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Studies on Fatty Acid Composition and Proximate Analyses of Anethum Sowa L. (Dill) Seed

Md. Moshfekus Saleh-E-In[a] and Sudhangshu Kumar Roy[b]

[a]Department of Chemistry, Government Bangla Colllege, Dhaka, National University, Gazipur, Bangladesh. and [b]Chemical Research Division, BCSIR Laboratories, Dhaka-1205, Bangladesh.

Abstract

Anethum sowa L. (Dill) seeds were investigated to determine the fatty acid composition and proximate analyses. The seeds contain 9.36 % fatty oil. The saturated and unsaturated fatty acids contributed 6.22% and 93.78% respectively of the oil. The per cent composition of the extracted oil was identified by Gas Liquid Chromatography (GLC). Among the six fatty acids identified from this study oleic acid contributed the highest proportion (87.10%), where as, linolenic, palmitic, stearic, behenic and arachidic all together contributed the rest (12.90%). Proximate analyses showed that *A. sowa*. seeds are good source of dietary fibre. Overall Dill seeds oil can be considered as a good source of oleic acid.

Keywords: *Anethum sowa,* dill seed oil, fatty acid composition, oleic acid, linolenic acid, Gas liquid chromatography.

Introduction

Plant taxonomists, in general, regard *Anethum sowa*(Dill, Indian Dill and Bengali-Shulfa) and *Anethum graveolens* (European Dill) out of the three species of the genus *Anethum* as one composite species recognizing them as two types or varieties (Bentham and Hooker *et al.* 1862-7; Buwalda 1949; Minosuke 1958). The herb *Anethum sowa* grows 2-2.5 ft. high and like fennel have small feathery leaves, which stand on sheating foot-stalks with linear and pointed leaflets. Stem in erect slightly branched, cylindrical, striated, smooth and pale green. The seeds of *Anethum sowa* are longer than those of *Anethum graveolens* and their dorsal ridges are paler in color. Each seed is about 4 mm long and oval, as most split in two after harvesting. The majority of Dill

seeds look flat on one side and convex on the other, with a few seeds retaining a fine, 1 mm stalk (Anonymous 1985; Chopra *et al.* 1982; Pruthi 1998). *A. sowa* fruits are less fragrant than *A. graveolens*. Both of them have been of extensive commercial interest (Baslas *et al.* 1971).

Anethum sowa L., commonly known as Dill, Indian Dill, Shulfa or Sowa a genus of the family *Apiaceae (Umbelliferae)* is an annual and winter crop. It is native to Europe and commercially produced in subtropical and temperate regions such as India, Pakistan, Egypt, United States, Hungary, England, Germany, Holland, Finland and as well as, grown in almost in all districts but extensively in the northern regions of Bangladesh (Simon *et al.*1984). The people of this region grow as pot herb and use to flavor curries. It is an important condiment crop which is largely used for flavorings and seasoning of various foods such as salads, sauces, soups, sea foods, especially pickled vegetables and a popular ingredient of curry powder (Dey 1896). The seed oil is also used as scenting agents in detergents, soaps, air-fresheners, insect repellents, intermediate in the synthesis of perfume chemicals and as a pharmaceutical aid. The seeds are also used as folkloric medicine e.g. aromatic, carminative, specially useful in Aromatherapy functions, also as digestion aid and their infusion reduces flatulence, hiccups, stomach pains and insomnia (Woolf 1999; Bakowski and Michalik 1986; Halva and Pukka 1987; Paakkonen *et al.*1989; Guenther 1950).

Vegetables and plant seeds are the most promising sources of lipids, simple and complex carbohydrates, proteins, minerals and secondary metabolites. These are used for better health of human also for industrial and as well as, pharmaceutical purposes (Mowla *et al.* 1990). Lipids are the major constituents of food. It is an essential item of human consumption either as such or in refined or hydrogenated form. Fresh vegetables may contain 0.1-1.0% lipids on fresh weight basis (Hytowitz. *et al.* 1984; Mowla 1990). Their presence, quantity and composition are important not only for organoleptic satisfaction but also for nutrition and keeping quality. They provide the essential fatty acids for body need and serves as the structural material of cell membranes in all tissues. They also play a significant role in normal biological functions and in relation to major problems in health and agriculture (Gurr *et al.*1975; King 1970; Hansen 1990). The fatty acids produced from any type of oil seed may vary with lipid class, geographical location, cultivar, soil type, climate, moisture, temperature, maturity of the seed and agricultural practice (Galliard *et al.* 1975; Kinsella *et al.* 1975; Chu *et al.* 1979; Ching Kuang Cho 2000).

With the increasing demand of vegetable oils and spice in the country, the investigations of the oil seeds of Dill have assumed great importance. From the literature survey no work has been found reported and carried out about the composition of fatty acids of the seed of Anethum sowa in Bangladesh. Hence the present investigation was carried out (a) to estimate the chemical composition of the seed as well as, that of the extracted oil from the remaining seed cake of *A. sowa;* (b) to compare the quality and quantity of fatty acids with other commercial seed oil as well as spice quality and (c) to evaluate whether the oil could be used in edible purposes and as an important raw material as well as functional products of pharmaceutical aid.

Materials and Methods

i. Plant materials

The Dill *(Anethum sowa* L.) plants were cultivated in loamy soil at Keranigonj, Dhaka of Bangladesh. The seeds were harvested at the age of about 5 month, in the month of May, 2004 when seeds were grayish black in color. The sample was cleaned to separate dirt, sundried and followed by the determination of the moisture content and steam distillation to free from essential oil. The moisture contents of the fresh seed samples were determined by the standard method (IUPAC 1977). The chemicals used for this study were of E. Merck, Germany.

ii. Extraction

The essential oil free seed samples were sundried, removed of all visible impurities and powdered by warring blender. About 115.0g. of crushed seeds cake were then extracted with petroleum ether (b.p. 40-60^{o}C) in a Soxhlet apparatus for 72 hours to isolate the oil with three replications. It was first filtered following distillation to remove solvent under reduced pressure. The dark brown colored oil obtained was ready to analyze using AOAC method (AOAC 1984).

iii. Physico-chemical study of the oil

The physico-chemical properties like specific gravity, refractive index, acid value, iodine value (Hanus method), saponification value etc. of *Anethum sowa* seeds were determined with three replications as per methods cited under references (AOAC 1984; A Manual..1976; British Pharmacopoeia 2004; Kirk and Sawyer, 1991) and the results are shown in Table I.

iv. Proximate analysis

The meal left after oil extraction was sundried and it was subjected for determination of the percentages of moisture, ash, nitrogen, protein, carbohydrate and crude fibre

were done according to the standard methods (AOAC 1984; A Manual..1976; Van Soest 1976; NIN 1993) with three replications (shown in Table II). The gross food energy was estimated (Edeoga *et al.* 2003; Osborn 1978) using the equation:

FE = (% CP×4) + (% Lipids ×9) + (%CHO×4)

Where: FE = Food energy (in g./calories), CP=Crude protein and CHO=Carbohydrate

v. Identification and quantification of fatty acids

The fatty acid composition was determined by analysis of their methyl esters. The fatty acid methyl esters (FAMEs) were prepared from the oils by esterification using BF_3-MeOH complex (AOAC 1984; British Standard methods 1958). The complete conversion of esterification was checked by means of TLC. The FAMEs were analyzed by Gas Liquid Chromatography (GLC). Standard FAMEs (E. Merck) were used for the identification of the peaks.

vi. Instrument and separation conditions

The fatty acid methyl esters were analyzed on a PYE UNICUM PU: 4500U Gas Chromatograph (England) fitted with a flame ionization detector (FID) and an electronic integrator equipped with SE-54 quartz capillary column (30 m × 0.25 mm *i .d.* and 0.25µm film thickness). Carrier gas nitrogen (N_2) at a flow rate of 3 ml/min. The separation was affected at 100^OC - 220^OC. The following temperature program carried out the GC analysis: Initial temperature 100^OC, increases at 4^OC/min to 220^OC at 30 min. The oven, injection and detection temperatures were fixed at 100^O, 220^O and 230^OC respectively. Splitting 80 %, speed of the chromatogram was 0.5 mm/min. The fatty acids were identified by comparison of relative retention times and peak positions of the chromatogram with that for the standard fatty acids. The amounts of fatty acids were calculated from the peak areas computed by LKB 2220 electronic recording integrator. The fatty acid composition of the extracted oil obtained from this study is represented in Table III.

Results and Discussion

A.sowa seed contain 9.36% fatty oil. The physico-chemical properties of the oil are shown in Table I. The oil was opaque and viscous liquid of dark brown color with an unpleasant odor and bitter taste. It was freely miscible in chloroform, carbon tetrachloride, petroleum ether, di-ethylether and in alcohol on warming. The optical rotation was found to be + 9.34^O observed at 26^OC .The refractive index (R1) of the oil was 1.4706 at 29^OC. Which was comparable with soybean

oil (1.466-1.470) and rice bran oil (1.470-1.473) (Mowla 1990; Kirk *et al.* 1991). The refractive index indicated that the oil contains fairly large amount of long chain unsaturated fatty acid (Mabaleha *et al.* 2004; Ali 1998). The specific gravity of the oil was found 0.9231 at 30^{O}C, which indicated that the oil contains low molecular weight of fatty acids. It is also closer to soybean oil (0.919-0.923), mustard oil (0.914-0.923) and safflower oil (0.923-0.928) (Mowla *et al* 1990; Ching Kuang Cho 2000).

about the oils and fats. The extracted oil *(A. sowa)* had the iodine value 98.72, saponification value 183.26, and acid value 15.67. The sapoinfication value was quite similar to the range of rice bran oil (181-195), rapeseed oil (168-183) and mustard oil (173-184) (Mowla *et al*. 1990; Ching Kuang Cho 2000) which were typical C_{16} and C_{18} oils. Iodine value of the oil was similar to the iodine value (Witz method) for groundnut (80-106), rapeseed oil (97-110), rice bran oil (92-109) and mustard oil (96-124) (Mowla *et al*. 1990; Ching Kuang Cho.2000). The saponification

Table I. Physico-chemical characteristics of Dill seed oil

Characteristics	Results
Appearance	An opaque, viscous oily liquid with dark brown color.
Odor and taste	Unpleasant odor with bitter taste.
Miscibility and solubility	Insoluble in water, freely miscible in chloroform, carbon tetrachloride, pet-ether, hexane, diethyl ether and also miscible in alcohol on warming.
Specific gravity at 30^{O}C	0.9231 ± 0.0012
Refractive index (n^{29}_{d})	1.4706 ± 0.0005
Optical rotation at 26^{O}C	+9.340 ± 2.0
Acid value (mg KOH/g)	15.67 ± 0.4
Iodine value (Hanus method)	98.72 ± 2.0
Saponification value (mg KOH/g)	183.26 ± 2.5

Each value represents the average of three replicate analyses ± SD

Properties of the oil such as acid value, iodine value and saponification value gave structural, stability and quality information

value indicated the presence of high proportion of higher fatty acids and iodine value also suggested the oil to be an unsaturated

one. The acid value was very higher than other edible oils like soybean, mustard, palm and rice bran (refined) oil. The higher acid value indicated that the grade of this extracted oil is not suitable for direct edible purposes. It may be used for consumption through refining or may be used for industrial purposes. The drying property of the oil was examined and it was found to be non-drying in nature.

Table II. Nutritive and proximate composition of the Dill seed

Parameters	Results (% w/w)
Moisture (fresh seed)	13.31
Dry matter(fresh seed)	86.69
Crude fibre	28.88
Nitrogen	3.01
Protein	18.87
Fat	9.36
Ash	6.98
Carbohydrate	22.58
Food energy	250.13 (g./calories)

Each value represents the average from three replications

The nutritive and proximate compositions determined in the studied sample of *A. sowa* seed were shown in Table II. The moisture, crude fibre, protein, ash and total carbohydrates were found to be 13.31%, 28.88%, 18.87%, 6.98% and 22.58% respectively. It was observed that plants with relatively high fibre content had low percentage of ash content. The Dill seed Should fairly high food energy value 250.137 (g./calories) which might be due to the high lipid content (9.36%). The high content of carbohydrate, protein as well as crude fibre are noticeable characteristics of the seed. The high fibre content (28.88%) of the *A. sowa* seed may possess positive effect in human diet. Besides, it may increase feacal bulk and lowers gastric cholesterol (Edeoga *et al*. 2003; Enwere 1998).

Gas liquid chromatographic analysis of the fatty acid showed that the saturated fatty acids present in the oil sample were mainly palmitic acid (4.27%), stearic acid (0.95%), arachidic acid (0.46%) and behenic acid

Table III. Fatty acid composition of Dill seed oil by GLC

Name of fatty acids	Retention time	Peak area	Percent composition
Palmitic acid $C_{16:0}$	17.68	33901	4.27
Linolenic acid $C_{18:3}$	21.60	55313	6.68
Oleic acid $C_{18:1}$	21.86	690820	87.10
Stearic acid $C_{18:0}$	22.35	7559	0.95
Arachidic acid $C_{20:0}$	26.68	1250	0.46
Behenic acid $C_{22:0}$	30.70	4258	0.54
Total percentage			100.00

(0.54%) which altogether accounted for over 6.22% saturated FA of the total fatty acid. The unsaturated fatty acids present in the oil samples were mainly oleic acid (87.10%) linolenic acid (6.68%) which contain 93.78% of the total oil.The oleic acid percentage is comparable to the olive oil (65-85%), safflower oil (79.7%) and linolenic acid percentage is similar to the soybean oil (2-10%), rapeseed oil (7-9%) and mustard oil (6.5-6.8%). On the other hand the saturated acid of palmitic is almost comparable to the grape seed oil (4-11%) and sunflower oil (4.29%) (Mowla *et al*. 1990; Ching Kuang Cho 2000).

Healthful fats (i.e. lower saturates and higher mono -unsaturated) have led to meet various consumer demands: (i) increased mono-unsaturated fatty acids: oils with increased mono-unsaturated (such as the high oleic varieties of oil seed) are low in polyunsaturated (linolenic acid) which are pron to oxidation. (ii) A high oleic oil also may help to reduce raised levels of total plasma cholesterol without reducing the high density lipoprotein (HDL) cholesterol level (US Department 1990; Francie *et al.*1995).

Common vegetable oils usually contain 6-15% saturated fatty acids (Norton 1989; Golfman and Bohme 2001; Kamal Eldin and Yanishlieva 2002). Dill seed oil contain 6.22% saturated fatty acid of the total oil, although it is slightly higher in respect of the lower limit of the said percentage range but it is comparatively better for human consumption. Owing to its high percentage of the unsaturated fatty acid (93.78%) especially the oleic acid (87.10%), it may be concluded that Dill seed of Bangladesh origin has suitable nutritional properties and therefore, may be considered as edible oil after proper refining. Otherwise the extracted oil may be tapped as a source of oleic acid. On the basis of above information the oil can also be used in the food and pharmaceutical industries as an important raw material for developing functional products.

Conclusion

Oils and fats have a significant role in human nutrition similarly in the production of various useful chemicals and industrial products. Demand of quality oils and fats is increasing all over the world. To cope with the increasing demand of oils and fats from new- conventional sources is getting importance.

The present study showed that, Dill seeds contain 9.36% fatty oil, but could be advantageous over the other vegetable oils in respect to health benefit (High PUFAs in the oil) as it contains 87.10% of oleic acid and 6.68% linolenic acid. However further study on the selection of high oil yielding variety of Dill *(A. sowa)* seed from available species is needed for commercial exploitation of the oil.

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References

A Manual of Laboratory Techniques. (1976) National Institute of Nutrition. Indian Council of Medical Research, Hyderabad-500007, India. pp.1-5.

Ali M.M., Hussain, M.G., Nurul Absar and Shahjahan, M. (1998) Investigation on rice bran: composition of rice bran and its oil. Bangladesh *J .Sci. Ind. Res.* **33(2):**170-177.

Anonymous. (1985) The Wealth of India. Raw Materials. CSIR New Delhi. **1:**272-275.

AOAC. (1984) Association of Official Analytical Chemist. Official Methods of Analysis 14th Edn. Sydney, Williams. Arlington, USA.

Bakowski, J. and. Michalik, H. (1986) Przydatnosc Niektorych Gatunkow Warzyw do Produkcji Suszow. Suitability of Several Vegetable Species for Drying. Biul. Warzywn. **12:**191-216 [in Polish].

Baslas R.K, Gupta R. and. Baslas, K.K. (1971) Chemical examination of essential oils from plants of *genus Anethum (umbelliferae)*- oil of seeds of *Anethum graveolens* (part-1). *The Flavour Industries.* **2:**241-245.

Bentham, G. and Hooker, T.D. (1862-7) Genera Plantarum. (Recve & Co.). p.919.

British Pharmacopoeia (B.P). (2004) **IV:** A 248-50

British Standard Methods of the Analysis of the Oils and Fats (1958) B S 684, British Standards Institution Incorporated by Royal Charter. British Standard House, 2 park St. London W.1.

Buwalda, P. (1949) Flora Malesiana. Botanic Gardens, Indonesia Bogor. **IV (Ser.1):** 136.

Ching Kuang Chow (2000) Fatty Acids in Foods and their Health Implications. Second Edition Marcel Deker Inc. Publisher, 270, Madison Avenue, New York, NY 10016.

Chopra, R.N., Chopra, I.C., Honda K.L. and Kapur, L.D. (1982 reprinted) Chopras Indigenous Drugs of India. Academic Publishers, New Delhi India 2nd Eds. pp. 692- 93.

Chu, W.S. and Sheldon, V.L. (1979) Soybean oil quality as influenced by planting site and variety . *J. Am Oil Chemists Soc.* **56:** 71-73.

Dey, K.L. (1896) The Indigenous Drugs of India, 2nd Eds. (Thaker,Spink & Co.Calcutta. p.233.

Edeoga, H.O., Okwu D.E. and Mbaebie, B.O. (2003) Minerals and nutritive value of some Nigerian medicinal plants. *Journal of Medicinal and Arometic Plant Science.* **25:** 1010-1015.

Enwere, N. J. (1998) Food of Plant Origin, Afro Orbis Publishers, Nsukka. pp.22-30.

Francie, G.D., Pamele J.W., Linda M.P. and Thomas, J.B. (1995) Fatty acid composition of oil from exotic corn breeding materials. *Journal American Oil Chemical Society.* **72 (9):** 981-87.

Galliard, T., Berkeley, H.D. and Matthews, J.A. (1975) Lipids of potato tubers. Effects of storage temperature on total, polar and sterol lipid content and fatty acid composition of potato tubers. *J. Sci. Food Agric.* **26:** 1163.

Golfman, F.D. and Bohme, T. (2001) Relationship between fatty acid profile and vitamin E content in maize hybrids *(Zea mays* L). *Argic. Food Chem.* **49:**4990-4994.

Guenther, E. (1950).The Essential Oils.IV: 619-635.

Gurr, M.I. and Jams, A.T. (1975) Lipid Biochemistry -An Introduction. Chapman & Hall London. p.201.

Halva, S and Puukka, L. (1987) Studies on fertilization of dill *(Anethum graveolens* L.) and basil *(Osimum basilicum* L):I. Herb yield of dill and basil affected by fertilization. *J. Agric. Sci. Fin.* **59(1):** 11-18.

Hansen, H.S. (1990) How do (n-3)- fatty acids affect. Prostaglandins? INFORM. **1:** 644.

Hytowitz, D.B. and Matthews, R.A. (1984) Composition of Foods, Vegetables and Vegetable products. Raw, Processed and Prepared, Agriculture, Hand book.8-11, U.S, Dept. of Agriculture, Washington D.C.

IUPAC. (1976/1977) Standard Methods for the Analysis of Oils, Fats and Derivatives. 6th Edition, Pergamon Press, Paris.

Kamal-Eldin, A. and Yanishlieva, N.V.(2002) N-3 fatty acids for human nutrition: stability concideration. *Eur.J Lipid Sci. Technol.* **104:** 825-836.

King, C.G. (1970) Biological and medical aspects of fats. *J. Am Oil Chemists' Soc.* **47:**418A.

Kinsella, J.E., Posati L., Weihrauch J. and Anderson, B. (1975) Lipids in foods: problems and procedures in collating data, *CRC Crit, Rev .Food Technol.* **5:** 299.

Kirk, S.R. and Sawyer R.. Pearson's (1991) Composition and Aanalysis of Foods 9th Eds. Longman, Scientific and Technical Press, Essen United Kingdom, pp. 617-620.

Mabaleha, M.B. and Yeboah, S.O. (2004) Characterization and compositional studies of the oils from some legume cultivars, *Phaseolus vulgari*, grown in Southern

Africa. *JAOCS.* **81(4):**361-364

Minosuke, H.(1958) Umbelliferae of Asia (Including Japan), (Botanical Institute, Kyoto University, Kyoto, Japan.1:182.

Mowla G., Sheick N.M. and. Kamal, A.S.M. (1990) Hand Book on Edible Oils and Fats with Special Reference to Bangladesh 1st Edition, City Press, Dhaka-1000, Bangladesh.

NIN. (1993) Manual of Laboratory Techniques. National Institute of Nutrition. ICMR, Hyderabad, India.

Norton, G. (1989) Nature and Biosynthesis of Storage Protams, in Oil Crops of the World; G Robbenlen; R.K. Downey and A.Ashri Eds, McGraw-Hill: New York. pp. 165-191.

Osborn, D.R. and Voogt, P. (1978) Calculation of Calorific Value. In: The Analysis of Nutrients in Foods. Academic Press, New York, pp. 239-240.

Paakkonen K., Malmsten T. and. Hyvonen L. (1989) *J. Food Sci.* **54(6):** 1485-1495.

Pruthi, J.S. (1998) Spices and Condiments. National Book Trust, New Delhi, India. pp.123-126.

Simon, J.E., Craker L.E. and Chadwick, A.F. (1984) Herbs an Indexed Bibliography, 1971-1980, The Scientific Literature on Selected Herbs and Aromatic and Medicinal Plants of the Temperate Zone.75, Archon Books, Hamden, C.T.

U.S Department of Agrcultural and US. Department of Health and Human Services. (1990) Nutrition and Your Health; Dietary Guidelines for Americans, 3rd Edn, Home and Garden Bull. No. 232, Washington DC.

Van Soest, P J. (1976) *J. Anim. Sci.* **26:** 119.

Woolf. (1999) *Essential Oil Poisoning Clinical Toxicology.* **37:** 721-727.

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