g and 15g of betel leaves



	Apperance	Colour	Flavour	Taste	Texture
Standard	78.32	78.21	76.55	77.85	74.2
Cutlet with 8g of betel leaves	80.93	79.46	78.73	79.1	79.83
Cutlet with 11g of betel leaves	77.63	92.66	91.93	91.2	74.7
Recipe with 15g of betel leaves	94.13	79.46	72.1	72.1	91.2

Figure 4: Acceptability of standard cutlet with betel leaf cutlet incorporated with 8g, 11g and 15g of betel leaves



	Apperance	Colour	Flavour	Taste	Texture
Standard	79.54	80.1	78.89	78.9	78.86
Coconut Ladoo with 8g of betel leaves	92.66	79.83	79.1	81.3	78.73
Coconut Ladoo with 11g of betel leaves	79.1	95.23	94.13	77.26	96.33
Coconut Ladoo with 15g of betel leaves	83.86	84.23	95.96	96.33	82.4

Figure 5: Acceptability of standard coconutladoowith betel leaf coconutladooincorporated with 8g, 11g and 15g of

] incorporation of 11g and 15g of betel leaves in the standardized
1 s.

NUTRIENT ANALYSIS

Table2:Nutrient content of Betel Leaf Parupu Poodi (50g)

Amount of betel leaves	Carbohydrate (g)	Protein (g)	Fat (g)	Ascorbic Acid (mg)	β-carotene (µg)	Calcium (mg)	Potassium (mg)
8g	29.29	11.70	0.91	1.96	440	52.18	606.24
11g	29.47	11.77	0.93	2.69	580.25	58.06	626.58
15g	29.71	11.87	0.96	3.66	767.25	65.9	653.7

It can be inferred from the table that with the addition of betel leaves the values of ascorbic acid, β-carotene, calcium and potassium are heightened whereas there is no significant difference in the carbohydrate, protein and fat values.

Table 3: Nutrient content of Betel Leaf Moore (500ml)

Amount of betel leaves	Carbohydrate (g)	Protein (g)	Fat (g)	Ascorbic Acid (mg)	β-carotene (µg)	Calcium (mg)	Potassium (mg)
8g	14.19	12.92	20.22	8.81	1408.25	602.43	541.74
11g	14.37	12.97	20.24	9.54	1548.5	608.31	562.08
15g	14.61	13.09	20.27	10.51	1735.5	616.51	1188.75

It is observed from the table that with the addition of betel leaves the values of ascorbic acid, β-carotene, calcium and potassium are heightened whereas there is no significant difference in the carbohydrate, protein and fat values.

Table 4: Nutrient content of Betel Leaf Stuffed Paratha (225g)

Amount of betel leaves	Carbohydrate (g)	Protein (g)	Fat (g)	Ascorbic Acid (mg)	β-carotene (µg)	Calcium (mg)	Potassium (mg)
8g	100.86	1.67	12.47	45.21	783.15	106.38	545.6
11g	101.04	1.72	12.49	46.21	923.4	112.26	565.94
15g	101.28	1.84	12.52	46.91	1110.4	120.1	593.06

The inference from the table is that with the addition of betel leaves the values of ascorbic acid, β-carotene, calcium and potassium are heightened whereas there is no significant difference in the carbohydrate, protein and fat values

Table 5: Nutrient content of Betel Leaf Cutlet (220g)

Amount of betel leaves	Carbohydrate (g)	Protein (g)	Fat (g)	Ascorbic Acid (mg)	β-carotene (µg)	Calcium (mg)	Potassium (mg)
8g	69.62	10.14	15.62	32.06	834.5	63.48	511.84
11g	69.8	10.21	15.64	32.79	974.75	69.36	535.18
15g	70.04	10.31	15.67	33.76	1161.75	77.2	559.3

It can be inferred from the table that with the addition of betel leaves the values of ascorbic acid, β-carotene, calcium and potassium are heightened whereas there is no significant difference in the carbohydrate, protein and fat values.

Table 6: Nutrient content of Betel Leaf Coconut Ladoo (500g)

Amount of betel leaves	Carbohydrate (g)	Protein (g)	Fat (g)	Ascorbic Acid (mg)	β-carotene (µg)	Calcium (mg)	Potassium (mg)
8g	151.4	48.83	160.42	9.81	416	564.18	1756.74
11g	152.07	48.90	160.44	10.54	556.25	570.06	1770.08
15g	152.31	49.05	160.47	11.51	743.25	577.9	1804.2

It can be observed from the table that with the addition of betel leaves the values of ascorbic acid, β-carotene, calcium and potassium are heightened whereas there is no significant difference in the carbohydrate, protein and fat values.

Inference:

The taste of the betel leaves in the recipes was well accepted by the panelists. The savory items namely betel leaf parupu poodi, betel leaf cutlet and betel leaf stuffed paratha received positive feedback in terms of the spicy flavour of the product which suggests that increasing the amount of betel leaves to more than 15g may also be easily accepted by the population of young adults. The sweet dish (betel leaf coconut ladoo) also received positive feedback saying that the dish taste similar to a mint ball

and gives a sense of refreshment. Students seemed to enjoy both the betel leaf coconut lodoo with 11g of betel leaf and the one with 15g, which suggests that the amount of betel leaf can be increased more than 15g in future studies. The beverage, betel leaf moore, gained acceptability in terms of taste but quite a few did not like the colour of the betel leaf moore with 15g of betel leaves saying that it appears too dark in comparison to the standard moore. The rest of the aspects of the betel leaf moore were well accepted by the panelists consisting of young adults.

4. CONCLUSION

The present study looked into the avenue of nutrition in association with betel leaves with positive outcomes, proving that the betel vine once used only as a mouth freshener can be easily utilized in everyday meal pattern. As the betel vine is rich in calcium, ascorbic acid, β-carotene and potassium, these properties can be utilized to combat undernutrition.

From this study, it can be concluded that around 15g of betel leaves when incorporated in a recipe is successfully accepted by young adults. With the increase in the amount of betel leaves, the nutritive value also increases hence introducing these recipes to the population would be helpful for the community.

With the ever growing awareness about underutilized herbs and plants amongst the general public, there is a great commercial scope for producing and selling betel leaf incorporated recipes. As this is a locally available ingredient all over the country, betel leaf can be easily incorporated in everyday meals by kitchen gardening as well.

The study faced the following limitations: the amount of betel leaves incorporated could not be included in higher amounts due to its pungent taste; the acceptability trial was carried out with female panelist; supplementation effects were not studied.

Following suggestions can be incorporated in future researches: the present study was carried out only in Ethiraj College for Women, similar research can be carried out with panelists from different colleges in Chennai, India; the acceptability test of betel leaf incorporated recipes can be carried out with different age groups; the present study was carried out with only female participants, similar research can be carried out with male panelists; betel leaf incorporated recipes can be supplemented to support the literature on health benefits of betel leaves; betel leaves can be incorporated in more savory recipes as it was easier to mask the pungent taste of the leaf with appropriate spices.

ACKNOWLEDGMENT

First and foremost, I would like to thank the almighty for giving me strength and courage to complete this study successfully and showering his blessings throughout my life. I am extremely blessed to have wonderful and motivating parents **Mrs. M. Kalpakam** &**Mr. B. Muthu Subramanian** who always stood behind me and have gone out of the way to help me complete this Thesis.

I owe my gratitude, sincere and heartfelt thanks to **Mrs. Rajkala A. M.Sc., Assistant Professor**, Department of Clinical Nutrition & Dietetics, Ethiraj College for Women, Chennai, for valuable ideas and suggestion throughout this study, for her guidance, motivation and also for her help to perform a quality work in completing the dissertation.

I would like to thank **Mrs. Varalakshmi Rajam S. M.Sc, M.Phil.**, Assistant Professor and Head (Self-Supporting), Department of Clinical Nutrition & Dietetics, Ethiraj College for Women, Chennai, for her support.

I am grateful to **The Principal**, Ethiraj College for Women, for providing all the facilities available in the college to complete my study successfully. Special thanks to the subjects who willingly participated in my study for their co-operation and extended support. I express my thanks to my dear friends who were constantly motivating me to complete my study successfully.

I am indebted to **Mr. XavierM.Sc, M.Phil.**, Statistician, Loyola College, Chennai for helping me in doing the required statistical analysis.

I am highly indebted to all those who have contributed to my project directly and indirectly. I extend my sincere thanks to the management and the entire Department Staff Members.

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