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FATTY ACID COMPOSITION OF SOME LEAFY VEGETABLES OF BANGLADESH

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ABSTRACT

Fatty acid composition of six different leafy vegetables of Bangladesh was investigated. The amount of bound fatty acids was found to be higher than the free fatty acids in all the leafy vegetables. Different fatty acids were identified and their relative proportions were determined by GLC from the leafy vegetables.

INTRODUCTION: Dietary fat or oil plays an important role as a nutrient for human and animal. The total fat intake is closely related to those of socio-economic progress and food availability. People of the village of Bangladesh survive on a diet that is almost exclusively made up of vegetable foods. Intake of saturated fatty acids (SFA) was fast observed to be strongly associated of coronary heart diseases [1-4].

Epidemiological and clinical studies have also suggested that SFA intake is associated with the risk of developing diabetes [4] and various types of cancer [5].

More recently, it has also been recognized that certain isomerized fatty acids produced during the manufacturing of commercial solid vegetable fats (*Trans* fatty acids) are most detrimental to cardiovascular health [6]. Many controlled studies have assessed the quantitative effects of changes in dietary fat quality and quantity on the blood lipid profile [7-10].

In the fatty acid series some of the higher members, particularly palmitic and stearic acids occur in natural fats [11]. The fatty acids in plants are generally straight-chain compounds, ranging from three to eighteen carbons.

Fatty acids containing an even number of carbon atoms are present in substantial amount because they are built up of two carbon atoms at a time, from acetic acid units.

Fatty acids are insoluble in water and are extracted from plant tissues by organic solvents of low polarity like petroleum ether or chloroform. They are generally found in ester linkage but are also found free and in loose molecular complexes with protein. Although alkaloids, terpenoids, steroids, flavones and their glycosides, phenols, and phenolic acids constitute a major portion of non-carbohydrate materials of a plant, fatty acids are always present in varying amounts in all plant materials. These fatty materials may influence the handling of the plant tissues as well as any chemical treatment done on it.

Therefore, the study of fatty acids, the major constituent of all fatty matters is important for the well-being of the society.

Leafy vegetables are one of the major foods of the rural people of Bangladesh. So a thorough investigation of the leafy vegetables of Bangladesh is necessary to find out its different aspects.

Although investigations on the leafy vegetables have been carried out [12, 13] but its more investigations using the modern techniques are necessary to explore their latent importance as nutritional aspects and medicinal role. With this end in view, investigation has been undertaken to carry out a fatty acids analysis for some indigenous leafy vegetables.

The present report deals with the isolation of fatty materials from different leafy vegetables and identification and quantification of the different fatty acids present as free and in bound form.

MATERIALS AND METHODS:

Chemicals and solvents: All the reagents used in the present work were analytical grade (Merck and BDH). All the solvents were distilled before use. Standard fatty acids were purchased from Sigma, USA.

Sample collection and preparation: Six leafy vegetables (**Table 1**) were collected from the different places such as from local markets, paddy field, crop field or bank of river of Dhaka, Gazipur and Barisal district of Bangladesh. The taxonomy of the plant was confirmed in consultation with Prof. Dr. Md. Abul Hassan, Department of Botany, University of Dhaka, Bangladesh. A voucher specimen of each plant was deposited in the Bangladesh National Herbarium (BNH) also. After collection of the sample, the plant material was washed with water to remove mud and dust particles. Then, it was cut into small pieces, dried in open air and finally dried in an oven at below 45°C. The dried plant material was grinded with a grinder mill (Cyclotec, 200 meshes) and stored at room temperature in an air tight container to carry out all the experiments.

Extraction of dried powder of leafy vegetables: Each dried vegetables powder (50 g) was extracted twice with (500 mL) petroleum ether (b.p. 40-60°C) under reflux condition for 30 minutes. After refluxing, the content of the flask was allowed to cool at room temperature and filtered. Each extract was evaporated to dryness using a rotary evaporator. The percentage of yield of the petroleum ether extract was recorded in **Table 2**.

TABLE 1: BOTANICAL, ENGLISH AND LOCAL NAME OF COLLECTED LEAFY VEGETABLES OF BANGLADESH

Botanical Name	Family	English Name	Local Name
Hygrophila auriculata (Schum.) Heyne.	Acanthaceae	Starthorn leaves	Sulmardon Shak
Ipomoea batatas L.	Convolvulaceae	Sweet potato leaves	Mishti Alu Shak
Lathyrus sativus L.	Fabaceae	Chickling pea leaves	Kaloe Shak
Pisum sativum L.	Fabaceae	Pea leaves	Motor Shak
Trigonella foenum-graecum L.	Fabaceae	Fenugreek leaves	Maythi Shak
Enhydra fluctuans Lour.	Compositae	Marsh herb leaves	Helencha Shak

TABLE 2: AMOUNT OF PETROLEUM ETHER EXTRACT, BOUND AND FREE FATTY ACIDS ISOLATED FROM DIFFERENT LEAFY VEGETABLES

Name of the leafy vegetables	Amount (g/100 g of dry powder)			
	Petroleum ether extract	Bound fatty acids (BFA)	Free fatty acids (FFA)	Total fatty acids
Starthorn leaves	1.42	0.28	0.19	0.47
Sweet potato leaves	1.75	0.32	0.12	0.44
Chickling pea leaves	1.55	0.25	0.12	0.37
Pea leaves	2.04	0.14	0.11	0.25
Fenugreek leaves	2.00	0.42	0.32	0.74
Marsh herb leaves	1.09	0.26	0.12	0.38

Analysis of fatty acids: The free fatty acids (FFA) and bound fatty acids (BFA) were isolated from the petroleum ether extract [14, 15]. The amount of FFA and BFA of each vegetable are presented in **Table 2**. FFA and BFA were converted into their methyl ester [14, 15] and these were analysed using GLC (Shimadzu 9A, Column-BP-50, Detector-FID, 170°C-1 min/4°C-270°C-30 min). The results are given in **Table 2**.

RESULTS AND DISCUSSION: Six different leafy vegetables (**Table 1**) were collected locally, cleaned, dried and powdered. The powdered materials were separately extracted with petroleum ether to isolate fatty materials. From the **Table 2**, it is observed that the amount of petroleum ether extract is highest in Pea leaves (2.04 g/100 g of dry powder) and lowest in Marsh herb leaves (1.09 g/100 g of dry powder).

The amount of petroleum ether extract of other leafy vegetables lies in between these values indicating the presence of significant amount of fatty materials in the samples.

From the petroleum ether extracts of the leafy vegetables the free and bound fatty acids were isolated separately [14, 15]. From **Table 2**, it appears that both the bound fatty acids (BFA) and free fatty acids (FFA) are highest in Fenugreek leaves 0.42 and 0.32 g/100 g respectively. But the same is lowest in Pea leaves (0.14 and 0.11 g /100 g), respectively. The BFA contents in the leaves of Starthorn, Sweet potato, Chickling pea and Marsh herb are 0.28, 0.32, 0.25 and 0.26 g/100 g of dry powder, respectively. The FFA contents of those are 0.19, 0.12, 0.12 and 0.12 g/100 g of dry powder, respectively. This reveals that the BFA of the leafy vegetables are relatively higher than their corresponding FFA. This may be due to the fact that the bound fatty acids are associated with other organic compounds and hence the proportion of the FFA is relatively lower.

Both the BFA and FFA of the samples were separately converted into their methyl ester with BF_3-MeOH [14, 15] and the fatty acids were identified and their relative percentage were determined using GLC comparing the retention time of the individual fatty acid with those of the standard samples (**Table 3**). It appears from **Table 3**, that the leafy vegetables contain a mixture of different saturated and un-saturated fatty acids. The major fatty acids found as BFA are palmitic acid (33.26 %) and behenic acid (17.23 %) are in Marsh herb leaves, oleic acid (46.91 %) and caprylic acid (22.45 %) are in Fenugreek leaves, palmitolic acid (42.12 %) and palmitic acid (31.80 %) are in Pea leaves, oleic acid (41.46 %) and stearic acid (23.87 %) are in Chickling pea leaves, oleic acid (21.57 %) and lauric acid (20.23 %) are in Sweet potato leaves, and oleic acid (44.04 %) and linolic acid (26.73 %) are in Starthorn leaves, respectively. The major fatty acids found as FFA are palmitic acid (42.20 %) and behenic acid (13.42 %) are in Marsh herb leaves, arachidic acid (57.67 %) and oleic acid (23.08 %) are in Fenugreek leaves, palmitic acid (28.63 %) and palmitolic acid (23.00 %) are in Pea leaves, myristic acid (37.75 %) and palmitic acid (29.91 %) are in Chickling pea leaves, oleic acid (26.71 %) and capric acid (18.10 %) are in Sweet potato leaves and linolic acid (41.97 %) and oleic acid (19.85 %) are in Starthorn leaves, respectively. Palmitolic acid, oleic acid and linolic acid are unsaturated fatty acids.

Along with these major acids there are other acids as minor constituents in various proportions in the leafy vegetables. Fatty acids composition of Marsh herb leaves is comparable to those compositions of soybean oil [15] and corn oil but the fatty acids composition of Fenugreek leaves is comparable to that of butter [15]. Fatty acids composition of Pea and Chickling pea leaves are comparable that of coconut oil [15]. The overall fatty acids composition (**Table 3**) of the leafy vegetables shows pattern of edible or useable fats and oil. So, these vegetable may be contribute as an alternative sources for energy and unsaturated fatty acid for low-income group of people those are living on rice and leafy vegetables.

The total amount of saturated and unsaturated fatty acids in BFA and FFA of the leafy vegetables are calculated and presented in **Table 4.**

TABLE 3: RELATIVE PERCENTAGE OF FATTY ACIDS FOUND IN SOME DIFFERENT LEAFY VEGETABLES

Name of the vegetables →	Marsh herb leaves		Fenugreek leaves		Pea leaves		Chickling Pea leaves		Sweet potato leaves		Starthorn leaves	
Fatty acid ↓	BFA	FFA	BFA	FFA	BFA	FFA	BFA	FFA	BFA	FFA	BFA	FFA
Caprylic	-	-	22.45	4.74	3.32	-	4.08	-	-	-	-	-
Capric	-	-	-	1.70	4.09	-	1.59	-	11.56	18.10	9.27	-
Lauric	-	-	3.15	-	-	5.00	1.04	5.52	20.23	-	-	-
Myristic	-	0.59	1.87	-	7.72	8.86	-	37.75	4.17	16.26	-	6.92
Palmitic	33.26	42.20	-	1.94	31.80	28.63	1.53	29.91	6.44	10.35	-	-
Palmitolic	-	-	-	3.21	42.12	23.00	3.13	15.59	-	8.42	-	6.60
Stearic	5.98	8.72	7.38	5.58	-	-	23.87	-	6.23	3.15	12.70	15.53
Oleic	7.61	6.63	46.91	23.08	-	-	41.46	-	21.57	26.71	44.04	19.85
Linolic	15.33	12.60	5.25	2.08	-	13.08	15.87	-	12.06	11.66	26.73	41.97
Arachidic	11.34	8.41	4.16	57.67	3.58	14.54	1.15	7.90	4.57	-	7.26	-
Behenic	17.23	13.42	6.12	-	7.37	6.88	3.11	-	5.65	5.34	-	9.13
Lignoceric	9.25	7.43	2.70	-	-	-	3.15	3.32	7.52	-	-	-

TABLE 4: AMOUNT OF SATURATED AND UNSATURATED FATTY ACIDS IN BFA AND FFA

Name of the vegetables	Amount of fatty acids (g/100 g of dry powder)					
	Saturated			Unsaturated		
	FFA	BFA	Total	FFA	BFA	Total
Starthorn leaves	0.060	0.083	0.143	0.131	0.201	0.331
Sweet potato leaves	0.062	0.211	0.273	0.054	0.107	0.161
Chickling pea leaves	0.046	0.097	0.143	0.071	0.148	0.219
Pea leaves	0.068	0.078	0.147	0.039	0.057	0.096
Fenugreek leaves	0.231	0.199	0.429	0.091	0.217	0.308
Marsh herb leaves	0.091	0.197	0.288	0.027	0.059	0.086

It appears from the **Table 4** that the leafy vegetables such as Starthorn, Fenugreek and Chickling pea leaves are rich in unsaturated fatty acids. These acids decrease total blood cholesterol and low-density lipoprotein. These are also more prone to oxidation. Some of the unsaturated fatty acids, those are conjugated to fat-soluble antioxidants, have potential health benefit.

Leafy vegetables are richest plant food in the nature. A significant amount of saturated and unsaturated fats are found in leafy vegetables. So, the leafy vegetables are important contributors to the beneficial health effects of human. The fatty acid profile will also contribute to enrich knowledge for further advanced research in the field of phytochemistry.

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