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Research Article

ANALYSIS OF HEAVY METALS AND MINERALS IN FRUIT JUICES BY INDUCTIVELY COUPLED PLASMA MASS SPECTROMETRY COUPLED WITH ATOMIC ABSORPTION SPECTROSCOPY

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ABSTRACT

The aim of the study was to investigate the amount of heavy metals and minerals in fruit juices collected from different vendors as a basis for evaluating their possible effects on the health of consumers. The heavy metals (As, Cd, Cu, Hg, Pb, and Zn) were analyzed by ICP-MS while minerals (Ca, Fe, Na and K) were analyzed by AAS. In the present study, no heavy metal was detected in the fruits juice samples. The minerals content (Ca, Fe, Na and K) were found to be within limit that will not be harmful to consumers. The study shows that the fruit juices are safe for consumption and have no toxic effect on the health of the consumers.

INTRODUCTION

Fruit Juices are essential part of modern diet in almost every society. Fruits and fruits product are known to be good source of nutrients such as minerals and vitamins (Nahar *et al.,* 1990). Fruit Juices are available in most part of the world in bottles, Cans, Cups, Laminated Paper packs and almost every other form of packing in the diet, of Most people, irrespective of age included Significantly thus, It contribute to good health. (Tasnim *et al.,* 2010). In countries having hot climate means that the intake of liquid must be high to compensate for the expected losses from respiration (Al Jedah and Robinson, 2002). Fruit Juices deserve special attention because of their important influence on human health. Intake of fruit juices has been constantly related with reduced risk of many cancer types (Brock *et al.,*1988) and might be protective against stroke (Feldman, 2001) and hold up the beginning of Alzheimer's disease (Dai *et al.,* 2006).

As a result of the Soil, atmosphere, underground and surface water pollution, our foods and beverages are contaminated with heavy metals. Heavy metals are potential environmental contaminants which can cause health problems if present in excess in the food we eat, thereby requiring Special attention throughout the world due to their adverse effect even at low concentrations (Das, A. 1990). Several cases of human disease, disorders, malfunction and malformation of organs due to metal toxicity have been reported (Jarup *et al.,* 1998). Determination of heavy metals composition of food is of interest because of their essential or toxic Nature. For example, Iron, Zinc, Copper, Chromium, cobalt, and manganese are essential, while lead, cadmium, nickel, and mercury are toxic at when taken in. Minerals are of great importance in determining the fruit nutritional value. Potassium, calcium are the Major ones. The importance of minerals such as potassium, calcium, Sodium etc. to human health is well documented. Required amount of these elements must be in human diet to pursue good healthy life (San *et al.,* 2009). A number of these mineral elements are required in varying amount by humans for proper growth, function and overall well being (obinwa *et al.,* 2005; Hussain *et al.,* 2010). While these elements are essential, they can be toxic when taken in excess

MATERIALS AND METHOD

Material

Juice Sample

Collection of fruit Juice samples was performed from commercially available vendors. Fruit juices samples of six

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different types were bought from different vendors. They were grouped as follows:

Sample1: Apple juice
Sample2: Orange juice
Sample3: Mango juice
Sample4: Multifruit juice
Sample5: pulpy orange juice
Sample6: aam panna juice

Chemicals, Stock solution

All the chemicals used in the study were of analytical grade (thermo fisher)

Methods

Cleaning Procedure

Glass apparatus were washed first with water and detergent, and then Rinse with tap water, followed by double distilled water, then with 10% nitric acid solution. And finally rinse 4-5 times with double distilled water.

Digestion of Sample

In the present study wet digestion method has been used. 5ml (approx) of well mixed juice sample was taken and transferred to 100ml beaker and 5 ml HNO_3 was added and cover with watch glass the mixture was heated to 95c^o on hot plate, and the digestion continued till no brown fumes evolved and solution becomes clear and colourless. The beaker is then cool to room temperature. The solution is then transferred into a volumetric flask and make up the mark with double distilled water.

Principle

A known weight of sample is digested using wet digester with concentrated nitric acid. The digested sample is diluted to known Volume and analyzed in ICP-MS/AAS.

Preparation of Standards for ICP-MS

Stock Solution #1

Mixed standard

	Concentration		
ICP-Multi Std-33	10	± 0.03	mg/l
ICP-Multi Std-17	10	± 0.03	mg/l
Mercury	1000	± 6.0	mg/l

Stock solution of Intermediate #2

	Aliquot (ml) from #1	Made up volume (ml)	Conc. (mg/l)
ICP-Multi Std-33	5.0	50	1.00
ICP-Multi Std-17	5.0	50	1.00
Mercury	0.05	50	1.00

Calibration curve standards

Label	Aliquot (ml) from #2	Made up volume (ml)	Conc. (mg/l) Mixed Std.
CC1	0.025	50	0.5
CC2	0.05	50	1.0
CC3	0.25	50	5.0
CC4	0.5	50	10.0
CC5	1.0	50	20.0
CC6	2.0	50	40.0
CC7	3.0	50	60.0
CC8	5.0	50	100.0

Preparation of standards for AAS

Stock solution #1

Mixed standard	Concentration		
Calcium	1000	± 3.0	mg/l
Iron	1000	± 2.0	mg/l
Potassium	1000	± 5.0	mg/l
Sodium	1000	± 4.0	mg/l

Label	Aliquot (ml)from #1	Made up volume (ml)	Conc. (mg/l) Na	Conc. (mg/l) K	Conc. (mg/l) Ca	Conc. (mg/l) Fe
CC1	0.0025	100	0.25	0.25	0.5	0.1
CC2	0.050	100	0.50	0.50	1	0.2
CC3	0.100	100	1.00	1.00	2	0.5

Sample Analyses

Atomic Absorption Spectroscopy coupled with inductively coupled plasma Mass spectrometry was used in the study, instrumental conditions were adjusted, and instruments were calibrated by blank solution and finally metals/minerals contents of the fruits were analyzed. Cu, Zn, As, Cd Hg and Pb were analysed by ICP-MS while Ca, Fe, Na and K were analysed by AAS.

Calculation of Results

***Metal Content**:* The Metal content of the sample was calculated according to the following equation by ICP-MS:

$$\text{Result (mg/kg)} = \frac{[\text{Inst. Reading of sample (ng/ml)-Inst. Reading of blank(ng/ml)}]\text{x Final volume (ml)}}{\text{Weight of sample (g)} \times 1000}$$

Mineral Contents: The minerals content of the sample was calculated according to the equation by AAS:

$$\text{Result (mg/g)} = \frac{[\text{Inst. Reading of sample (ng/ml)-Inst. Reading of blank(ng/ml)}]\text{x Final volume (ml)}}{\text{Weight of sample (g)} \times 10}$$

RESULT AND DISCUSSION

Result

Table 1 shows the result of heavy metals that were analyzed in the entire sample. The heavy metals investigated were Arsenic, Cadmium, Copper, Mercury, Lead and Zinc, and all of these heavy metals were not detected in the fruit juice sample. All samples for detection of heavy metals were analysed by ICP-ms which can detects metals in part per billion (ppb).

Table 2 gives the result of minerals that were analyzed in all samples. Minerals investigated were Calcium, Iron, Sodium and Potassium. All minerals were analyzed by AAS which detects the minerals in part per million (ppm). Iron was not detected in all the six samples. In sample1, calcium was found to be 3.38 mg/100kg, sodium 21.70 mg/100kg and potassium 15.54 mg/100kg. In sample2, calcium was found to be 24.06 mg/100kg, Sodium 1.70 mg/100kg and Potassium 21.70 mg/100kg. Sample3 had 68.37 mg/100kg of calcium, 20.26 mg/100kg of Sodium and 59.55 mg/100kg of Potassium. Sampled4 had 43.5 mg/100kg of calcium, 128.18 mg/100kg of Sodium and 32.37 of Potassium. Sample5 contain 47.38 mg/100kg of Calcium, 15.74 mg/100kg of Sodium and 25.03 mg/100kg of Potassium. In sample6, calcium had 5.3 mg/100kg, Sodium 11.12 and Potassium 5.75 mg/100kg.

Table 1 Level of Heavy metals (mg/kg)

parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
Arsenic	ND	ND	ND	ND	ND	ND
Cadmium	ND		ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND
Zinc	ND	ND	ND	ND	ND	ND

Table 2 Level of Minerals (mg/100g)

Parameter	Sample1	Sample2	Sample 3	Sample 4	Sample 5	Sample 6
Calcium	3.38	24.06	63.87	43.45	47.38	5.39
Iron	ND	ND	ND	ND	ND	ND
Sodium	21.70	1.70	20.26	128.18	15.74	11.12
Potassium	15.54	21.70	59.55	32.37	25.03	5.75

DISCUSSION

The evaluation of commercial fruit juices is an important issue for consumer safety as they are widely consumed throughout the world (franke *et al.,* 2006). Heavy metals are of great concern because of their toxic effect even at low concentration and their tendency of accumulating in human organ, which may lead to serious organ damage.

According to food safety and standard of India (contaminants, toxins and residues) regulation 2011, the maximum permissible limit in fruit juices for lead, cadmium, copper, arsenic, mercury and zinc is 1ppm, 1.5ppm, 5ppm, 0.2ppm, 1ppm and 5ppm respectively.

In the present study, all the metals in question were not detected, which is in line with the food safety regulation. These findings suggest that with respect to heavy metals, the fruit juices have no effect on the health of its consumers.

For minerals, calcium was found to be higher in sample 3, 4 and 5. Calcium is of important because of its role in teeth, bone, muscular system and heart function (Brody 1994). Ion was not detected even though it is an essential element which helps in haemoglobin formation. High amount of sodium was found in sample 4. Sodium play important role in the transport of metabolites. Sample 3 have high level of potassium. An increase level of potassium in blood causes reduced renal function, and abnormal breakdown of proteins and severe infection and gastrointestinal damage (murtaja *et al.,* 2015).

(Saupi *et al.,* 2009) stated that the ratio of K/Na in any food is an important factor in prevention of hypertension arteriosclerosis, with potassium depresses and Na enhances blood pressure.

CONCLUSION

The result shows that the fruit juices are safe for consumption and have no toxic effect on the health of the consumers.

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