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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(4): 602-605

www.thepharmajournal.com
Received: 07-02-2019
Accepted: 08-03-2019

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Nutritional composition of fresh and dehydrated betel leaves

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Abstract
The objective of the study was to standardise the process of dehydration and analyse the nutritional composition of the fresh and dehydrated betel leaves both *Kariyele* and *Ambadiyele.* Different physical and physico- chemical parameters were studied. Both types of betel leaves were dried in hot air oven at 60 °C for 3 h. The fresh and dehydrated samples were analyzed for selected nutritional and antinutritional composition. *Kariyele* had 83.86% moisture, 3.49g protein, 2.63g total ash,49.85 Kcal energy,20.66mg vitamin C and 78.15mg antioxidant contents whereas *Ambadiyele* had 0.86g fat, 2.03g crude fiber and 3716µg β – carotene. In case of dehydrated samples *Kariyele* had higher moisture 13.53%, protein 13.47g, energy 288.54 Kcal, vitamin C 34.73 mg, potassium 4054 mg and sodium 32.83 mg. Whereas fat 4.62g, ash 15.33g, crude fiber 6.5g, β – carotene 6693µg and minerals calcium, phosphorus, iron and zinc content were 2894.2 mg, 242.3mg, 40.98 mg and 6.75 mg respectively. Oxalic acid 0.53g and tannin 503 mg/g TAE were found to be higher in *Ambadiyele.* Dehydration is the simplest convenient method for preserving these sources of micronutrients and dehydrated GLV are a concentrated natural source of micronutrients and they can be used to enrich nutritional profile of the conventional products.

Keywords: Dehydration, betel leaves, pre-treatment, nutritional, and antioxidant

1. Introduction
Deep green heart shaped leaves of *Piper betel* or Betel vine are popularly known as paan in India, belongs to *Piperaceae* family and has over 2000 species. The scientific name of betel vine is *Piper betel L*. *Piper betel* vine is native to Malaysia but it is also cultivated in India, Sri Lanka, Bangladesh, Burma and Nepal (Guha, 2006) [7] . Betel leaves are consumed by about 15-20 million people in the country. Using traditional methods it is cultivated on 55,000 hectare with an annual production worth about Rs. 9000 million in India. (Mazumder *et al.*, 2016) [15]. The vine is dioecious (both male and female plants are different) shade loving perennial root climber. There are about 100 varieties of betel vine in the world, of which about 40 are found in India. (Aishwarya *et al.*, 2016) [2].
Leaves are rich source of many antioxidants *viz.* flavonoids, terpenoids, tannins, alkaloids, saponins *etc*. Betel vine is one of the invaluable medicinal plants, leaves are used for many medicinal purposes and has been described from ancient time as an aromatic stimulo-carminative, astringent and aphrodisiac. (Sengupta *et al.*, 2013; Sripradha, 2014) [19, 20]
In spite of having rich source of micronutrients betel leaves have shorter shelf life as they are highly perishable in nature. Drying and dehydration are the methods to preserve the perishable raw commodity against deterioration and to reduce the cost of packaging, handling, storing and transporting the material by converting it into a dry solid. Advances in vegetable and fruit drying and dehydration techniques are helpful in the development of novel value-added products which meet the quality standard, stability and functional requirement coupled with the economy of the country. Dried and dehydrated fruits and vegetables can be successfully used for different food preparations. Hence, dehydration is one of the best methods of preservation of green leafy vegetables (GLV). Dehydrated GLV are concentrated source of nutrients. Being rich in essential micro - nutrients the green leafy vegetables can be utilized for the purpose of enrichment of food products (Datta *et al.*, 2015) [6]. Hence, the present study was undertaken to dehydrate betel leaves and to assess nutritional composition of fresh and dehydrated betel leaves both *Kariyele* and *Ambadiyele.*

2. Material and methods
2.1 Procurement of material
The two varieties of betel leaves *i.e. Kariyele* and *Ambadiyele* were procured from the local market of Bengaluru.

2.2 Preparation of betel leaves for drying:
Fresh, green, undamaged leaves are taken, washed in running water, chopped into small pieces, weighed and then they were dried. The technique used in the present study for dehydration was hot air oven drying.

2.3 Pre-treatments
Ten grams betel leaves were taken and soaked for 15 minutes in different solutions *viz.* 0.1% salt, 0.1% sugar, 0.1% citric acid and 0.2% KMS. Then the samples were dried at 60˚C in hot air oven for 3 hrs.

2.4 Physical and physico- chemical properties of betel leaves
The fresh betel leaves were subjected to different physical and physico- chemical parameters like leaves weight, length and width using a method described by (Karimi *et al.*, 2009) [10], colour (Munsell, 1952) [16], percent recovery (Kumari, 2013) [11], pH (Chandra, 2013) [4] and TSS (Magwaza and Opara, 2015) [14].

2.5 Dehydration/ drying: The temperature was maintained at 60 ^{0}C and the leaves were sufficiently dried till they became crisp and brittle to touch. The leaves took 3 hours for complete drying. The dried leaves were ground into powder using an electric grinder and sieved through a 60 mesh sieve. The dehydrated powder was packed in aluminium foil pouches and stored in ambient temperature for further use.
The fresh and dehydrated betel leaves powder was analysed for following components. Moisture, protein, fat, crude fiber, ash, carbohydrate and energy were estimated by standard methods (AOAC 1980) [3]. Minerals like potassium, sodium, iron, zinc and Antinutrients such as oxalic acid and tannins were estimated by the method of (AOAC 1980) [3]. β-carotene by spectrophotometer method (Ranganna, 2002) [18], vitamin-C by titration method using iodate solution (Tauber and Kleiner, 1935) [22], antioxidant by DPPH method (Kang and Saltvelt, 2002) [9], calcium by titration method (Heau *et al.*, 1965) [8] and Phosphorus by atomic spectrophotometer (Adelowo *et al.*, 2016) [1]. Minerals and antinutrients were estimated only for dehydrated samples.

3. Results and discussion
In the present study physical and physico- chemical parameters of betel leaves (*Kariyele* and *Ambadiyele*) such as leaf weight, length, width, colour, total soluble solids and pH were recorded and are presented in Table 1. Both *Kariyele* and *Ambadiyele* leaves had average weight (3.3g and 1.83g), length (15.10cm and 16.8cm), width (9.9cm and 7.76cm), colour H (V/C): 7.5GY (4/4 and 5/5), per cent recovery (89.69% and 89.46%), pH(5.7 and 4.6) and 0 ^{0} Brix total soluble solids respectively.
Weight and width of leaves were more with *Kariyele* whereas length was more with *Ambadiyele*. Per cent recovery was almost same in both types of leaves however, pH was slightly higher in *Kariyele.* The results are on par with study conducted by Suryasnata (2016) [21] who found that betel leaves were 4 – 7 inch long and 2 – 4 inch broad and colour of leaves were bright green to green- yellow.
Both types of fresh betel leaves *i.e. Kariyele* and *Ambadiyele* were treated with sugar, salt, KMS and citric acid solution and those were dried at 60^0 C for 3 hours. The results are depicted in Table 2. There was no significant difference with respect to sugar and salt pre-treatments, but slight colour loss was observed in leaves treated with citric acid and leaves treated with KMS solution. Significant differences in dried quality was not observed between pre-treated and control samples. Hence, it was decided to dry the leaves without any pre-treatments for further research work. There is no much difference between fresh leaves and leaves pre-treated with sugar and salt solution. This may be due to the low concentration of sugar and salt. Similar findings were reported by Lewicki (1998) [13] who found that sugar in low concentration for short duration of treatment do not invoke extensive mass transfer between the tissue and surrounding solution resulting in no differences in the quality of material and soaking of plant tissue in salt solution prior to drying apparently does not affect the firmness but influences behaviour of dehydrated material upon rehydration.
Negi and Roy (2000) [17] studied on savoy beet, amaranth and fenugreek leaves which were subjected to different blanching and drying treatments to establish the retention of β – carotene, ascorbic acid and chlorophyll. The leaves were blanched at 95±3 ^{0}C in water, water followed by potassium metabisulphite (KMS) dip, salt solution, salt solution followed by KMS dip and mixture of sodium bicarbonate, magnesium oxide and KMS. It was dried in sun, shade, solar drying, cabinet drying and low temperature drier. Water followed by potassium metabisulphite dip was found most suitable for blanching and selected for drying and low temperature drier had least effect on β – carotene, ascorbic acid and chlorophyll content of the processed product.
Nutritive value of fresh and dehydrated betel leaves (*Kariyele and Ambadiyele)* were analysed. The results of the study are presented in Tables 3, 4 and 5. The Table 3 shows nutrient content of the fresh betel leaves. It was found that *Kariyele* had 83.86% moisture, 3.49g protein, 0.73g fat, 2.63g total ash, 1.96g crude fiber, 7.33g carbohydrate, 49.85 Kcal energy per 100g. Whereas *Ambadiyele* had 85.13% moisture, 3.06g protein, 0.86g fat, 1.59g total ash, 2.03g crude fiber, 7.33g carbohydrate, 49.30 Kcal energy per 100g. β – carotene, vitamin C and antioxidant contents were 3220µg, 20.66mg and 78.15mg in *Kariyele* and 3716µg,19.72mg and 72.34mg in *Ambadiyele* respectively. Moisture, protein, total ash, vitamin- C and antioxidants were higher in *Kariyele* whereas fat, crude fiber and β – carotene were higher in *Ambadiyele*. Carbohydrate and energy content were almost same in both the varieties. Similar values are reported by Mazumder *et al.,*(2016) [15] who reported that fresh betel leaves contains moisture 85-90%, protein 3-3.5%, fat 0.4 -1.0%, carbohydrate 0.5-6.10%, fibre 2.3%,minerals 2.3-3.3%, calcium 0.2-0.5%, phosphorus 0.05-0.6%, iron 0.0050 - 007%, vitamin C 0.005 – 0.01% and energy 44 Kcal per 100g. The results of the nutrient analysis revealed that the betel leaf samples after dehydration became a concentrated source of nutrients. The results are in accordance with the studies done by Lakshmi and Vimla (2000) [12] which showed that the leaves retained good amounts of protein, fiber and calcium in the various samples of the leaves dried by sun drying and cabinet drying.
Proximate composition was analysed for both *Kariyele* and *Ambadiyele* dehydrated powder and results are presented in Table 4. It was found that dehydrated *Kariyele* had 13.53% moisture, 13.47g protein, 4.46g fat, 14.66g total ash, 5.2g crude fiber, 48.63g carbohydrate and 288.54 Kcal energy.β-carotene, vitamin C and antioxidant content were 5440µg, 34.73mg and 43.01mg respectively. Whereas dehydrated *Ambadiyele* powder had moisture 12.66%, protein 12.07g and fat 4.62 g. Amount of total ash was 15.33 g, crude fibre 6.5 g,

carbohydrate48.82 g and energy 285.14 Kcal. β-carotene, vitamin C and antioxidant contents were 6693 µg, 32.86 mg and 39.81mgrespectively.

Minerals and Antinutritional contents of dehydrated betel leaves both *Kariyele* and *Ambadiyele* are presented in Table 5. Minerals *i.e.* calcium, potassium, sodium, phosphorus, iron and zinc contents were 2018.8mg, 4054 mg, 32.83 mg, 213, 23.15mg and 4.65mg respectively. Oxalic acid and tannin content was 0.36g and 447 mg respectively was found in Dehydrated *Kariyele* powder and Calcium 2894.2 mg, potassium 3822.3 mg, sodium 24.3mg, phosphorus 242.3 mg, iron 40.98 mg and zinc 6.75 mg. Oxalic acid and tannin content was 0.53g and 503 mg respectively were found in dehydrated *Ambadiyele* Powder. Moisture, protein, energy, vitamin- C, potassium and sodium were higher in *Kariyele* powder whereas fat, total ash, crude fiber, carbohydrate, β – carotene, calcium, phosphorus, iron, zinc, oxalic acid and tannins were higher in *Ambadiyele.* The results were on par with Chauhan and Aishwarya (2016) [5], reported the nutrient content of dried betel leaves powder moisture 9.45%, protein 3.30%, fat 1.10%, fiber 10.15%, ash 6.87%, carbohydrate 63.92%, vitamin C, iron and calcium as 1.11%, 2.57% and 1.53% respectively. These values are lower than present study values except for fiber and carbohydrate, which might be due to difference in variety, drying condition and climatic conditions.

4. Conclusion

Dehydration resulted in concentration of nutrients. Dehydration is one of the simple, easy, oldest and convenient method of preservation of green leafy vegetables, which are highly seasonal and perishable. The abundantly available betel leaves are nutridense and dehydrated betel leaves are rich source of micronutrients. Dehydrated betel leaves can be incorporated into product formulation to enrich nutritional value of the products and to combat micronutrient deficiencies in developing countries.

5. Acknowledgement

University of Agricultural Sciences, Department of Food Science and Nutrition, GKVK, Banglore to conduct this research is appreciated.

Table 1: Physical and physico – chemical parameters of betel leaves

Parameters	*Kariyele*	*Ambadiyele*
Leaves weight (g)	3.3	1.83
Leaves length (cm)	15.10	16.8
Leaves width (cm)	9.9	7.76
Colour H (V/C)	7.5 GY (4/4)	7.5 GY (5/5)
Per cent recovery (%)	89.69	89.46
Total soluble solids(^{0} B)	0	0
Ph	5.7	4.6

Table 2: Sensory profile of pre-treated dried betel leaves

Treatment	Temperature (°C)	Concentration (%)	Colour		Appearance		Overall Acceptability	
			K	A	K	A	K	A
Control	60	-	Brownish green	Green	Good	Good	Good	Good
Salt	60	0.1	Brownish green	Green	Fair	Fair	Good	Good
Sugar	60	0.1	Brownish green	Green	Fair	Fair	Good	Good
Citric acid	60	0.1	Brown	Olive green	Poor	Poor	Poor	Poor
KMS	60	0.2	Brownish green	Green	Fair	Poor	Good	Poor

K – *Kariyele*, A- *Ambadiyele,*

Table 3: Proximate composition of fresh betel leaves (Per 100g fresh weight)

Nutrients	*Kariyele*	*Ambadiyele*
Moisture (%)	83.86	85.13
Protein (g)	3.49	3.06
Fat (g)	0.73	0.86
Total ash (g)	2.63	1.59
Crude fiber (g)	1.96	2.03
Carbohydrate (g)	7.33	7.33
Energy (Kcal)	49.85	49.30
Vitamins		
β – carotene (µg)	3220	3716
Vitamin C (mg)	20.66	19.72
Antioxidant (mg ascorbic acid equivalents/100g)	78.15	72.34

Table 4: Proximate composition of dehydrated betel leaves powder (Per 100g dry weight)

Nutrients	*Kariyele*	*Ambadiyele*
Moisture (%)	13.53	12.66
Protein (g)	13.47	12.07
Fat (g)	4.46	4.62
Total ash (g)	14.66	15.33
Crude fiber (g)	5.2	6.5
Carbohydrate (g)	48.63	48.82
Energy (Kcal)	288.54	285.14
Vitamins		
β – carotene (µg)	5440	6693
Vitamin C (mg)	34.73	32.86

Table 5: Mineral and antinutrient content of dehydrated betel leaves powder (Per 100g dry weight)

Nutrients	*Kariyele*	*Ambadiyele*
Calcium (mg)	2018.8	2894.2
Potassium (mg)	4054	3822
Sodium (mg)	32.83	24.3
Phosphorus (mg)	213	242.3
Iron (mg)	23.15	40.98
Zinc (mg)	4.65	6.75
Oxalic acid(g/100g)	0.36	0.53
Tannins(mg/g TAE)	447	503

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