A potential source of Omega-6 and Omega-9 in *Cucumis melo* Seed Oil from Arid Zone of Rajasthan

Singhal Shreshtha, Omprakash, Kumar Praveen and Arora Arun Kumar*
Department of Chemistry, Faculty of Science, J. N. V. University, Jodhpur – 342005, Rajasthan, INDIA
*drarunkarora@gmail.com

Abstract
Omega-6 and Omega-9 fatty acids are a type of polyunsaturated fatty acids. Omega-6 is used for reducing the risk of heart disease, lowering total cholesterol levels, lowering bad cholesterol levels, raising good cholesterol levels and reducing cancer risk. The nutritional value of oleic acid (omega-9) in a balanced diet has been the subject of a number of studies with particular emphasis on the cardiovascular system. The seeds of Cucumis melo were collected from arid zone of Rajasthan, India. The physicochemical properties of Cucumis melo oil were evaluated.

Results of proximate analysis show crude fat (31.2%) and crude protein (28.5%). Muskmelon seed oil had clear bright yellowish colour with offensive odour with iodine value (124.2 mg/g oil) and saponification value (196.2 mg/g oil). We concluded that the muskmelon seeds are rich in oil and protein therefore, have a reasonable economic potential which can be harnessed. On HPLC analysis, stearic acid (9.4%), palmitic acid (13.2%), linoleic acid (60.2%) and oleic acid (18.9%) were found to be present in Cucumis melo seed oil. Most predominant polyunsaturated fatty acid was linoleic acid or omega-6. Oleic acid or omega-9 was also found as major fatty acid. Heavy metals are among the major environmental contaminants and pose a severe threat to human and animal health by their long-term persistence. MP-AES technique was used for determination of heavy metals (Cd, Zn, Fe, Ni and Pb) accumulated in seed oil of Cucumis melo.

Keywords: *Cucumis melo*, Omega-6, Omega-9, Muskmelon, Seed Oil.

Introduction

Edible oil is a biological mixture of esters derived from glycerol and a chain of fatty acids[8]. Physical and chemical characteristics of oil are influenced by the type and proportion of the fatty acids on the triacylglycerol. Fatty acids may be classified as short-chain (2–8 C), medium (8–12 C) and long-chain (13–24 C) or saturated fatty acid, monounsaturated fatty acid and polyunsaturated fatty acids depending on the presence or absence of double bonds[20]. Long-chain fatty acids are meanly composed of palmitic acid (C16:0), oleic acid (C18:1) and linoleic acid (C18:2) [30]. They play an important role in the human diet due to the control of the metabolism of cholesterol associated with cardiovascular disease[9]. Melon peels and seeds by-products have been recognized as a good source of fatty acids whereas seeds are the richest in LCFA in the whole melon[13,15].

Omega-6 fatty acids are lower harmful (low density cholesterol) and boost protective (high density cholesterol). They help in improving the body sensitivity to insulin and keep sugar in control. Omega-9 fatty acids have health benefits particularly on cardiovascular system.

Metal contamination issues are increasing due to metal toxicity in mining industries, foundries, smelters, coal-burning power plants and agriculture. Heavy metals, such as cadmium, copper, lead; chromium and mercury are major environmental pollutants, particularly in areas with high anthropogenic pressure. Heavy metals can be emitted into the environment by both natural and anthropogenic causes. The major causes of emission are the anthropogenic sources specifically mining operations.[6,10,14] Heavy metal accumulation in soils is of concern in agricultural production due to the adverse effects on food safety and marketability, crop growth due to phytotoxicity and environmental health of soil organisms.

The influence of plants and their metabolic activities affects the geological and biological redistribution of heavy metals through pollution of the air, water and soil[22]. Heavy metals are persistent in the environment, contaminate the food chains and cause different health problems due to their toxicity. Chronic exposure to heavy metals in the environment is a real threat to living organisms[2,28].

The main organ for long-term cadmium accumulation is the kidney[23]. Here the half-life period for cadmium is approx. 10 years. A life-long intake can therefore lead to a cadmium accumulation in the kidney, consequently resulting in tubulous cell necrosis. The blood concentration of cadmium serves as a reliable indicator for a recent exposition while the urinary concentration reflects past exposure, body burden and renal accumulation[11,17].

The general population is exposed to Pb from air and food. Children are particularly susceptible to Pb exposure due to high gastrointestinal uptake and the permeable blood brain barrier leading to neurotoxin effects even at low level of exposure[4]. The toxicity of Pb is caused by its direct interference with activity of different enzymes or displacing essential metal ions from metallo-enzymes. Kidney and liver are considered potential targets of Pb toxicity before storage in bones[26].

Most of arid zone fruits such as watermelon, papaya, bitter gourd, bottle gourd and sweet melon are consumed in the fresh form. They are generally well-known for their nutritional values which include vitamins and carbohydrates. On the other hand, fruits are extensively identified as good source of a healthy diet and adequate use could help to reduce a wide range of diseases like forms of cancer, stroke, heart disease and other chronic diseases[5,16].

The cucurbitaceous family, also commonly referred to as the cucumber, gourd, melon, or pumpkin family is a medium-sized plant family, primarily found in the warmer regions of the world. It is a family of economically important species of which the fruits are used for nutrition and medicinal purposes[7, 12]. There are a number of reports dealing with chemical and nutritional characteristics of fruits about seed varieties, mineral nutrients, edibility and stability of their oils[3, 25, 29]. For instance, pumpkin seeds were reported to contain higher levels of potent phytochemicals such as sterols with a great promise for immunomodulation, reproductive health, as well as therapeutic effect over a range of diseases[21].

Cucumis melo Linn is belonging to Cucurbitaceous family, commonly known as Muskmelon or sweet melon (in English), Kharbuja (in Hindi), Ervaru (in Sanskrit). Muskmelon is also known as "Nut meg" melon. The name is derived from the Roman habit of sprinkling the fruit with powdered musk to accentuate the flavour. The word 'Musk' is derived from Persian literature which means "Perfume" and other word "melon" is fresh from the latin Melopepo meaning "apple-shaped melon". Leaves are simple, alternate, orbicular-reniform[27] with 3-7 palmate lobes and also often with soft hairs; lobes are not deep and acute. Female peduncle sometimes 5 cm. Fruit is fleshy, spherically ovoid and hairy[19].

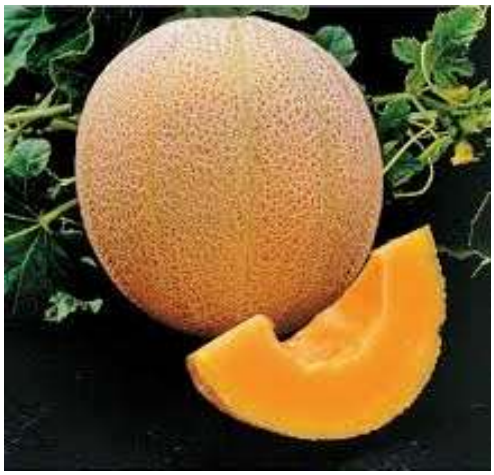
The unripe fruit is bitter and sour; may cause skin eruptions and strangury. The ripe fruit is sweet, oily, wholesome; cooling, fattening; tonic, laxative, aphrodisiac, diuretic; cures "vata", biliousness, insanity, ascites; allays fatigue; causes "kapha" (Ayurveda). The fruit is of different kinds: sweet, acrid, sour tonic, laxative, galactagogue, diuretic, strengthens the heart, the brain and the body; in general cures ophthalmia, urinary discharges; causes congestion of the eyes, in plethoric people gives headache; may cause indigestion.

Muskmelon seeds are used to lower blood pressure, sharpen eye sight being rich in vitamin A, well for hair growth and strengthens immune system due to presence of vitamin C. Seeds are helpful in acidity and constipation due to their neutral pH. The oil from the seeds is said to be very nourishing. Not only the seeds but the pulp of the fruit is a powerful diuretic, very beneficial in chronic and also in acute eczema. In China and Japan, the stalks of the fruit are considered as cooling and demulcent.[19] They are widely used as cosmetics such as skin lotions containing melon juice[24]. Skin protecting cosmetic liposomes comprises Ca ion and/or Mg ion and superoxide dismutase from melon concentrates[1,18].

Material and Methods

Sampling: The seeds of *Cucumis melo* plants were collected from arid zone of Rajasthan, India. Seeds were dried in air. Extraction of oil from seeds was done by solvent extraction method. The clean and dried seed samples were crushed in mortar and by using petroleum ether (60-80^{0}C) in a Soxhlet apparatus for 6 hrs, the oil was extracted from crushed seeds. The solvent is removed under reduced pressure. The obtained oil was stored in cool place (refrigerator) until further investigation.

Reagents: HNO_3, H_2SO_4, H_2O_2, HF, $HClO_4$ and HCl were of superior quality. Double deionized water was used for all dilutions. All the plastic and glassware were cleaned by soaking in dilute HNO_3 and were rinsed with distilled water prior to use. The working standard solutions of heavy metals used for calibration were prepared by diluting a stock solution of 1mg /L (Pb, Cd, Zn, Fe and Ni).



Fruit

Seeds

Mineral metal analysis: One of the methods for determination of the total contents and speciation analysis of heavy metals of their environmental concentrations is atomic absorption spectroscopy. This method is simple and very selective. In this study, we determined the concentration of heavy metals in seed oil of *Cucumis melo* plant by MP-AES method. Extraction of Pb, Cd, Co, Ni, Zn and Cu was performed in unconventional aqueous biphasic system formed by addition of hydrophobic salt of tetrahexylammonium bromide to aqueous sample with neither organic solvents nor salting-out agents. The metal ions were quantitatively recovered with 4-(2-pyridylazo)-resorcinol.

The extract was diluted with ethanol/HCl and introduced directly into an MP-AES instrument. The factors influencing extraction (pH, reagent concentration, phase contact time etc.) and MP-AES detection parameters were studied and optimized.

Preparation of standard for metal: In spectrophotometric measurements, we are concerned with solution having very small concentration of the metal to be determined. It follows that the standard solution which will be required for analysis must also contain very small concentration of the relevant metal. Standards are prepared by dissolving 1gm of metal cadmium, nickel, iron lead and zinc in minimum quantity of aqua regia (3:1) HCl and HNO_3, made up to 1 litre in volumetric flask by adding deionized water. This is a stock solution which contains about 1mg/L of required metal and then the working standard solution is prepared by suitable dilution of stock solution.

After the oil had been extracted, percentage of oil content in unit mass of seeds is determined. The equivalent is exposed to physiological test, for example, moisture content by vacuum oven method, acid value test, iodine value test using Wij's reagent and saponification value test and chemical analysis of seed oil.

Fatty acid analysis: The fatty acids composition of *Cucumis melo* plant oil was determined in two steps. In first step, hydrolysis of oil was done and mixed fatty acids were obtained and in second step, this mixture of fatty acids was further derivatised to their methyl esters. The formation of methyl esters was confirmed by thin layer chromatography (TLC). The methyl esters so obtained were analysed by HPLC.

Results and Discussion

Nutritional Analysis: The moisture content of *Cucumis melo* seeds is a bit low i.e. 4.2%. This shows that the seeds are very high in dry matter content which is an advantage because it reduces microbial activities, prevents oxidation-reduction reaction, algae and fungi growth and increases their shelf life when properly stored. The % protein obtained is similar to the values of seeds rich in protein which was 28.5%. Their high % protein will make them serve as a proper source of amino acids and protein for both man and animal. *Cucumis melo* seed is high in crude fibre when observe from the result, it has enough fibre for dietary nutrition which will help to maintain intestinal distension, reduce constipation, colon diseases and cancer.

Table 1
Physico-chemical Properties of *Cucumis melo* seeds

Sample	*Cucumis melo* Seeds
Carbohydrate (%)	6.9
Protein (%)	28.5
Fat (%)	31.2
Dietary Fiber (%)	24.7
Moisture (%)	4.2
Ash (%)	4.3
Iodine value (mg/g)	124.2
Saponification value (mg/g)	196.2

Fatty acid analysis: The high pressure liquid chromatographic analysis of the total lipids indicates that the amount of linoleic acid was maximum (60.2%), oleic acid was the second major unsaturated acid (18.9%) present in the oil with the minor amount of saturated acid such as palmitic acid (13.2 %) and stearic acid (9.4) (Table 2). These results are in accordance to earlier reports which show that oleic and linoleic acid are major fatty acids in most of the species of Cucurbitaceous family.

Table 2
Fatty acid composition

S.N.	Fatty acid	% Composition
1	Linoleic acid (C18: 2)	60.2
2	Oleic acid (C18: 1)	18.9
3	Palmitic acid (C16: 0)	13.2
4	Stearic acid (C18: 0)	9.4

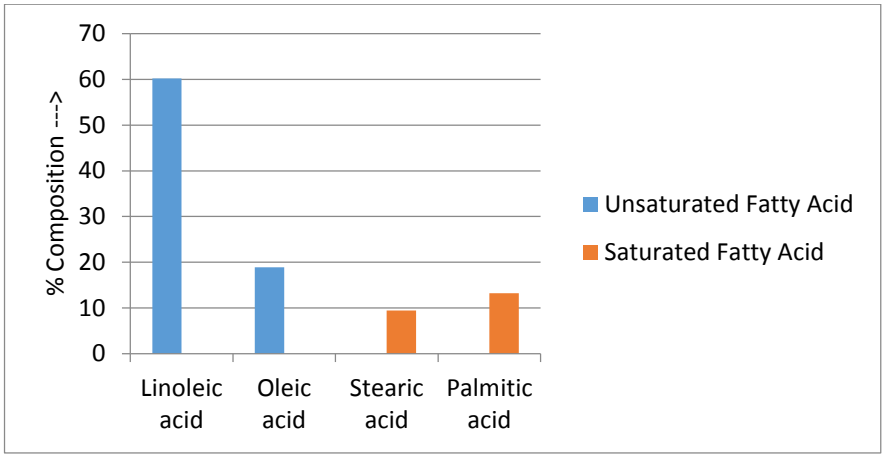


Figure 1: Plot showing comparison between Unsaturated and Saturated Fatty Acids

Table 3
Mineral content of *Cucumis melo* seeds

S. N.	Analyte	Sample concentration unit (mg/L) in *Cucumis melo* seeds
1	Ca	2445
2	Cd	0.07
3	Zn	69
4	Cu	19.5
5	Fe	156
6	K	7226
7	Mg	4295
8	Mn	28.2
9	Na	81
10	Ni	0.9
11	Pb	1.32
12	As	0.23

Metal Analysis: Minerals offer a wide range of health benefits to the human body. Minerals such as calcium and magnesium provide structures for our bones. Sodium and potassium help in the maintenance of normal blood pressure. Iron is a part of haemoglobin and myoglobin. Copper, zinc and manganese play an important role in the breakdown of carbohydrates, fats and proteins into digestible forms and convert them into energy. Trace elements like copper (Cu), manganese (Mn) and zinc (Zn) are essential in bone metabolism as cofactors for specific enzymes.

Conclusion

In conclusion, the present study revealed that the seed oils of *Cucumis melo* species, widely distributed in Rajasthan, seem to be a promising source of polyunsaturated fatty acids. Oleic acid and linoleic acid were the major unsaturated fatty acids. Oil from *Cucumis melo* seeds can be proposed as potential source of oil with health benefits to populations in developing countries. Linoleic acid (omega-6) was found in high percentage. Linoleic acid is an essential fatty acid.

The result reveals that bioaccumulation of heavy metals is less in *Cucumis melo* seeds. *Cucumis melo* seeds were observed to be very good sources of calcium, magnesium and potassium and can be used as mineral supplement. The musk melon seeds are rich sources of valuable bioactive compounds and can be explored as nutraceuticals. The seeds provide opportunities to develop as medicines, cosmetics, value added products and dietary supplements.

References

1. Ahmad M.I., Ansari S.H., Naqvi K.J. and Shuaib M., Pharmacognostical Studies and Establishment of Quality Parameters of *Cucumis Melo* L.C.V. Namdhari, *International Journal of Pharmacy and Pharmaceutical Sciences*, **4(4)**, 324-329 **(2012)**

2. Ali H., Khan E. and Ilahi I., Environmental Chemistry and Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity and Bioaccumulation, Hindawi, *Journal of Chemistry*, **2019**, 14 **(2019)**

3. Aravind G., Debjit B., Duraivel S. and Harish G., Traditional and Medicinal Uses of Carica papaya, *Journal of Medicinal Plants Studies*, **1**, 7–15 **(2003)**

4. Athar M. and Vohora S.B., Heavy metals and environment In Man and environment series, ed., Ray P.K., New Delhi, 1-195 **(1995)**

5. Azhari S., Xu1 Y.S., Jiang Q.X. and Xia W.S., Physicochemical Properties and Chemical Composition of Seinat (*Cucumis melo* var. *tibish*) Seed oil and its Antioxidant Activity, *Grasas Y Aceites*, **65,** 1-8 **(2014)**

6. Battarbee R., Anderson N., Appleby P., Flower R.J., Fritz S., Haworth E., Higgit S., Jones V., Kreiser A., Munro M.A., Natkanski J., Oldfield F., Patrick S.T., Richardson N., Rippey B. and Stevenson A.C., Lake Acidification in The United Kingdom, Ensis, London, **(1988)**

7. Craig W. and Beck L., Phytochemicals, Health Protective Effects, *Canadian Journal of Dietetic Practice and Research*, **60**, 78-84 **(1999)**

8. Da Silva A.C. and Jorge N., Bioactive Compounds of the Lipid Fractions of Agroindustrial Waste, *Food Research International*, **66**, 493-500 **(2014)**

9. Dorni C., Sharma P., Saikia G. and Longvah T., Fatty Acid Profile of Edible Oils and Fats Consumed in India, *Food Chemistry*, **238**, 9-15 **(2018)**

10. Duruibe J.O., Ogwuegbu M.O.C. and Egwurugwu J.N., Heavy Metal Pollution and Human Biotoxic Effects, *International Journal of Physical Sciences*, **2(5)**, 112-118 **(2007)**

11. Godt J., Scheidig F., Grosse-Siestrup C., Esche V., Brandenburg P., Reich A. and Groneberg D.A., The Toxicity of Cadmium and Resulting Hazards for Human Health, *Journal of Occupational Medicine and Toxicology*, **1**, 22 **(2006)**.

12. Goldberg G., Plants: Diet and Health, The Report of a British Nutrition Foundation Task Force, Blackwell Science, Oxford U.K., 347 **(2003)**

13. Gómez-García R., Campos D.A., Aguilarb C.N., Madureira A.N. and Pintado M., Valorization of Melon Fruit (Cucumis melo L.) By-products: Phytochemical and Biofunctional Properties with Emphasis on Recent Trends and Advances, *Trends in Food Science & Technology*, **99**, 507-519 **(2020)**

14. Hutton M. and Symon C., The Quantities of Cadmium, Lead, Mercury and Arsenic, Entering the U.K. Environment from Human Activities, *Science of Total Environment*, **57**, 129-150 **(1986)**

15. Ismail M., Fatty Acid Composition and Antioxidant Activity of Oils from Two Cultivars of Cantaloupe Extracted by Supercritical Fluid Extraction, *Fats and Oils*, **61(1)**, 37-44 **(2010)**

16. Jeffrey C., Appendix: An Outline Classification of the Cucurbitaceae, In Bates D.M., Robinson R.W. and Jeffrey C., eds., Biology and Utilization of the Cucurbitaceae, Comstock, Cornell University Press, Ithaca, 449–463 **(1990)**

17. Jin T., Nordberg M., Frech W., Dumont X., Bernard A., Ye T.T., Kong Q., Wang Z., Li P., Lundstrom N.G., Li Y. and Nordberg G.F., Cadmium Biomonitoring and Renal dysfunction among a Population Environmentally Exposed to Cadmium from Smelting in China (ChinaCad), *Biometals*, **15(4)**, 397-410 **(2002)**

18. Kaneko A., Kaise K. and Uemura H., Skin-protecting Cosmetics containing Calcium and/or Magnesium Compounds and Superoxide Dismutase, Patent No. JP 2007022931 **(2007)**

19. Kiritikar K.R. and Basu B.D., Indian Medicinal Plants, Vol. II, International Book Distributors, Dehradun, 1140-1142 **(1999)**

20. Kostik V., Memeti S. and Bauer B., Fatty Acid Composition of Edible Oils and Fats, *Journal of Hygienic Engineering and Design*, **4**, 112-116 **(2013)**

21. Machibya Z.P. and Saria J.A., Assessment of Heavy Metal Contamination in Edible Fruit Seeds from Dares Salaam City, Tanzania, *Journal of Environmental Science, Toxicology and Food Technology*, **14**, 21-26 **(2020)**

22. Nagajyoti P.C., Lee K.D. and Sreekanth T.V.M., Heavy metals, Occurrence and Toxicity for Plants, *A Review: Environmental Chemistry Letters*, **8**, 199-216 **(2010)**

23. Orlowski C. and Piotrowski J.K., Biological Levels of Cadmium and Zinc in the Small Intestine of Non-occupationally Exposed Human Subjects, *Human and Experimental Toxicology*, **22(2),** 57-63 **(2003)**

24. Rima K.K., Stabilization of Skin lotions containing a Melon juice, Patent No. JP57108006 **(1982)**

25. Soha M., El-Ghany S.A. and Dalia A.H., Biological Study on the Effect of Pumpkin Seeds and Zinc on Reproductive Potential of Male Rats, In Proceeding of the 5th Arab and 2nd International Annual Scientific Conference on: Recent Trends of Developing Institutional and Academic in Higher Specific Education Institutions in Egypt and Arab World, Faculty of Specific Education Mansoura University, Egypt, 2383–2404 **(2010)**

26. Vaishaly A.G., Mathew B.B. and Krishnamurthy N.B., Health Effects Caused by Metal Contaminated Ground Water, *International Journal of Advances in Scientific Research*, **1(02)**, 60-66 **(2015)**

27. Venkateswarlu K., Devann N., Priya R.V. and Kumar P.B., Muskmelon: Minerals, Nutritional Values, Pharmatutor-Art-2086, Pharmacy Infopedia **(2015)**

28. Wieczorek-Da browska M., Tomza-Marciniak A., Pilarczyk B. and Balicka-Ramisz A., Roe and Red deer as Bioindicators of Heavy Metals Contamination in North-Western Poland, *Chemistry and Ecology*, **29(2)**, 100-110 **(2013)**

29. Yanty N.A.M., Lai O.M., Osman A., Long K. and Ghazali H.M., Physicochemical Properties of *Cucumis Melo* var. *inodorus* Honeydew Melon Seed and Seed Oil, *Journal of Food Lipids*, **60**, 42–55 **(2007)**

30. Zhang C., Su, H., Baeyens J. and Tan T., Reviewing the Anaerobic Digestion of Food Waste for Biogas Production, *Renewable and Sustainable Energy Reviews*, **38**, 383-392 **(2014)**.

(Received 05th February 2021, accepted 06th March 2021)