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Pabitra Subba
Department of Horticulture, Sikkim University, 6th Mile, Tadong, Gangtok, Sikkim, India

Sujata Upadhyay
Department of Horticulture, Sikkim University, 6th Mile, Tadong, Gangtok, Sikkim, India

VR Muddarsu
Department of Horticulture, Sikkim University, 6th Mile, Tadong, Gangtok, Sikkim, India

S Manivannan
Department of Horticulture, Sikkim University, 6th Mile, Tadong, Gangtok, Sikkim, India

Anjana Pradhan
Department of Horticulture, Sikkim University, 6th Mile, Tadong, Gangtok, Sikkim, India

Correspondence
Sujata Upadhyay
Department of Horticulture, Sikkim University, 6th Mile, Tadong, Gangtok, Sikkim, India

Determination of Multi Element Profile of Himalayan Filbert (*Corylus ferox*)

Pabitra Subba, Sujata Upadhyay, VR Muddarsu, S Manivannan and Anjana Pradhan

Abstract
Himalayan filbert (*Corylus ferox*) is one of the indigenous underutilized fruit crops of the State of Sikkim. The study has been conducted at Dept. of Horticulture, Sikkim University, Gangtok during 2014-15 with an objective to determine the multi-elemental nutritional profile of Himalayan filbert (*Corylus ferox*). The Himalayan filbert fruits were collected from all the four districts of Sikkim i.e. East, West, North and South. There were altogether eight samples i.e. two samples from each of the four districts of Sikkim. Three replications were taken for each sample and the statistical design used was Completely Randomized Design (CRD). The multi-elements were determined by means of Inductively Coupled Plasma-Mass Spectrometry (ICPMS). The major elements potassium, magnesium and phosphorus and minor elements manganese, iron, copper, zinc and boron showed highest values. The toxic elements were present under safe level of human consumption. The commercial cultivation of underutilized crop should be promoted in the state of Sikkim.

Keywords: Himalayan filbert, multi elements, underutilized fruit crop

Introduction
The *Corylus* L. genus contains a wide diversity of deciduous shrub and tree species that are important components of many temperate forests across the Northern Hemisphere.
The hazelnut is one of the major world nut crops and the top hazelnut producing country in the world is Turkey and its production accounts for approximately 75 per cent of worldwide production in 2014 followed by Italy, Spain, and USA. Small producers are China, Iran, Georgia, and Azerbaijan (Kilic and Alkan 2006) [3].
Corylus ferox, is also known as Himalayan tree hazel occuring in high latitudes in India, Nepal, Bhutan, Sikkim and North-Western Yunnan Province in China. People of Sikkim locally call it Kotus which has spiny husk present on it. In Sikkim it grows in forests on mountain slopes up to 1700-3800 m. It is a deciduous tree species growing up to height of 9 to 10m, hardy in nature. The cluster is very similar to the spiny chestnuts (*Castanea* L.) burrs. Nuts are ovoid–globose to slightly Compressed and 1.0 to 1.5 cm in diameter. The chromosomal number of *Corylus forex* is 2n = 22, {Mehlenbacher (1991a) and Thompson *et al*. (1996)} [7, 8].
It is one of the most important nut crops throughout the world and it is a valuable horticultural crop based on its beneficial nutrient composition, especially for human nutrition and diet. There are different nutrients present in hazelnut such as protein, crude fat, starch, sugar, minerals and vitamins etc. Vitamins present in hazelnut are vitamins B_1, B_6, thiamine, riboflavin, folic acid, crude fibre, carbohydrate etc. Minerals present in hazelnut are K, Mn, Mg, Ca, Fe, Zn, B, Al, Cr, As, P, Si, Ni, Ti, S, Na and Cu. Hazelnut kernels are consumed as natural, blanched and roasted or their products, such as sliced, chopped, flour, oil and hazelnut butter in the world. Hazelnut kernels are a good source of fat essential for human health. Hazelnut oil decreases the cholesterol level in blood and also controls adverse effects of hypertension. Hazelnuts are consumed all over the world, not only as a fruit but also in a diversity of manufactured food products, such as snacks, chocolates, cereals, bakery, dairy, salad, sauce, ice creams, and other dessert formulations. By keeping in view, the above mentioned points regarding development of full nutritional profile of Himalayan filbert, the present study was undertaken with the objectives of determination of multi element profile of Himalayan Filbert (*Corylus ferox*).

Materials and methods
The present research work entitled "Determination of Multi element Profile of Himalayan Filbert (*Corylus ferox*)" was carried out during the year 2013-2015 in the P.G Laboratory,

Department of Horticulture, Sikkim University, 6th mile Samdur, Tadong, Gangtok. The study was conducted by using Himalayan filberts (*Corylus ferox*) were the experimental materials used in the present study. The samples were collected in month of November to December, 2014. Himalayan filberts were collected from different parts of Sikkim such as East, West, North and South districts. The number of treatments were eight for each treatment with three replications. The samples were collected from East Sikkim i.e., T1 from Namcheybong and T2 from Lashithang; West Sikkim i.e., T3 from Chakaleydara and T4 from Sombaria; T5 was collected from Ganbari and T6 from Perbing from South Sikkim; T7 from Phudong and T8 from Mangshela from North Sikkim. Samples were kept into the hot air oven at 60^0C for 3 to 4 days then the nuts were ground with the help of Willey mill grinder to make it into fine powder. The fine powder were put into the plastic container and kept at room temperature until use.

Sample digestion

The Multi-wave digestion system (Anton Par microwave 3000) was used for sample digestion. For solid sample mineralization, a Multi-wave digestion system (Anton Par microwave 3000) was used for sample digestion. The amounts of approximately 0.2 g per sample, 8 ml of 69% nitric acid was added into the digestion tube. The Ramp was maintained at 20, Hold 20, I.R 190^0C, Rate 0.3bar/sec and Power 1200 watt. The digested samples were transferred to 50ml volumetric flask when the temperature of the samples was reduced and the distilled water was added for making the final volume of 50ml.The liquid samples were transferred into the narrow mouth bottle container before the minerals were determined by ICP-MS.

Determination of multi-elements content of Himalayan filbert were carried out by a commercial system of Inductively Coupled Plasma Mass Spectrophotometry (ICPMS) Perkin Elmer Nex ION 300X. Digested samples were analysed for the ionic constitution using multi elements standards solution1, 3 and 5 solution containing analysis were used as a standards such as Ag, Al, B, Ba, Be, Bi, Ca, Cd, Co, Cr, Cs, Cu, Fe, Ga Se, Ln, K, Li, Mg. Mn, Mo, Na, Nb, N, Ti, Pb, Rb, Ge, Se, Si, Sr, Tn, U, V, W, Zn, Zr.

Results and discussion

Major elements content of Himalayan filbert are reported in Table 1. Phosphorus, potassium, sodium, magnesium, calcium and Sulphur were established as major elements of the Himalayan filbert. The highest phosphorus and potassium content in Himalayan filbert were found in Lashithang (1.28mg L^{-1}), (3.00mg L^{-1}), sodium in Chakaleydara (0.07mg L^{-1}), magnesium in Lashithang (2.67mg L^{-1}), calcium in Chakaleydara (0.67mg L-1) and Sulphur in Mangshela (1.77mg L^{-1}). Among the major elements, potassium was most abundant followed by magnesium, Sulphur, phosphorus, calcium and sodium. Therefore, the phosphorus and potassium concentrations in our study were lower than those reported by the (Koksal *et al*., 2005) [4] for 17 different hazelnut varieties grown in black sea region of Turkey. The reasons might be plant species is differences, climatic conditions and location. The mineral composition of hazelnut kernels depended not only on the samples but also on the growing conditions such as soil and geographical conditions, climatic conditions, use of different instruments at the time of the extraction and digestion of the samples.

The Himalayan filbert were observed to have higher sodium, calcium, Sulphur and magnesium concentrations as compared to the earlier findings of European filbert (Koksal *et al.*, 2005) [4]. Magnesium plays an essential role in reducing the risk of cardiovascular disease. The RDA of magnesium for adults is 400mg, so consumption of 100g of hazelnut supplies about 37.49%.

Table 1: Determination of major elements content on Himalayan filbert

Treatment no.	Major elements content on dry wt. basis mg L^{-1}					
	P	K	Na	Mg	Ca	S
T1	1.10	2.70	0.01	2.47	0.60	0.02
T2	1.28	3.00	0.05	2.67	0.52	Traceable
T3	0.76	2.34	0.07	2.29	0.67	0.15
T4	0.80	2.43	0.01	2.32	0.56	0.18
T5	0.94	2.46	0.01	2.13	0.48	0.44
T6	0.81	2.46	0.01	2.40	0.54	-0.02
T7	0.84	2.58	0.01	2.39	0.60	0.13
T8	Traceable	Traceable	Traceable	Traceable	Traceable	1.77
G.M	0.816	2.243	0.212	2.084	0.495	0.330
SEm	0.354	0.424	0.289	0.455	0.457	0.408
CD at 5 %	0.106	0.127	0.865	0.136	0.136	0.122

Minor elements contents of Himalayan filbert are reported in Table 2. Manganese, iron, copper, zinc, boron and Silicon were established as minor elements of Himalayan filbert. The maximum manganese, iron, copper, zinc and Silicon content in Himalayan filbert were found in Namcheybong (0.18mgL^{-1}), (0.11mg L^{-1}), (0.01mg L^{-1}), (0.03mg L^{-1}) and (0.01mg L^{-1}). The highest boron content was reported as Lashithang (0.02mg L^{-1}). Manganese, iron and silicon content in Himalayan filbert studied were higher than the one found in Turkish hazelnut cultivars (Koksal *et al.*, 2005) [4]. Copper are trace elements essential for important biochemical functions and necessary for maintaining health throughout life. The Himalayan filbert was observed to have lower copper content as compared to earlier published (Koksal *et al*., 2005) [4]. Several studies have indicated that the mineral composition of hazelnut is affected by variety, geographical origin, harvesting time, climatic conditions and composition of soil, irrigation, use of fertilizers and methods of cultivation may effect nutritional composition of hazelnut.

The Himalayan filbert was observed to have similar zinc content as compared to the earlier findings of European filbert (Koksal *et al*., 2005) [4]. The reasons might be similar cultivation conditions.

Table 2: Determination of minor elements content on Himalayan filbert

Treatment No.	Minor elements content in Himalayan filbert on dry wt. basis mg L^{-1}					
	Mn	**Fe**	**Cu**	**Zn**	**B**	**Si**
T1	0.18	0.11	0.01	0.03	Traceable	0.01
T2	0.02	0.04	0.01	0.02	0.02	0.01
T3	0.04	0.05	Traceable	0.02	Traceable	Traceable
T4	0.05	0.05	Traceable	0.01	Traceable	Traceable
T5	0.05	0.03	Traceable	0.02	Traceable	Traceable
T6	0.04	0.08	Traceable	0.01	Traceable	0.01
T7	0.04	0.05	Traceable	0.01	Traceable	Traceable
T8	Traceable	-0.02	Traceable	Traceable	-0.01	Traceable
G.M	0.525	0.487	0.333	0.150	0.125	0.375
SEm	0.408	0.289	0.167	0.204	0.204	0.353
CD at 5 %	0.122	0.865	0.499	0.612	0.612	0.106

Toxic elements contents of Himalayan filbert are reported in Table 3. Aluminum, chromium, nickel, arsenic, titanium and Lead were established as toxic elements of the Himalayan filbert. In the present study the maximum aluminum and chromium content in Himalayan filbert were found in Namcheybong (0.05mg L^{-1}), (0.01mg L^{-1}). The highestnickelcontent was found in Phudong (0.02mg L^{-1}). The maximum arsenic and titanium content were found in Lashithang (0.07 mg L^{-1}), (0.02 mg L^{-1}) and Leadcontent was found in Ganbari (0.89mg L^{-1}).

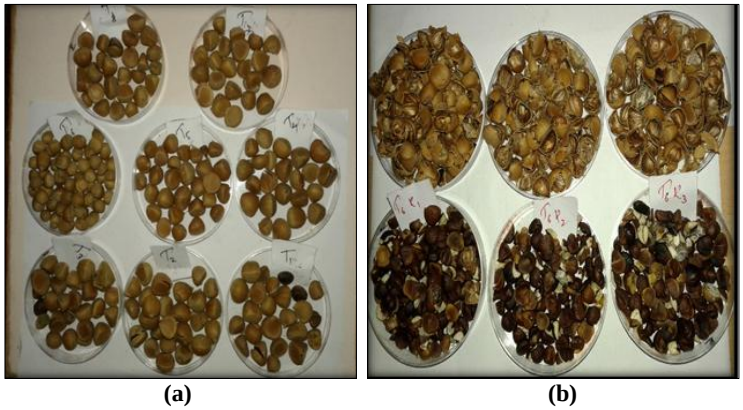
Alasalvar *et al.* (2003) [1] reported that maximum Aluminium content in European filbert was measured as (5.02mg/100g), chromium (0.01mg/100g), nickel (1.25mg/100g), Pb (0.03mg/100g). In the present study the maximum aluminium content in Himalayan filbert was found as (5.0mg/100g), chromium (1.0 mg/100g), nickel (2.0mg/100g) and lead content was found to be (0.89mg/100g).The Himalayan filbert was observed to have similar aluminium content to European filbert. The reasons might be similar cultivation conditions. The Himalayan filbert was observed to have higher chromium, nickel and lead content as compared to the earlier findings of European filbert given by (Alasalvar *et al.*, 2003) [1]. However, the toxic elements concentration obtained in Himalayan filbert are under safe range for human consumption.

Table 3: Determination of toxic elements content on Himalayan filbert

Toxic elements content in Himalayan filbert on dry wt. basis mg L^{-1}						
Treatment no.	**Al**	**Cr**	**Ni**	**As**	**Ti**	**Pb**
T1	0.05	0.01	0.02	Traceable	0.01	0.16
T2	0.02	0.01	Traceable	0.07	0.02	0.32
T3	0.03	0.01	0.01	Traceable	Traceable	0.09
T4	0.03	Traceable	0.01	Traceable	Traceable	0.11
T5	0.01	Traceable	0.01	Traceable	Traceable	0.89
T6	0.05	0.01	0.01	Traceable	0.01	0.04
T7	0.03	Traceable	0.02	Traceable	0.01	0.25
T8	Traceable	Traceable	Traceable	Traceable	Traceable	Traceable
G.M	0.283	0.583	0.100	0.875	0.625	0.232
SEm	0.391	0.167	0.289	0.204	0.156	0.540
CD at 5 %	0.117	0.499	0.865	0.612	0.467	0.162

Conclusion

As per findings of the present study it may be concluded that Himalayan filbert is nearly similar to European filbert in all the multi- elements. Himalayan filbert may be recommended in place of European filbert. The data obtained in this study to confirm that Himalayan filberts are a rich source of a number of important macro and micro elements. Himalayan filbert can play a major role in human nutrition and health because of its high and special nutritional components. Thus, these nutritional attributes show that Himalayan filbert can serve as an important healthy food in the human diet. The results on dietary nutrients e.g. ash content, fat content, protein content, vitamin C content and reducing sugar etc. are being reported for a separate publication. The commercial production of Himalayan filbert in the State of Sikkim and its export with proper packaging or processing need to be strengthened.



(a) **(b)**

Plate 1 (a, b): Himalayan filbert after drying

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