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Development and sensory evaluation of tamarind leaf based chocolate for nutrient enrichment

B Harshitha, Janaki Srinath Puskuri, T Supraja, G Swarupa Rani and N Balakrishna

Abstract
Focusing on the problems of seasonal availability, quality and storage of leafy greens, dehydration has become the most used way of preservation. Confectionery has always been very popular industry and chocolate occupies major share in the market and happens to be an all time favourite for all age groups.Tamarind leaves are underutilized green leafy vegetables being rich sources of β carotene, minerals and fiber although used in cuisine seasonally. Because of increasing trend in the consumption of nutritious novel products an attempt was made to incorporate the Dehydrated tamarind leaves powder into the chocolate variants of Light, Dark, and Light, dark combination of 1:1 at 5%, 10% and 15% incorporation. Among all the developed chocolates, the 5% dehydrated tamarind leaf powder incorporation made with Light Dark compound combination (1;1) chocolate was the most acceptable with highest mean scores for majority attributes like Color, Glossy, Surface, Sweet, Flavour, Odour, Texture, Structure, Firmness, Break, Melting quality, Grainy, Astringency and Overall acceptance when compared with the other incorporations. The nutrient analysis of the most acceptable chocolate revealed that it had 1.33% of moisture, 3.56% of ash, 5.79% of protein, 26.64% of Fat, 2.06% of Crude fiber, 71.21% of Carbohydrates, 505.5 K cal of Energy and showed significant difference from the respective control chocolate. Addition of dehydrated tamarind leaf at 5% concentration has enriched the chocolate confectionery item with key nutrients such as fibre, ash, carbohydrates substantially and mildly increased protein, Fat and energy. Dehydrated Tamarind leaf incorporation into acceptable chocolates can pave way for value addition of under utilized abundantly available, traditionally consumed commonly available green leaves and help in nutrient enrichment of a confectionary item popular in vulnerable groups such as school age children and adolescent girls and boys.

Keywords: Dehydration, dehydrated green leafy powder, tamarind leaf powder, chocolate variants, light chocolate, dark chocolate, light and dark chocolate, confectionary, underutilized greens, sensory evaluation, novel food, nutrient enrichment, fibre rich chocolate, healthy confectionary

Introduction
"Tamarind", (*Tamarindus indica* L.) called as *Imli*/Indian date is a multipurpose plant. The pulp of the organic product is used as a flavor in Asian food, particularly in the southern states of India (Okello *et al*., 2017) [1]. It is the most popular food known for its unique flavor and the tartness of this makes any food delicious. Tamarind fruits are used in different products like pectin, tamarind juice concentrates tamarind powder, tartrates, tamarind kernel powder, tamarind paste (Deepak *et al*., 2016) [2]. Besides the domestic and industrial usage, tamarind pulp is a rich source of minerals and nutrients and the seeds have potential for the weight management and the fruits have Laxative and Anti coagulant properties.
Every part of the tree has its own benefits but leaves are most useful and are consumed as vegetable. Tamarind leaves are a great source of vitamins such as Vitamin C, ß-carotene and with high mineral content, especially magnesium, calcium, phosphorus, and potassium (Carvalho *et al*., 2020) [3]. As per Indian food composition data base 2017, 100 g of Tamarind leaves contain 5.8g of Protein, 1.25g of ash, 0.49g of Fat, 66.93 mg of Calcium, 2.84mg of Iron, 465 mg of Potassium, 13.43mg of Sodium, 0.93 mg of Zinc, 30 IU of Vitamin A and 28.22 mg of Vitamin C, polyphenols of 27.65 mg and Caffeic acid of 0.23 mg (IFCT, 2017) [4]. These leaves are preferably eaten when tender and are regularly used to make plates of mixed greens, curries furthermore soups. Adeniyi *et al*., 2021 [5] have reported that Tamarind leaves have antimicrobial, cell reinforcement and wound- healing properties. In order to preserve the green leafy vegetables with short storage quality, Dehydration is the most important technique used to preserve without the losses of the nutrients (Subhash and Neeha, 2014) [6]. Deepak *et al*., 2016 [2] has reported the Dehydrated Tamarind leaves contain good

amount of 4.65, Protein of 4.08 (g), 1.52 (g) of Fat, 1.0 (g)of crude fiber, 86.26 (g) of Carbohydrates, 375 (Kcal) of Energy, 2.5(g) of Ash, 166.8(µg) of β carotene, 2.40 (mg) of Vitamin C, 0.18 (mg) of Iron, 96(mg) of Calcium. Leng *et al.* has conducted a study on the antioxidant capacity and Total phenolic content of the fresh, Oven dried, Stir fried tamarind leaves and has reported that the leaves contains 39.30 mg/g, 47.73 mg/g and 139.7 mg/g of phenols respectively.

Chocolate is perhaps the most preferred food form, devoured by individuals of all ages. Chocolate products are the ubiquitous desserts and snacks worldwide made from the cocoa beans from the tree *Theobroma cacao*, a native tree to South America. (Talawar *et al*., 2021) [7]. Because of the regular and vast availability, rich healthy benefits of these tamarind leaves in India, an attempt was made to enrich chocolate with incorporation of these dehydrated leaves into the chocolate variant compounds like Light, Dark and combination of Light and dark (1:1).

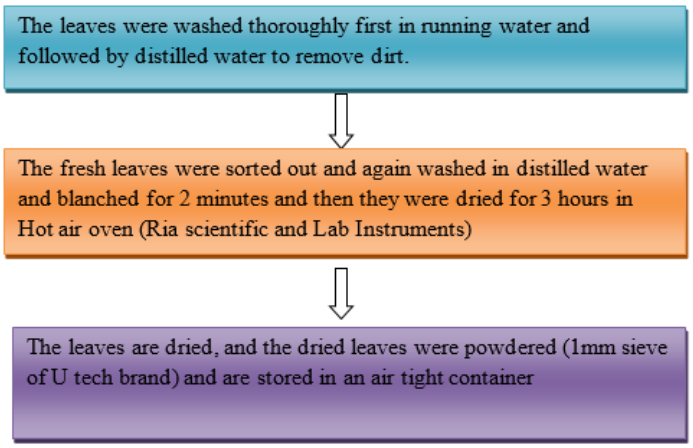
Materials and Methods

Tamarind leaves were procured from the local market, Premavathipet, Rajendranagar and the chocolate slabs were procured from the Morde brand for Light compound and 2m Cocoa Brand for dark compound Amazon store Hyderabad.

The chocolate compounds used for the study were Light, Dark, and combination of Light and Darkin the ratio of (1:1). Dehydrated tamarind leaves powder which was prepared according to the procedure described by Len *et al*., 2017 was incorporated at 5%, 10%, 15% into the different chocolate compounds. Chocolate was prepared according to the procedure described by Shah, R., 2021.

Primary processing

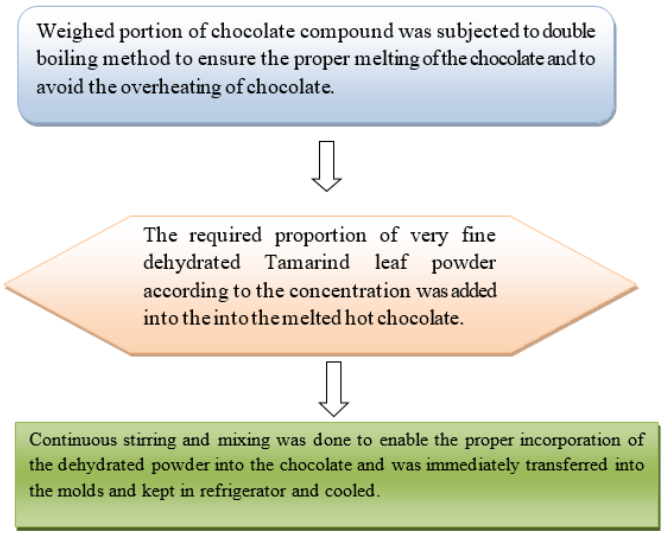
Preparation of dehydrated green leaves: (Leng *et al*., 2017) [8].



Preparation of Tamarind leaf incorporated chocolate

The incorporation of the dehydrated tamarind leaf powder was done in the three variants of chocolate compound i.e., Light, Dark and Light and dark (1:1) combination with the formulations at 0%, 5%,10%,15% concentrations.

Preparation of Chocolate: (Shah, R.2021) [9].



Sensory evaluation

Sensory properties play an important role for the acceptance, likeability and defining the quality standards of chocolate. Because of its unique characteristics, there are many of the sensory, oral, tactile attributes which are sorted out mainly to distinguish how each of the attribute plays an important role in defining the overall choice and preference of the chocolate. Based on studies of Popov-Raljic and Lalicic-Petronijevic., 2009 [10], Kissiedu *et al*., 2020 [11], Ilmi *et al*., 2016 [12] the following attributes were chosen as appropriate to define the

anticipated attributes i,e Appearance (Form, color, Glossy, Surface) Taste(Bitter, Sweet) Flavor (Aroma, Odour) Texture(Structure, firmness, break) Melting quality (Mouth feel, Thickness, Smoothness, Grainy, Mouth coating, Residue remaining), Astringency and Overall acceptability. Sensory evaluation was carried out at PGRC, PJTSAU, by 5 trained and 15 semi trained panelists using 9- point hedonic scale which consisted of scores from 1-9 were 1, being Dislike extremely and 9, being like extremely. As described by the method of Meilgaard *et al*., 1999 [13], sensory panelists were asked to score the product based on the above listed sensory attributes. Each chocolate product was coded with 3 digit unique number for sensory evaluation and the sensory panel members were provided with water and Salt biscuits to rinse their mouth between each sample tasting and to avoid the overlapping of the tastes. (Kissiedu *et al*. 2020) [11].

Proximate analysis: Further based on the sensory evaluation, the best combination of chocolate incorporation with high mean scores of majority of the attributes was evaluated for the proximate analysis as follows. Moisture by AOAC 2005 [14] method, Ash by AOAC 2005 [14] method, Protein by AOAC 2005 [14] method, Fat by AOAC 1997 [15], Crude fiber by AOAC 2005 [14], Carbohydrates by AOAC 1980 [15], and Energy by AOAC 1980 [16].

Results: The results of the sensory evaluation and proximate analysis are statistically analyzed and enumerated in Table 1,Table 2, Table 3 & Table 4

Light Compound Combinations

The results of the Light compound combinations are enumerated in Table 1. Among the light compound dehydrated tamarind leaves incorporated combinations 10% and 15% were significantly different with control as regards the attribute of Appearance, however 5% incorporated chocolate was not significantly different with control. For the sensory attribute of Form all the dehydrated tamarind leaves incorporated combinations of 5, 10, and 15% were significantly different with respect to control. For the sensory attribute of Colour, only 15% dehydrated tamarind leaves incorporated compound was significantly different from control where as 5, 10% incorporation has not showed any difference. All the combinations were significantly different with control as regards the sensory attribute of Glossiness. As regards the sensory attribute of surface, only 5% incorporation of dehydrated tamarind leaves powder combinations showed no significance difference, while 10 and 15% incorporations were significantly different with control. With regards to the attributes Taste, Bitter, Sweet, Flavour and Aroma all the dehydrated tamarind leaves incorporated light compound combinations of 5, 10, 15% showed significant difference with respect to the controls. For the sensory attributes of odour, Texture, only 5% showed no significant difference with control were as 10, 15% were significantly different with respect to controls among all the dehydrated tamarind leaves powder incorporated chocolate combinations. With regards to the attribute Structure all the dehydrated tamarind leaves incorporated combinations of 5, 10 and 15% showed significant difference with respect to control. For the sensory attributes like Firmness, Break only 5% incorporation of dehydrated tamarind leaves powder showed no significance difference with respect to control were as 10, and 15% showed significant difference with respect to control. With regards to the attributes like Melting quality, Mouth feel, Thickness, Smoothness, Grainy, Mouth Coating, Residue remaining, Astringency, Overall acceptability all the combinations of 5, 10 and 15% showed significant difference with respect to the control of light chocolate.

Table 1: Mean scores of Light compound combinations

% Incorporation	0	5	10	15	CD Value
Attributes					
Appearance	8.80±0.523^{a}	8.55±0.510^{a}	8.30±0.733^{b}	8.20±0.834^{c}	0.33
Form	8.80±0.410^{a}	8.40±0.598^{b}	8.30±0.657^{c}	8.45±0.605^{d}	0.34
Color	8.70±0.571^{a}	8.50±0.607^{a}	8.45±0.686^{a}	8.35±0.671^{b}	0.37
Glossy	8.75±0.550^{a}	8.35±0.587^{b}	8.25±0.639^{c}	8.20±0.696^{d}	0.36
Surface	8.85±0.366^{a}	8.55±0.510^{a}	8.30±0.733^{b}	8.40±0.681^{c}	0.37
Taste	8.95±0.224^{a}	8.10±0.553^{b}	8.00±0.858^{c}	7.40±0.995^{d}	0.49
Bitter	8.85±0.366^{a}	8.35±0.671^{b}	8.15±0.745^{c}	7.55±0.999^{d}	0.48
Sweet	8.75±0.444^{a}	8.25±0.716^{b}	7.85±0.671^{c}	7.40±0.995^{d}	0.46
Flavour	8.75±0.444^{a}	8.00±0.649^{b}	8.00±0.858^{c}	7.45±0.759^{d}	0.44
Aroma	8.85±0.366^{a}	8.05±0.686^{b}	7.90±0.718^{c}	7.35±0.813^{d}	0.42
Odour	8.40±2.010^{a}	8.05±0.686a	7.80±0.834^{b}	7.45±0.826^{c}	0.56
Texture	8.65±0.489^{a}	8.40±0.681^{a}	8.10±0.718^{b}	7.90±0.912^{c}	0.44
Structure	8.85±0.366^{a}	8.40±0.681^{b}	8.10±0.718^{c}	7.85±0.988^{d}	0.42
Firmness	8.70±0.470^{a}	8.40±0.598^{a}	8.20±0.768^{b}	7.95±0.759^{c}	0.42
Break	8.80±0.410^{a}	8.40±0.503^{a}	8.15±0.745^{b}	8.00±0.795^{c}	0.40
Melting quality	8.80±0.410^{a}	8.30±0.733^{b}	8.05±0.759^{c}	7.75±0.851^{d}	0.40
Mouth feel	8.90±0.308^{a}	8.40±0.754^{b}	8.00±0.973^{c}	7.55±0.826^{d}	0.43
Thickness	8.80±0.410^{a}	8.20±0.696^{b}	8.05±0.686^{c}	7.65±0.671^{d}	0.39
Smoothness	8.85±0.366^{a}	8.25±0.786^{b}	7.65±0.587^{c}	7.20±0.834^{d}	0.40
Grainy	8.95±0.224^{a}	8.05±0.686^{b}	7.55±0.686^{c}	7.05±0.887^{d}	0.41
Mouth coating	8.80±0.410^{a}	8.00±0.795^{b}	7.55±0.826^{c}	7.30±1.081^{d}	0.48
Residue remaining	8.95±0.224^{a}	7.95±0.605^{b}	7.45±0.759^{c}	7.15±0.813^{d}	0.41
Astringency	8.90±0.308^{a}	8.00±0.725^{b}	7.60±0.940^{c}	7.60±1.046^{d}	0.47
Overall acceptability	8.85±0.366^{a}	8.20±0.696^{b}	7.60±0.821^{c}	7.35±0.813^{d}	0.41

Note: -Values are expressed as means± standard deviation

-Variations in super scripts indicate $p< 0.05$ significance of mean differences across concentrations

LC: Light Chocolate

Dark compound combinations

The results of the Dark compound combinations are enumerated in Table 2. Among the Dark compound incorporated combinations with dehydrated Tamarind leaves powder the 5,10% showed no significant difference with control and only 15% incorporation showed significant difference with respect to control with regards to the attribute Appearance. For the sensory attributes Form, Colour, Glossy among the dark combinations only 5% incorporated dehydrated tamarind leaves powder combination showed no significance but 10 and 15% showed significant difference with control. Regarding surface attribute, among the incorporated dehydrated Tamarind leaves powder combinations, the 5 and 10% combinations were not significantly different were as 15% showed the significant difference with respect to control. With regards to the attribute, Taste all the dehydrated tamarind leaves powder incorporated combinations showed significant difference with control. For the sensory attribute Bitter, only 5% showed no significance difference with respect to control were as 10, 15% showed significant difference with control. Among all the dehydrated tamarind leaves powder incorporated combinations, for the sensory attributes like Sweet, Flavour, Aroma, Odour, Texture the 5,10 and 15% showed significant difference from the control. With regards to the Structure, 5% incorporation of dehydrated tamarind leaves powder combination showed no significance difference with respect to control where as 10 and 15% showed significant difference. Among all the dehydrated Tamarind leaves powder incorporated dark compound combinations all 5, 10 and 15% showed significant difference with respect to the control for the sensory attribute of Firmness. With regards to the sensory attributes Break and Melting Quality only 5% incorporation of dehydrated Tamarind leaves powder showed no significance difference with respect to control were as 10, 15% showed significant difference with control. For the sensory attribute, Mouth Feel among the dehydrated Tamarind leaves incorporated combinations all 5, 10, 15% showed significant difference with control. With regards to the attributes like Thickness, Smoothness, Mouth Coating and Astringency the 5% incorporation showed no significance where as 10 and 15% incorporation showed significant difference with respect to the control among the dehydrated tamarind leaves powder incorporated dark combinations. With regards to the attributes like Grainy, Residue remaining, overall acceptance all the combinations incorporated with dehydrated tamarind leaves powder the 5, 10 and 15% showed significant difference with dark chocolate control among all the combinations.

Table 2: Mean scores of Dark compound combinations

% Incorporation	0	5	10	15	CD Value
Attributes					
Appearance	8.85±0.366^{a}	8.70±0.571^{a}	8.55±0.605^{a}	8.25±0.967^{b}	0.33
Form	8.70±0.470^{a}	8.55±0.686^{a}	8.25±0.786^{b}	8.05±1.146^{c}	0.34
Color	8.80±0.410^{a}	8.55±0.686^{a}	8.25±0.851^{b}	8.10±1.021^{c}	0.37
Glossy	8.65±0.489^{a}	8.45±0.686^{a}	8.25±0.786^{b}	8.15±0.988^{c}	0.36
Surface	8.60±0.503^{a}	8.65±0.671^{a}	8.25±0.786^{a}	7.95±1.146^{b}	0.37
Taste	8.75±0.444^{a}	8.15±0.988^{b}	7.80±1.105^{c}	7.20±1.196^{d}	0.49
Bitter	8.25±0.851^{a}	7.95±0.887^{a}	7.60±0.995^{b}	7.30±1.174^{c}	0.48
Sweet	8.85±0.366^{a}	8.20±0.951^{b}	8.05±1.050^{c}	7.20±1.056^{d}	0.46
Flavour	8.80±0.410^{a}	7.95±0.945^{b}	7.85±0.875^{c}	7.45±1.050^{d}	0.44
Aroma	8.70±0.470^{a}	7.95±0.887^{b}	7.70±0.923^{c}	7.35±0.933^{d}	0.42
Odour	8.85±0.366^{a}	8.00±0.858^{b}	7.70±0.923^{c}	7.35±0.988^{d}	0.56
Texture	8.75±0.444^{a}	8.15±0.813^{b}	8.10±0.968^{c}	7.80±1.005^{d}	0.44
Structure	8.70±0.470^{a}	8.40±0.754^{a}	8.25±0.786^{b}	7.85±1.040^{c}	0.42
Firmness	8.80±0.410^{a}	8.35±0.671^{b}	8.25±0.786^{c}	7.70±1.031^{d}	0.42
Break	8.75±0.550^{a}	8.45±0.605^{a}	8.10±0.852^{b}	7.90±1.021^{c}	0.40
Melting quality	8.75±0.444^{a}	8.35±0.671^{a}	7.95±0.826^{b}	7.90±1.021^{c}	0.40
Mouth feel	8.75±0.444^{a}	7.95±0.605^{b}	7.85±0.813^{c}	7.30±0.979^{d}	0.43
Thickness	8.70±0.470^{a}	8.40±0.681^{a}	8.10±0.788^{b}	7.65±0.988^{b}	0.39
Smoothness	8.50±0.513^{a}	8.15±0.587^{a}	8.00±0.725^{b}	7.15±0.933^{c}	0.40
Grainy	8.85±0.366^{a}	8.05±0.759^{b}	7.55±0.686^{c}	6.80±0.768^{d}	0.41
Mouth coating	8.60±0.503^{a}	8.30±0.801^{a}	7.65±0.813^{b}	7.05±1.099^{c}	0.48
Residue remaining	8.80±0.410^{a}	8.25±0.444^{b}	7.45±0.759^{c}	7.10±0.968^{d}	0.41
Astringency	8.50±0.513^{a}	8.20±0.616^{a}	7.80±0.834^{b}	7.40±1.142^{c}	0.47
Overall acceptability	8.85±0.366^{a}	8.25±0.716^{b}	7.80±0.951^{c}	7.05±0.759^{d}	0.41

Note: -Values are expressed as means± standard deviation

-Variations in super scripts indicate $p< 0.05$ significance of mean differences across concentrations

DC: Dark chocolate

Light, Dark Compound Combination (1:1)

The results of the Light, Dark compound combination in the ratio of 1:1 are enumerated in Table 3. Among the light-dark compound dehydrated Tamarind leaves incorporated combinations only 5% showed no significant difference with control and 10,15% were significantly different with control with regards to the attribute of Appearance. For the sensory attribute of Form among the dehydrated Tamarind leaves powder incorporated light and Dark combinations all 5,10,15% showed significant difference with control. With regards to the attributes Colour, Glossy, and Surface among all the dehydrated Tamarind leaves powder incorporated light and Dark combinations only 5% showed no significance were as 10 and 15% showed significant difference with control. Among the dehydrated Tamarind leaves powder incorporated light and Dark combinations for the sensory attribute Taste all the incorporations 5, 10 and 15% were significantly different with control. With regards to the sensory attribute Bitter and

Sweet only 5% incorporation showed no significance were as 10 and 15% showed significant difference with respect to the control. For the sensory attributes like Flavour and Texture among the dehydrated Tamarind leaves powder incorporated combinations all 5, 10, and 15% showed significant difference with control. Further with regards to the sensory attributes like Aroma Odour, Structure, Firmness, Break, Melting quality, Mouth feel, Thickness and Astringency only 5% incorporation showed no significance were as 10 and 15% showed significant difference with respect to the control. For attributes such as Smoothness, Grainy, Mouth coating, Residue remaining and overall acceptance all the dehydrated Tamarind leaves powder incorporated combinations showed significant difference with respect to the light, dark combined (1:1) control among all the combinations.

Table 3: Mean scores of Light-dark compound combinations

% Incorporation Attributes	0	5	10	15	CD Value
Appearance	8.95±0.224^{a}	8.65±0.489^{a}	8.75±0.444^{b}	8.45±0.686^{c}	0.33
Form	8.95±0.224^{a}	8.60±0.503^{b}	8.65±0.489^{b}	8.45±0.605^{c}	0.34
Color	8.85±0.366^{a}	8.70±0.470^{a}	8.50 ±0.688^{a}	8.30±0.733^{b}	0.37
Glossy	8.75±0.444^{a}	8.70±0.470^{a}	8.50±0.607^{a}	8.25±0.851^{b}	0.36
Surface	8.85±0.366^{a}	8.70±0.470^{a}	8.45±0.605^{b}	8.30±0.801^{c}	0.37
Taste	8.75±0.716^{a}	8.15±1.040^{b}	7.75±1.020^{c}	7.25±1.020^{d}	0.49
Bitter	8.50±0.827^{a}	8.30±0.865^{a}	7.65±0.875^{b}	7.10±1.021^{c}	0.48
Sweet	8.80±0.523^{a}	8.35±0.745^{a}	7.95±0.759^{b}	7.40±0.995^{c}	0.46
Flavour	8.85±0.366^{a}	8.40±0.598^{b}	7.90±0.788^{c}	7.40±1.142^{d}	0.44
Aroma	8.80±0.410^{a}	8.50±0.688^{a}	8.05±0.759^{b}	7.25±1.020^{c}	0.42
Odour	8.70±0.470^{a}	8.55±0.686^{a}	7.85±0.745^{b}	7.20±0.894^{c}	0.56
Texture	8.85±0.366^{a}	8.40±0.598^{b}	8.05±0.887^{c}	7.40±1.142^{d}	0.44
Structure	8.90±0.308^{a}	8.55±0.605^{a}	8.05±0.759^{b}	7.70±1.129^{c}	0.42
Firmness	8.85±0.366^{a}	8.45±0.605^{a}	8.20±0.834^{b}	7.80±1.152^{c}	0.42
Break	8.80±0.410^{a}	8.55±0.686^{a}	8.00±0.795^{b}	7.75±1.118^{c}	0.40
Melting quality	8.70±0.470^{a}	8.60±0.598^{a}	8.20±0.894^{b}	7.85±0.875^{c}	0.40
Mouth feel	8.75±0.444^{a}	8.35±0.671^{a}	8.20±0.834^{b}	7.35±0.933^{c}	0.43
Thickness	8.70±0.470^{a}	8.35±0.671^{a}	8.15±0.671^{b}	7.25±0.910^{c}	0.39
Smoothness	8.85±0.366^{a}	8.25±0.639^{b}	8.00±0.725^{c}	7.10±0.912^{d}	0.40
Grainy	8.75±0.444^{a}	8.20±0.834^{b}	7.65±0.933^{c}	6.85±0.745^{d}	0.41
Mouth coating	8.70±0.470^{a}	8.15±0.745^{b}	8.00±0.973^{c}	7.05±0.826^{d}	0.48
Residue remaining	8.85±0.366^{a}	8.00±0.795^{b}	7.55±0.826^{c}	7.00±0.858^{d}	0.41
Astringency	8.75±0.444^{a}	8.35±0.745^{a}	7.85±0.813^{b}	7.25±1.164^{c}	0.47
Overall acceptability	8.90±0.308^{a}	8.25±0.639^{b}	7.80±0.834^{c}	6.85±0.933^{d}	0.41

Note: -Values are expressed as means± standard deviation
-Variations in super scripts indicate $p< 0.05$ significance of mean differences across concentrations
LDC: Light and Dark chocolate

Among all the Tamarind leaf incorporated combinations with light, dark and light, dark combined (1:1) at 5, 10 and 15% incorporations, data analysis of sensory evaluation of all the attributes, TLDA (5% incorporation of Light-dark compound combination) showed high acceptance with majority of high scores for the attribute with no significant difference with respect to the light, dark combined control. Similarly 10%, 15% also showed high mean scores but were significantly different from control. All attributes are depicted in the Figure No 1.

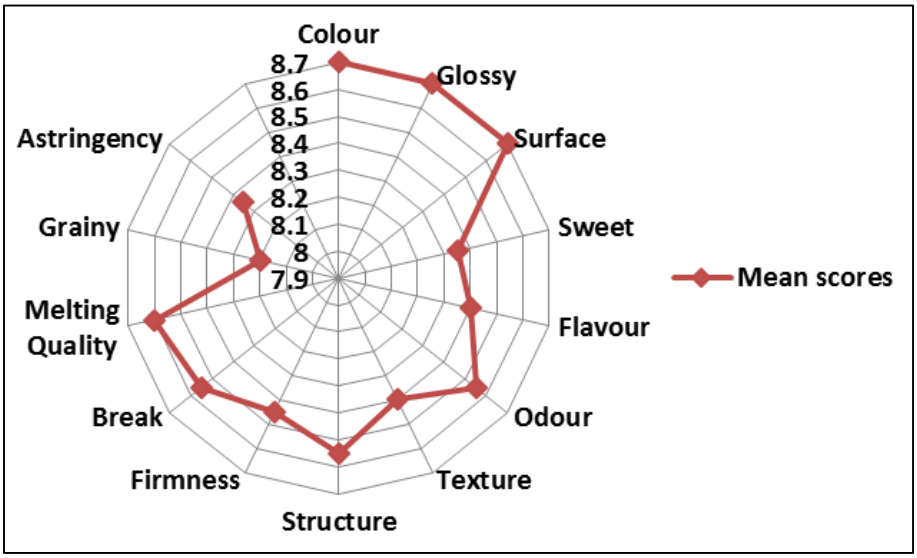


Fig 1: Mean scores of Sensory attribute of the best combination of 5% incorporation of Tamarind Leaves in Light dark (1:1) combination chocolate.

The results of proximate composition of the best accepted chocolate is depicted in Table 4..The results of the proximate analysis of the best accepted chocolate showed 1.33% of moisture, 3.56% of ash, 5.79% of protein, 26.64% of Fat, 2.06% Crude fiber of 2.06%, 71.21% of Carbohydrates, 505.5% of Energy and showed significant difference with respect to control Values.

Table 4: Proximate Composition of Selected Chocolate

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre(%)	Carbohydrates (%)	Energy (Kcal/100g)
LDC	1.4±0.01[a]	3.51±0.15[a]	5.65±0.02[a]	25.02±1.7[a]	0.99±0.02[a]	63.40±0.76[a]	501.4±0.6[a]
TLDA	1.3±0.01[b]	3.56±0.02[a]	5.79±0.01[b]	26.64±0.0[b]	2.06±0.03[b]	71.21±0.01[b]	505.5±0.2[b]
P value	0.00	0.01	0.00	0.00	0.00	0.00	0.00

Note: -Value are expressed as Means ±standard deviation of three determinants.
-Variations in super scripts indicate significant mean differences $p< 0.05$.
-Abbreviations: LDC: Light and Dark chocolate control, TLDA: Tamarind Leaves 5% light and Dark.

Discussion

Sensory evaluation helps to interpret the reactions of people to the products which are perceived by senses and to evaluate the product scientifically according to the characteristic attributes. According to the results the most commonly accepted formulation was 5% ($p>0.05$) incorporation of dehydrated tamarind leaves powder compared to 10% and 15% incorporation. The results were equipollent with the study conducted by Khan *et al*., 2019 [17] on the incorporation of moringa leaf powder into the chocolate. Abou-Zaid and Nadir, 2014[18] have reported that when Moringa leaf powder was incorporated in protein and mineral rich chocolate and Halawa tahinia at 10, 20 and 30% concentrations, the 20% incorporation has shown the highest acceptance with the sensory attributes like Color, Odour, Texture, Taste, Mouth feel and Overall acceptability. However, among the incorporation of 30% of moringa leaf powder the sensory attributes showed a significant reduction especially for the attributes like Color and Taste. Deepak *et al*., 2018 [19] has also reported that the tamarind leaf powder incorporation of 20% into Bengal gram chutney powder, Niger seed chutney powder, Hurigalu (a combination of raosted whole pulse used as snack) has scored the highest in all the attributes like appearance, color, texture, aroma, taste.

According to the results, of our study 10 and 15% incorporation of dehydrated Tamarind leaves powder in the chocolate has received similar mean scores as 5% and showed low mean scores for the attributes like Taste, Bitter, Aroma, odour, Mouth feel, Thickness, Smoothness, Grainy, Mouth coating, Residue remaining, Astringency and overall acceptability and showed High scores for the attributes like Appearance, Form, Color, Glossy, Surface, Sweet, Flavour, Structure, Firmness, Break and Melting quality. Addition of Dehydrated tamarind leaves powder at 5% is equal to adding 16 g of fresh green leafy vegetables which almost gives about 0.928 g of protein, 0.2 g of ash, 0.07g of fat, 10.70 mg of calcium, 0.45 mg of iron, 74.4 mg of potassium, 2.14 mg of sodium, 0.14 mg of zinc, 3.55 mg of vitamin C for 100g of chocolate. Further research can be done to improve these attributes to enhance acceptability because incorporation at 15% level will lead to equivalent of adding 48 g of fresh green leafy vegetables/100 g chocolate which can substantially enrich the micro nutrients and fibre. For the combination of the chocolate we used 50g of light and 50 g of dark chocolate but when compared with light chocolate, the light and Dark combination chocolate is rich in Fiber, Flavanoids, Phenols and has Less sugar which is nutritious and has good health benefits which can be helpful for the children and also for the adults.

Conclusion

The final most accepted chocolate was selected based on the sensory scores given by the panel members. Being the most inexpensive source of nutrients like vitamins, minerals, dietary fiber, Green leafy vegetables helps to fight against the micronutrient deficiencies. Taking into consideration of the local abundant availability of the tamarind leaves and due to the increase in consumer demand for the consumption of the confectionery foods like snack bar and chocolates, an attempt was made to develop chocolate with the incorporation of the dehydrated tamarind leaves powder which supplemented the nutrients like Fiber, Protein, Minerals, Vitamin C and antioxidants. Consumption of 20 g of tamarind leaves incorporated chocolate is equals to nearly the consumption of 3.21 g of fresh tamarind leaves which is a quite substantial amount of the intake through chocolate as a confectionary and dessert. Because of the low usage of the tamarind leaves when compared with the tamarind fruit, the leaves which are high in vitamins and minerals can be incorporated into products in the dehydrated form and eventually the consumption of these leaves can be improved paving way for value addition and nutrient enrichment of a underutilised abundant, traditionally accepted green leaf.

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