RJC

RASĀYAN *J. Chem.*
Vol. 8 | No.4 |448 - 451 | October - December | 2015
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

TRACING MERCURY AND CADMIUM SOURCES IN EDIBLE SUNFLOWER OIL

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ABSTRACT
Edible oil is the source of energy that is consumed on large quantities across the world. Sunflower oil consumption has increased as it contains linoleic acid that washes the cholesterol from arteries, also lowers low density level cholesterol. Hazardous Heavy metals even in trace levels are toxic to human beings as they cause various disorders. Mercury and cadmium in edible sunflower oil were determined using Atomic Absorption Spectroscopy. The levels of Hg and Cd in sunflower oil were above the acceptable limit, hence to identify source of the heavy metals was carried out in soil, water and in sunflower seeds from the regions where they are cultivated. The statistical descriptive measures and correlation were determined. The presence of heavy metals could be due adulteration with palm oil or other source.
Key words: Sunflower oil, Mercury, Cadmium, Soil, water, Sunflower seeds

INTRODUCTION

Sunflower oil is widely used for cooking as it contains good LDL cholesterol and has a good aroma. Edible oil is the source of energy[1], where in FDA recommends nearly 30% of energy can be from fat source. Consumption of edible oil is 39 grams per day for an individual where in 29 grams per day is sufficient. Sunflower is robust to pest that grows even in arid regions and is beneficial to farmers as it can be grown as an intercrop.

Chemometry and multivariate techniques [2-4]can be used to detect adulteration in sunflower oil. Heavy metals detection from edible oil requires sophisticated instruments like AAS, ICP-AES [5] that detects heavy metals even at trace levels. Heavy metal [6-7] sources in oil could be from soil or water. Contaminated Water is the major source of heavy metals, when planting near industrial units may pollute water and could contaminate the soil also.

Heavy metals even in traces are toxic[8] for human beings. Elemental mercury and methyl mercury both are toxic, as they mainly affect our central nervous system, also damages our kidney and lungs. The exposure is more harmful for pregnant women. Mercury poisoning leads to various diseases such as pink disease, Minamata disease and Hunter Russel syndrome and various symptoms include lack of coordination, sensory impairment etc.,Cadmium is carcinogenic and chronic exposoure causes irreversible damage to kidneys and livers, causes osteoporosis leads to pain in joints and increased risk of fractures. Proximal renal tubular dysfunction and itai-itai diseases are caused due to increased cadmium exposure. Phosphate fertilizers contain upto 100 ppm of cadmium, which leads to increased cadmium concentration in soil.

EXPERIMENTAL

Sunflower oil samples purchased from Kumbakonam market were tested for Mercury and cadmium using AAS. Soil, water and sunflower seed samples were collected from locations (Salem, Tamilnadu, India) where sunflower oil is cultivated and processed. Mercury and Cadmium traces were identified for the above samples using AAS.

Sunflower oil, seed and water analysis for mercury and cadmium were done at CARISM, SASTRA University, Thanjavur. Mercury and Cadmium in soils was done at Mettex Laboratories, Chennai.

Methods

Take in a silica crucible the powdered sample about 0.1 – 1.0 grams or 1- 20 ml for liquid samples, keep in a muffle furnace at 450-500°C for 4-5 hours until it turns into ash. Liquid samples of higher volume are reduced to 1-2 ml before ashing. The acquired ash is dissolved in a suitable acid. If required the ash can be subjected for digestion as defined below.

Digestion methodology

Samples are digested with 1:1 distilled water and concentrated Nitric acid on a hot plate for 4-5 hrs. They are kept in open condition and the loss of acid by vaporizations is adjusted by addition of the same acid mixture. After cooling, it is made up to 100 ml by adding Distilled water and is filtered using Whatman No. 1 filter paper before AAS analysis. The calculation formula is shown below-

$$Conc\ of\ Elmt\ \ in\ sample\ (ppm) = \frac{instrument\ reading\ (ppm) * Vol\ of\ digesion\ mixture\ (ml)}{qty\ (Wt) of\ sample\ taken\ for\ digestion\ (gm) or\ (ml)}$$

RESULTS AND DISCUSSION

The result of analysis of mercury and cadmium using AAS with the above method for sunflower oil samples are given below. Nearly 21 samples from different brands were tested and in 3 brands (coded as A, B, C) the heavy metals traces were found. The trace level presence of heavy metals is given below in Table-1. The chart shown in Fig.-1 describes the level of mercury in ppm and levels of cadmium in ppm in the sunflower oil samples.

Table 1: Mercury and Cadmium levels in Sunflower oil.

Sunflower Oil (coded)	Hg (ppm)	Cd (ppm)
A	71.44	0.46
B	84.84	0.42
C	87.94	0.56

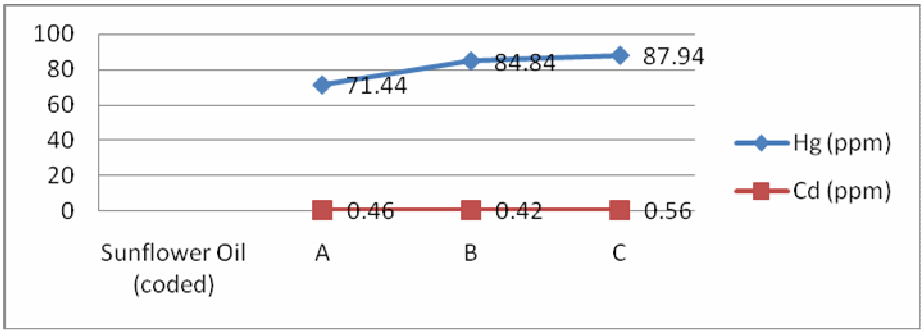

Fig.-1: Levels of Mercury and Cadmium in Sunflower oil

Water and Soil Analysis

To detect the source of mercury and cadmium analysis was carried out in water and soil. In India, sunflower is grown in about two million hectares and the yield is nearly one million tonne (Nearly 4% of world sunflower requirement). In Tamil Nadu, sunflower is grown inTrichy, Erode, Karur, Dindigul, Villupuram and Cuddalore regions. To identify the region, the location of processing and packaging of samples that showed heavy metal traces were carried out. The locations were Salem, Tuticorin,

Villupuram respectively and were coded as (S, T, V). Water and soil from the above sunflower cultivated regions were analyzed for mercury and cadmium. The results are given below in Table-2.

Table-2: Water and soil analysis from Salem, Tuticorin and Villupuram

Samples coded	Hg (ppm) (water & Soil)	Cd (ppm) water & Soil)
S	BDL	BDL
T	BDL	BDL
V	BDL	BDL

Sunflower seed Analysis

As soil and water had no traces of mercury and cadmium , as a next step sunflower seeds were analyzed using AAS for mercury and cadmium sources. It should be noted that sunflower absorbs the heavy metals from soil, so the possibility of heavy metals in sunflower oil could be from the seeds. The seeds from the above market were tested and no traces in the seeds also.

Statistical Analysis

A statistical analysis was performed for the mercury and cadmium levels obtained from oil, soil, water and seed. The descriptive statistics is given below in table 3.Sample variance is the variation of observations in the given sample which is 40 and 0.24 for mercury and cadmium. As different samples are drawn for same population would have different sample mean hence standard error is the standard deviation (i.e., on using sample mean as the method of estimation) of the sample means for all possible samples which is 18 and 0.1 for mercury and cadmium. Skewness measures the degree of symmetry; the samples are positively skewed with 0.06 and 0.12 respectively. The measure of Kurtosis describes the degree of peakness or flatness in the variable, as the values are negative-3.18& -2.96 the above samples form Platykurtic distribution .All other statistical measures such as mean,median, mode, maximum, minimum, count are the usual measures.

Table-3: Descriptive Statistics for Mercury and Cadmium in Oil, water, soil and seed.

Statistics	*Mercury*	*Cadmium*
Mean	40.70	0.24
Standard Error	18.34	0.11
Median	35.72	0.21
Mode	0.00	0.00
Standard Deviation	44.93	0.27
Sample Variance	2018.87	0.07
Kurtosis	-3.18	-2.96
Skewness	0.06	0.12
Range	87.94	0.56
Minimum	0.00	0.00
Maximum	87.94	0.56
Sum	244.22	1.44
Count	6.00	6.00

Correlation Analysis

As sunflower oil showed very high traces of heavy metals all possible sources such as soil, water and seeds were analyzed for correlation identification, except for the oil none of the sources showed heavy metal traces. Hence there is no correlation between heavy metals in sunflower oil and soil, water and seeds.

Presence of mercury and cadmium is above the FDA standards. To identify the source of the heavy metals experiment was carried out in water, soil and sunflower seed and was below the detectable limit. No correlation exists between the presence of heavy metals in soil, water and seed but chances could be during refining process or possibility of adulteration. Sunflower oil demand is high and so possibility of adulteration of sunflower oil with palm oil is prevailing in the society. GC/MS analysis of samples containing mercury and cadmium showed more of Palmitic acid 13%, according to Merck index, Palmitic acid in sunflower oil should be 6%.As all sunflower oil samples did not contain mercury and cadmium the possibility for the presence in few brands could possibly be due to adulteration with palm oil. Hence as a future work, presence of mercury and cadmium in palm oil will be traced.

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[RJC-1306/2015]