International Journal of Home Science 2024; 10(3): 514-517

International Journal of Home Science

ISSN: 2395-7476
IJHS 2024; 10(3): 514-517

www.homesciencejournal.com
Received: 08-11-2024
Accepted: 10-12-2024

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Nutritional evaluation and sensory characteristics of value added food products developed from dehydrated beet leaves

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Abstract
Beet leaves belongs to order Cryophyllales. Its botanical name is *Beta vulgaris* it is cool wheather crop. The beet greens are rich in nutrients as well as antioxidants which is usually discarded by people due to lack of knowledge about its nutritional importance. The present study was carried out with the objective (I) to dehydrate beet leaves and find out the compositional changes after dehydration (ii) to develop value added food products by incorporating dehydrated beet leaves, (iii) to assess the organoleptic quality of added food products (iv) to find out the nutritive value of value added food products incorporated with dehydrated beet leaves. The fresh leaves were tray dried at the temperature of 50-60°C for 3-4 hours. The dehydrated beet leaves were evaluated for the nutrients such as moisture, carb, fat, protein, crude fibre, iron, calcium and vitamin C respectively. It was observed that the moisture and vitamin C content of the leaves were decreased while the other nutrients were significantly increased. Organoleptic properties were analyzed by 9 point hedonic scale. On the basis of findings, T_0 (control), T_1 (5%), T_2 (10%), T_3 (15%) & T_4 (20%) T_0 was found to best in the case of colour, texture, flavour, taste and overall accpetibility while T_1 and T_2 were liked very much as compared to T_3 & T_4 while the nutrient content of T4 was highest among all the incorporation.

Keywords: Beet root leaves, treatment, replication, value added product, nutrients

Introduction
Dark green leafy vegetables are perhaps the most potent super food on the planet. They are also the most ignored and avoided foods as well. Green leaves are the food factory and heart of a plant where everything needed by its, is synthesized. Green leafy vegetables are comparatively cheap yet bountiful. Dark green leafy vegetables are an excellent source of fiber, folate, and carotenoids. These vegetables also contain vitamin C and K and the minerals iron and Calcium. In addition the dark green leafy vegetables act as antioxidants in the body. The substances in the dark green leafy vegetables remove free radicals from the body before they become harmful**.** Beet is known for its root as a source of nutrient but the leaves of beetroot contain good amount of micronutrients. Among all the leafy vegetables beet greens are one of the major source of micro nutrients which was first cultivated by Mediterranean (sea beets) for their edible leaves. Beet varieties of the early 1800s are still available today. The *Victory Seed Catalog* lists *Early Wonder Tall Top* that was introduced to the U.S. in 1811. Beetroot is a cool-weather crop that is hardy and tolerates some freezing. It grows best in spring and autumn, but does well in summer on the Highveld and in winter in the Lowveld. Excessively hot weather causes the appearance of alternating light and dark red concentric circles in the root known as zoning. On the other hand, very cold weather results in slow or no growth of the plant. Prolonged periods of low temperatures during winter can induce bolting. Beetroot seeds germinate at soil temperatures from 4, 5 to 30 °C, with the optimum being 18 to 24 °C.

The pigments that give beets their rich colors are called *betalains*. There are two basic types of betalains: betacyanins and betaxanthins. Betacyanins are pigments are red-violet in color. Betanin is the best studied of the betacyanins. Betaxanthins are yellowish in color. In light or dark red, crimson, or purple colored beets, betacyanins are the dominant pigments.

In yellow beets, betaxanthins predominate, and particularly the betaxanthin called vulgaxanthin. All betalains come from the same original molecule (betalamic acid).

Beets' sweet taste reflects their high sugar content, which makes beets an important source for the production of refined sugar (yet, the beets that are used for sugar consumption are of a different type than the beets that you purchase in the store). Raw beet roots have a crunchy texture that turns soft and buttery when they are cooked. The greens attached to the beet roots are delicious and can be prepared like spinach or Swiss chard. They are incredibly rich in nutrients, concentrated in vitamins and minerals as well as carotenoids such as beta-carotene and lutein/zeaxanthin.

Beets have proven to inhibit the growth of tumors, by preventing chemically induced cancers of the liver, skin, spleen and lungs. Beets are one of the richest sources of glutamine, a detoxifying amino acid essential to the health and maintenance of the intestinal tract. It helps in reducing markers of chronic inflammation, which damage blood vessels and can lead to conditions including heart disease, Alzheimer's, and Type-2 diabetes. It can increase the activity of two important enzymes in the liver, which protect liver cells from free radical attack. The powerhouse root also holds promise for staving off cardiovascular disease. In animal studies, beet-rich diets have led to benefits in cholesterol levels. In one study, total cholesterol dropped 30 percent, while HDL, or "good" cholesterol increased significantly.

Betaine also benefits the liver. It may help protect against fatty deposits in the liver, such as those that result from chronic alcohol use. Studies have shown that diets high in beets increase the activity of two detoxifying enzymes in the liver, which protect liver cells from free radical attack.

Today beet roots are used as a universal cure-all and are used in the treatment of AIDS. Beets is recommended as a general tonic and help disorders of the blood, are an effective detoxifier and recommended to relieve constipation because of their high fiber content. Because beets were "so appreciated by the ancients," they are recorded to have been offered on a silver tray to the Greek god, Apollo in his temple at Delphi, and eaten by Aphrodite to retain her beauty. According to legend, the Delphic oracle told Apollo, *"The radish is worth its weight in lead, the beet its weight in silver, the horseradish its weight in gold."*

Beetroot may be used for other things besides eating the greens and roots. Included are beetroot wine, beetroot crisps, and coloring for pasta. A pleasant wine and domestic ale can be brewed from Mangolds. They contain a considerable amount of alcohol when distilled. Sugar from sugar beets is also used to make "rum" (known as *tuzemak* in Switzerland) and a rectified spirit and vodka. Beets contain a pigment called *betalains* that is used for dyes. Betalains are a combination of a purple pigment (betacyanin) and a yellow pigment (betaxanthin). The dyes have been used for industrial red food colorants for improving the color of sauces and tomato paste, jams and jellies, and desserts and breakfast cereals. There are plans in the United Kingdom by BP and Associated British Foods to produce biobutanol (an alternative fuel) from surpluses of agricultural sugar beets.

The present research is carried out with the following objectives: (a) To dehydrate beet leaves and find out the compositional changes among the green and dehydrated beetroot leaves. (b) To develop value added food products by incorporating dehydrated beetroot leaves. (c) To assess the organoleptic quality of the value added food products. (d) To find out the nutritive value of value added food products made with dehydrated beet leaves. (e) To Study the shelf life of developed food product.

Methodology

Beet leaves were dehydrated by tray drying and nutrient analysis of dehydrated beet leaves was done for carbohydrates, fat, protein, crude fibre, by AOAC method calcium and iron by AAS method and Vitamin C by Dimethode. Four value added food products were made namely nimki, chura fry, stuffed capsicum, and incorporated with dehydrated beet leaves as T_o (control), T_1 (5%), T_2 (10%), T_3 (15%) and T4(20%) to increase their nutritive value. The organoleptic test was done by using 9 point hedonic scale. The nutritive value of carbohydrate, fat, protein, ash, crude fibre, iron calcium, Vitamin C was estimated. The optimum temperature for dehydrating beet leaves was set to 50-60°C for 3-4 hours. The moisture content decreased to 6.8% and vitamin C to 57.8mg. There was increased in other nutrients such as carbohydrate, fat, protein, crude fibre, ash, calcium, iron respectively in comparison to the nutritive value of fresh leaves.

Result and Discussion

Table 1: Proximate composition of dehydrated beet leaves per 100 gm

	Dehydrated Beet Leaves Per 100g			Mean
	R1	R2	R3	
Moisture (%)	6.3	6.6	6.4	6.4
Protein (g)	22.01	22.36	22.31	22.22
Carbohydrate (g)	44	45	43.8	44.26
Crude fibre (g)	7.88	7.42	7.96	7.75
Ash (g)	23.6	22.30	22.37	22.75
Calcium (mg)	1627	1630	1580	1612.3
Iron (mg)	105	106	102	104.33
Vitamin C(mg)	58.5	55	58	57.26

Table 2: Proximate composition of Fresh beet leaves per 100 g

Nutrient	Fresh Leaves Per 100 G
Moisture (%)	86.4
Protein (g)	3.4
Carbohydrate (g)	0.8
Fat (g)	0.7
Crude fibre (g)	6.5
Iron (mg)	16.2
Calcium (mg)	380
Vitamin C (mg)	70

Sources: ICMR book Nutritive value of Indian Foods

Proximate composition of fresh and dehydrated beet leaves per 100g was calculated. The proximate composition of dehydrated beet leaves in response to protein, fat, carbohydrate was increased significantly as compared to nutrient content of fresh beet leaves.

After dehydration, the moisture content of fresh beet leaves decreased from 86.4 g percent to 6.4 percent in dehydrated beet leaves. Srivastava and Kumar (1988) also reported that the residual moisture in the vegetables should not be more than 6-8 percent.

The nutrient contents of fresh leaves such as carbohydrate, fat, protein, crude fibre was 6.5g, 0.4g, 3.4g, 0.7g (data collected from ICMR); where as in dehydrated beet leaves the nutrient content increased 44.26 g, 2.93g, 22.22g, 7.75g respectively.

Iron and Calcium content of fresh beet leaves were found to have 16.2mg and 380mg while in dehydrated beet leaves were

increased 6 times i.e.104.3mg and calcium was increased 5 times i.e.1612.33mg respectively.

The vitamin C content of fresh beet leaves was 70 mg, while in dehydrated beet leaves it was found that the Total vitamin C content was decreased to 57.26mg.

Table 3: Effect of incorporation with dehydrated beet leaves on Overall acceptibility of Nimki

Replication and Treatments	Sensory Scores					Mean ± S.E.M
	R1	R2	R3	R4	R5	
T_0	8.4	9	8.4	8.5	8.6	8.5±0.13
T_1	8.1	8.5	8.2	8.4	8.2	8.2±0.18
T_2	7.9	8.4	8.1	8.4	8	8.1±0.11
T_3	7.5	7.9	7.8	8.4	7.6	7.8±0.15
T_4	7.1	7.6	7.7	8.2	7.4	7.6±0.18

F = 9.3 (16, 4), Significant $p \leq 0.05$

T_0 (Control), T_1 (5% Incorporation), T_2 (10% Incorporation), T_3 (15% Incorporation) T_4 (20% Incorporation)

The overall acceptability of 'Nimki' regarding incorporation with dehydrated beet leaves at four different levels, 5% (T_1), 10% (T_2), 15% (T_3) and 20% (T_4). The treatment T_0, scored maximum which was without incorporation with dehydrated beet leaves followed by treatment T_1 and T_2 then T_3 at 5%, 10% and 15% corporation at beet leaves and lastly T_4 at 20% levels respectively. From the Anova test it was observed that the calculated value of F was greater than tabulated value of F on i.e. (16, 4) D.F. at 5%. So it was concluded that there was significant difference between four treatments of nimki ($p \leq 0.05$).

Table 2: Effect of incorporation with dehydrated beet leaves on overall acceptability of cookies

Replication and Treatment	Sensory Scores					Mean ± S.E.M
	R1	R2	R3	R4	R5	
T_0	8.2	8.4	8.6	8.5	8.6	8.4±0.07
T_1	8.2	7.9	8.2	8.2	8	8.1±0.06
T_2	7.9	7.5	8.1	8	7.6	7.8±0.11
T_3	7.8	7.4	7.8	8	7.6	7.7±0.1
T_4	7.4	6.9	7.2	7.4	7.4	7.2±0.3

F = 5.5 (16, 4, Result: Significant $p \leq 0.05$

T_0 (Control), T_1 (5% Incorporation), T_2 (10% Incorporation), T_3 (15% Incorporation) T_4 (20% Incorporation)

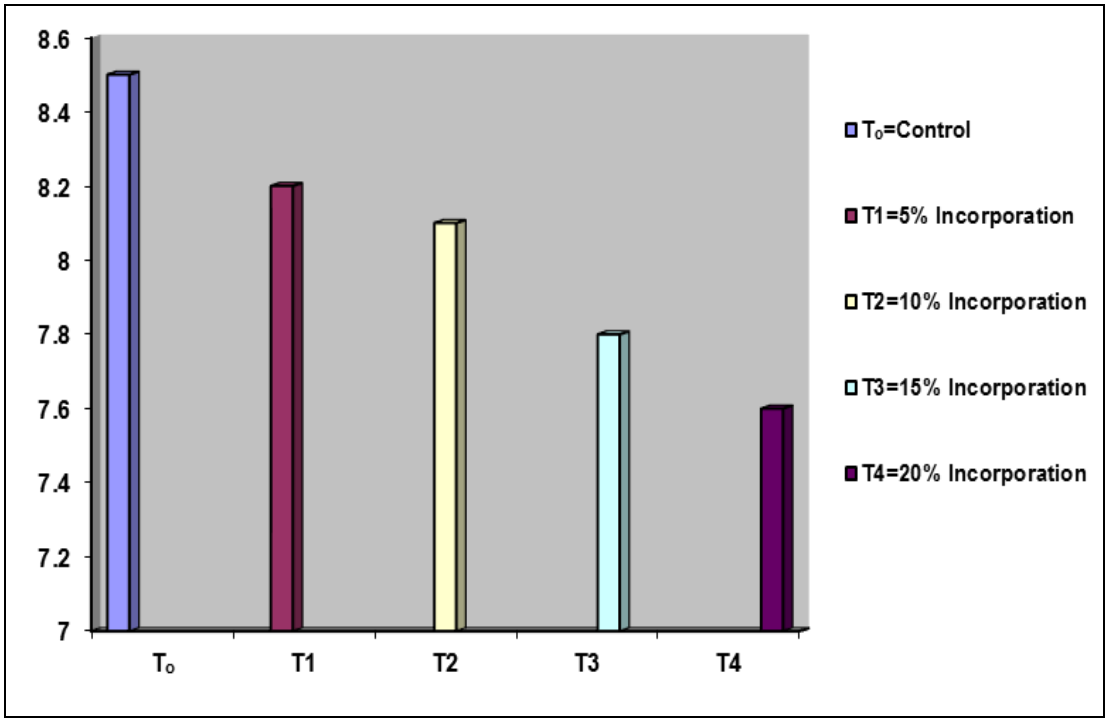

Fig 1: Graph showing overall acceptability of Nimki

The above data shows the average scores of cookies regarding the overall acceptability of cookies which indicates that the treatment to (Control) scored maximum while T_1 and T_2 liked very much and T_3 and T_4 liked moderately. From the Anova test it was found that calculated value of F was greater than the tabulated value of F on (16,4) D.F. at 5%.There was significant difference between four treatment of Cookies ($p \leq 0.05$).

Table 4: Nutritive value of Nimki

Treatment	Moisture	Protein	Fat	Cho	Crude Fibre	Calcium	Iron	Vit C
T_o	13.3	11	20.9	73.9	0.3	23	2.7	0
T_1	13.6	12.1	21	76	0.68	103.6	7.9	2.8
T_2	14.9	13.2	21.1	78.3	1.0	184	13.3	5.7
T_3	14.2	14.3	21.3	80	1.4	264.8	18.3	8.5
T_4	14.8	15	21	82.7	1.85	345	23.5	11.5

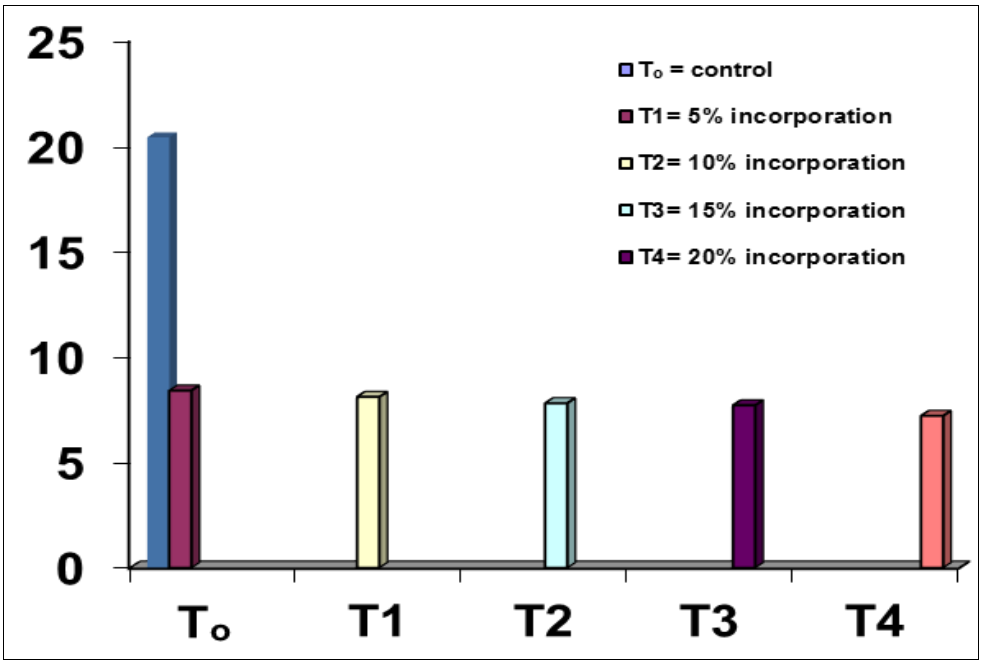

Fig 2: Overall acceptability of cookies

The Protein, carbohydrate, crude fibre, Calcium, iron and Vitamin C content of Nimki was highest for T4 only moisture and fat content was low.

Table 5: Nutritive value cookies

Treatment	Moisture	CHO	Fat	Protein	Crude fibre	Iron	Calcium	Vit C
T_0	120	177.7	86	14.3	0.3	3.0	155	2
T_1	120.5	179.9	86.1	15.4	0.6	8.2	235.6	4.8
T_2	120.8	182.1	86.2	16.5	1.0	13.4	316.2	7.7
T_3	121.1	184.3	86.4	17.3	1.4	18.7	396.8	10.5
T_4	121.4	186.5	86.5	18.7	1.8	23.9	477.4	13.4

All the Nutrient content i.e. moisture, carbohydrate, fat, protein, crude fibre, iron, calcium and vitamin C of T4 was highest as compare to T_1, T_2, T_3 and T_4.

Conclusion

At the end of the study it was now concluded that the nutrient content of dehydrated beet leaves become concentrated. The nutrient such as carbohydrates, fat, protein, iron, and calcium were increased while there was significant loss of Vitamin C content as compared to Fresh leaves content. The products were made by incorporating dehydrated beet leaves at T_4 i.e. 20% levels have the highest nutrient content among all the treatments while the overall acceptability of the T_4 was moderate.

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