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Effect of microwave roasting and storage on the extent of heavy metals present in dry fruits

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Abstract

Exposure of heavy metals to humans has risen continuously through the contaminated diet. The objective of the research is to determine the concentration of some heavy metals (Cu, Cr, Ni, Pb, Co and Cd) in dry fruits by Atomic Absorption Spectrometery. Ten samples of dry fruits i.e Almond *(P. amygdalus)*, Hazelnut *(C. vellanus)*, Dates *(Phoenix dactylifera)*, Cashew nuts *(Anacardium occidentale)*, Walnuts *(Juglans nigra)*, Raisins *(Vitis vinifera)*, Peanuts *(Arachis hypogeaea)*, Apricot *(Prunus armeniaca)*, Figs *(F. macrophylla)* and pistachio *(P. vera)* was collected and studied the effect of microwave roasting and storage on heavy metal concentration. The concentration of Cu ranges from 0.522-2.633 ppm, Co 0.01-1.001 ppm, Cr 0.02-0.909 ppm, Ni 2.550-5.990 ppm, Pb 1.001-10.002 ppm, Cd 0.722-8.332 ppm. Microwave roasting and storage has not appreciable effect on the metal concentration of selected dry fruits.

Key words: Microwave, Roasting, Heavy metals, Dry fruits, Atomic Absorption Spectrometry

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1. Introduction

The modern life style has completely changed the way of food consumption and preparation because of excess use of fast foods. The natural uptake of minerals, vitamins, sugars, fibres and pectins, etc. in human beings is achieved by vegetables and fruits consumption [1]. It is reported that health depends upon organized form of elements in human body and the imbalance of these elements cause many diseases [2]. The presence of heavy metals in higher concentration the permissible limits are toxic and causes disease. The atomic absorption spectrophotometer is used to analyse the presence of heavy metals [3-4].

Dried fruits and nuts are the durable supplies due to less water levels and traded commonly under normal conditions [5]. Raw and roasted nuts are largely consumed worldwide and are much important in the confectionery industry as major ingredient in candies and cookies. The nuts are considered highly nutritious and consumed worldwide indicates the levels of a micronutrients present in them reliably [6]. Dry fruits are the good source of nutrients and give advantages on the other diet supplements. The dry fruits are used in our daily life, because they strongly reduced the risk of cancer, stroke, heart disease and other chronic ailments. Climatic conditions, especially light intensity and temperature have a strong effect on nutritional level and quality of fruits [7]. Contact of chromium compounds with skin can cause skin ulcers [8]. It Heavy metals have both positive and negative effects on human life. These elements play major role in many biological processes, but have poisonous effects at higher concentration [9]. The persistent nature and potential toxicity of heavy metals and frequent consumption of fruits, it is essential to investigate the food items so that make sure the contaminant level of these metals must agree the international necessities [10]. The microwave oven is a widely used for food preparation. It refers to electromagnetic waves of 300 to 300,000 MHz frequency. The electromagnetic waves are of magnetic and electrical energy moving jointly in space [11].

The objective of this research work was not only to determine the concentration of some heavy metals i.e copper, chromium, cadmium, lead, nickel and cobalt in dry fruits and but also study the effect of microwave roasting and storage on concentration of heavy metals in selected dry fruit samples.

2. Materials and methods

2.1. Collection of Sample

Ten dry fruits samples were randomly collected from local market of Faisalabad, Pakistan. Composite

sample of one kg was collected and divided into parts as for different treatments. Samples were stored under ambient conditions (20-25 °C) until analysis. Ten dry fruits samples were used for analysis. Almond *(P. amygdalus)*, Pine nut *(C. vellanus)*, Dates *(Phoenix dactylifera)*, Cashew nuts (*Anacardium occidentale*), Walnuts (*Juglans nigra*), Raisins (*Vitis vinifera*), Peanuts (*Arachis hypodgeaea*), Apricot (*Prunus armeniaca*), Figs (*F. macrophylla*), Pistachio *(P. vera*).

2.2. Sample treatment

The nuts were crushed with a morter and pestle until powdery samples were obtained. The effects of two different treatments were studied such as microwave roasting and storage. These effects were studied on the metal profile of dry fruit samples. Dry fruit samples placed in Pyrex Petri dish was roasted in microwave oven at a frequency of 2455 MHz (oven capable of generating 500 W, medium power setting,) for t_1 = 3 minute, t_2 = 5 minute, and t_3 = 7 minute. After roasting of samples at different temperatures, dry fruit samples were allowed to cool at normal temperature and thoroughly mixed before to crushing [12]. To study the effect of storage on concentration of heavy metals, the samples were stored for the two years at the normal conditions. The dry fruit samples were purchased two years before the start of experimental work.

2.3. Sample digestion

Wet digestion method was used to digest the dry fruit samples. One gram of sample was weighed by weighing balance in the 250 mL digestion flask, add 10 mL of concentrated nitric acid (67 %) and hydrogen peroxide dropwise, heated on hot plate. The digestion procedure continued until the volume of sample was reduced to about 1 mL. The inner walls of the digestion flask were washed with double de-ionized water and the flask was swirled throughout the digestion to prevent the loss of samples and to keep the wall clean untill the solution become colorless. The samples were cooled for 5 minutes, filtered using Whatman No. 42 filter paper and less than 0.45 um Millipore filter paper. The filtrate transferred to a 25 mL volumetric flask and made upto volume with double de-ionized water before analysis [13].

2.4. Analysis of sample

Metal contents in the prepared samples were analyzed using Atomic Absorption Spectrophotometer (Hitachi Polarized Zeeman AAS, Z-8200, Japan. Selected metals for analysis in present work included Copper, Chromium, Cadmium, Lead, Nickel and Cobalt. All of the reagents used were analytical grade and purchased from Merck, Germnay.

3. Results and Discussion

The concentration of heavy metals was determined by atomic absorption spectrometer. Metals are essential nutrients due to their functioning in metabolism. Metal play an important role in many enzymes, as antioxidants and catalysts in human life [14]. Some of these trace elements like manganese, cadmium, chromium, zinc and copper are necessary micronutrients and perform various types of biochemical functions in all living organism. Humans need a specific amount of micronutrients like Zn and Fe, but excess uptake of non-essential metals like Pb and Cd can be highly harmful. Living beings cannot synthesize minerals element, these are usually required through food [9]. Heavy metal concentration in dry fruits varies with the composition of soil, with the pollution grade and on the plant fruit metals fixing capacity. High concentration of some heavy metals in dry fruits may mean that shoot of plant contain more concentration than roots. The reason of this would be large amount of atmospheric emission from vehicles or machines which deposited the metals on fruits during transportation and the places where they displayed for sale in open markets along roadside [1]. Among the heavy metals, copper is an important metal for many enzyme functions, notably superoxide dismutase and cytochrome oxidase. Copper (II) ion oxidized Cu (II) states, allowing vital role in iron absorption, elastin cross linking, free radical scavenging and in physiology of cell as cofactor of catalyst in redox chemistry of mitochondrial respiration [9]. Dry fruits or nuts are the best source of micro and macro nutrients, which give advantages on other food components. The dry fruits are the important part of our daily life, because they not only provide mineral elements but also reduced the risk of various diseases i.e. cancer, stroke, heart disease and other chronic ailments. The root stock used for plant, soil type, irrigation, mulching, fertilization, and cultural practices which influences the nutrient and water supply to plant that affect the quality and composition of cultivated plant [7]. The present research work is focused on determining the concentration of heavy metals and the effect of temperature and storage in different dry fruit samples in order to find environmental and ecological relationship between elements. The samples heated in consumer based microwave oven for 3, 5 and 7 minute and analyzed by atomic absorption spectrometry (Fig 2-4). The samples were also analyzed by fresh dry fruits (Fig 1) and storage (Fig 5) for comparison of metal concentration. In the human body cobalt metal has very little activity. It is the necessary component of vitamin B12, so that its sources, effect and uses are parallel to cyanocobalamin. In my findings the cobalt contents in different dry fruit samples have small values given in tables 1-10, which is little higher than given by WHO/FAO. The elevated level of lead is due to the uncontrolled development of urban areas and increasing industrialization. The concentration of cobalt is maximum in fig (anjeer) 1.169 ppm and least value is in raisin 0.079 ppm .The effect of roasting on the concentration of metals is not very considerable. Lead (Pb) is toxic environmental pollutant which reacts and also makes complexes with most of biomolecules. It strongly affects the nervous, reproductive, gastrointestinal, renal, immune, cardiovascular, muscular and skeletal systems. Lead is generally added in the environment by aerial sources including plant parts and soil. The highest concentration of lead is that it is easily absorbed and accumulated in different plant parts. The lead concentration in all dry fruit samples was within range, given by world health organization (WHO). Its value ranges from 4 to 9.9 ppm that is acceptable range.

Table 1: Concentration of heavy metals in almond

No of obs.	Almond		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1		Fresh Sample	1.075 ±0.02	8.810 ±0.11	1.363 ±0.02	0.519 ±0.01	3.398 ±0.02	0.743 ±0.03
2	Microwave Roasted	3 Min	0.963 ±0.05	7.854 ±0.03	0.996 ±0.02	0.388 ±0.01	2.435 ±0.06	0.697 ±0.01
3		5 Min	0.823 ±0.01	6.612 ±0.03	0.910 ±0.01	0.297 ±0.02	1.558 ±0.04	0.524 ±0.01
4		7 min	0.641 ±0.04	6.407 ±0.06	0.732 ±0.01	0.358 ±0.05	0.959 ±0.02	0.446 ±0.02
5		Stored Sample	0.489 ±0.03	8.854 ±0.02	0.576 ±0.05	0.655 ±0.01	2.517 ±0.03	0.712 ±0.01

Table 2: Concentration of heavy metals in pine nuts

No Of obs.	Pine nut		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1		Fresh sample	0.537 ±0.02	8.800 ±0.02	1.113 ±0.01	0.941 ±0.03	2.947 ±0.02	1.000 ±0.01
2	Microwave Roasted	3 min	0.458 ±0.05	7.322 ±0.003	0.532 ±0.03	0.788 ±0.02	2.612 ±0.02	0.807 ±0.06
3		5 min	0.321 ±0.03	6.245 ±0.002	0.646 ±0.03	0.725 ±0.04	1.634 ±0.04	0.740 ±0.03
4		7 min	0.308 ±0.01	4.722 ±0.01	0.522 ±0.05	0.745 ±0.02	1.1886 ±0.02	0.441 ±0.01
5		Stored sample	0.655 ±0.05	3.950 ±0.01	0.921 ±0.01	0.753 ±0.06	2.163 ±0.061	0.943 ±0.03

Table 3: Concentration of heavy metals in dates

No of obs.	Dates		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		1.002 ±0.01	9.566 ±0.01	0.589 ±0.07	0.921 ±0.01	5.447 ±0.03	1.769 ±0.02
2	Microwave Roasted	3 min	0.918 ±0.03	8.268 ±0.05	0.446 ±0.01	0.225 ±0.04	4.044 ±0.02	0.994 ±0.03
3		5 min	0.865 ±0.05	7.975 ±0.01	0.414 ±0.02	0.761 ±0.02	3.981 ±0.02	0.854 ±0.01
4		7 min	0.785 ±0.03	7.705 ±0.03	0.390 ±0.015	0.670 ±0.02	2.222 ±0.01	0.773 ±0.01
5	Stored sample		0.906 ±0.05	9.045 ±0.07	0.512 ±0.02	0.730 ±0.03	5.015 ±0.02	1.107 ±0.02

Table 4: Concentration of heavy metals in cashew nuts

No of obs.	Cashew nuts		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		0.837 ±0.01	3.341 ±0.01	2.772 ±0.07	0.400 ±0.01	3.963 ±0.03	1.454 ±0.02
2	Microwave Roasted	3 min	0.754 ±0.03	3.032 ±0.005	2.333 ±0.01	0.225 ±0.04	3.686 ±0.021	1.333 ±0.03
3	Microwave Roasted	5 min	0.667 ±0.05	2.739 ±0.01	2.222 ±0.02	0.105 ±0.02	3.077 ±0.04	1.118 ±0.01
4	Microwave Roasted	7 min	0.663 ±0.03	2.848 ±0.03	1.623 ±0.01	0.107 ±0.02	2.751 ±0.01	0.885 ±0.01
5	Stored sample		1.194 ±0.05	4.632 ±0.05	2.606 ±0.07	0.489 ±0.03	3.089 ±0.06	1.396 ±0.02

Table 5: Concentration of heavy metals in walnuts

No of obs.	Walnuts		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		0.888 ±0.05	9.221 ±0.04	1.043 ±0.02	0.387 ±0.02	3.776 ±0.01	0.855 ±0.03
2	Microwave Roasted	3 min	0.645 ±0.01	7.284 ±0.05	0.732 ±0.02	0.770 ±0.01	3.040 ±0.05	0.724 ±0.04
3	Microwave Roasted	5 min	0.513 ±0.02	5.919 ±0.01	0.653 ±0.02	0.093 ±0.01	2.831 ±0.05	0.625 ±0.02
4	Microwave Roasted	7 min	0.590 ±0.01	6.117 ±0.02	0.542 ±0.001	0.136 ±0.01	2.399 ±0.05	0.456 ±0.02
5	Stored sample		0.885 ±0.01	7.051 ±0.03	0.901 ±0.03	0.426 ±0.04	3.113 ±0.02	0.773 ±0.02

Table 6: concentration of heavy metals in peanut

No of obs.	Peanut		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		0.348 ±0.002	9.803 ±0.002	0.576 ±0.005	0.626 ±0.002	4.873 ±0.020	0.943 ±0.005
2	Microwave Roasted	0.248 ±0.002	8.856 ±0.064	0.488 ±0.001	0.471 ±0.0241	3.446 ±0.040	0.807 ±0.005	0.724 ±0.04
3	Microwave Roasted	0.136 ±0.002	8.546 ±0.002	0.377 ±0.001	0.322 ±0.002	2.453 ±0.050	0.762 ±0.002	0.625 ±0.02
4	Microwave Roasted	0.074 ±0.001	8.181 ±0.004	0.297 ±0.001	0.354 ±0.004	2.033 ±0.113	0.696 ±0.001	0.456 ±0.02
5	Stored sample		0.030 ±0.0005	9.002 ±0.001	0.498 ±0.0005	0.600 ±0.0005	3.938 ±0.063	0.896 ±0.002

Table 7: Concentration of heavy metals in raisins

No of obs.	Raisins		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		0.107 ±0.07	3.700 ±0.01	0.653 ±0.01	0.636 ±0.02	5.086 ±0.02	0.775 ±0.02
2	Microwave Roasted	3 min	0.0905 ±0.01	2.975 ±0.02	0.587 ±0.01	0.517 ±0.01	4.632 ±0.06	0.707 ±0.05
3	Microwave Roasted	5 min	0.0751 ±0.001	2.460 ±0.04	0.398 ±0.01	0.406 ±0.03	3.559 ±0.02	0.655 ±0.03
4	Microwave Roasted	7 min	0.079 ±0.001	2.591 ±0.003	0.267 ±0.001	0.395 ±0.002	2.958 ±0.008	0.555 ±0.004
5	Stored sample		0.436 ±0.006	5.443 ±0.002	0.501 ±0.001	0.593 ±0.001	4.233 ±0.002	0.507 ±0.005

Table 8: Concentration of heavy metals in apricots

No of obs.	Apricots		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		0.618 ±0.02	8.246 ±0.01	0.396 ±0.02	0.314 ±0.02	4.987 ±0.01	0.998 ±0.02
2	Microwave Roasted	3 min	0.567 ±0.02	6.786 ±0.05	0.364 ±0.03	0.238 ±0.02	4.111 ±0.11	0.887 ±0.01
3	Microwave Roasted	5 min	0.478 ±0.05	6.194 ±0.01	0.355 ±0.03	0.178 ±0.02	3.044 ±0.05	0.763 ±0.02
4	Microwave Roasted	7 min	0.492 ±0.002	6.631 ±0.001	0.309 ±0.002	0.202 ±0.001	2.732 ±0.04	0.655 ±0.03
5	Stored sample		0.774 ±0.05	7.671 ±0.01	0.387 ±0.01	0.461 ±0.02	4.856 ±0.04	0.913 ±0.02

Table 9: Concentration of heavy metals in Fig

No of obs.	Fig		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		1.568 ±0.05	0.924 ±0.03	1.033 ±0.01	0.734 ±0.02	4.771 ±0.01	7.661 ±0.02
2	Microwave Roasted	3 min	0.910 ±0.02	0.775 ±0.03	0.664 ±0.01	6.596 ±0.02	3.939 ±0.01	6.988 ±0.05
3	Microwave Roasted	5 min	0.825 ±0.05	0.634 ±0.03	0.397 ±0.01	0.537 ±0.03	3.661 ±0.01	6.144 ±0.02
4	Microwave Roasted	7 min	0.900 ±0.01	0.593 ±0.02	0.281 ±0.05	0.484 ±0.05	2.749 ±0.01	5.891 ±0.01
5	Stored sample		1.169 ±0.01	0.814 ±0.01	0.960 ±0.01	0.446 ±0.01	3.892 ±0.06	7.999 ±0.02

Table 10: Concentration of heavy metals in pistachio

No of obs.	Pistachio		Concentration of heavy metals in ppm					
			Cobalt	Lead	Copper	Chromium	Nickel	Cadmium
1	Fresh sample		1.029 ±0.06	1.115 ±0.004	0.991 ±0.06	0.733 ±0.03	5.681 ±0.06	6.577 ±0.04
2	Microwave Roasted	3 min	0.801 ±0.01	0.994 ±0.02	0.866 ±0.02	0.621 ±0.03	4.936 ±0.05	5.787 ±0.01
3	Microwave Roasted	5 min	0.661 ±0.05	0.772 ±0.01	0.571 ±0.05	0.436 ±0.03	4.192 ±0.01	4.383 ±0.01
4	Microwave Roasted	7 min	0.721 ±0.02	0.552 ±0.02	0.455 ±0.01	0.418 ±0.03	3.024 ±0.02	4.333 ±0.02
5	Stored sample		0.832 ±0.03	0.333 ±0.03	0.908 ±0.06	0.723 ±0.01	5.548 ±0.06	7.524 ±0.01

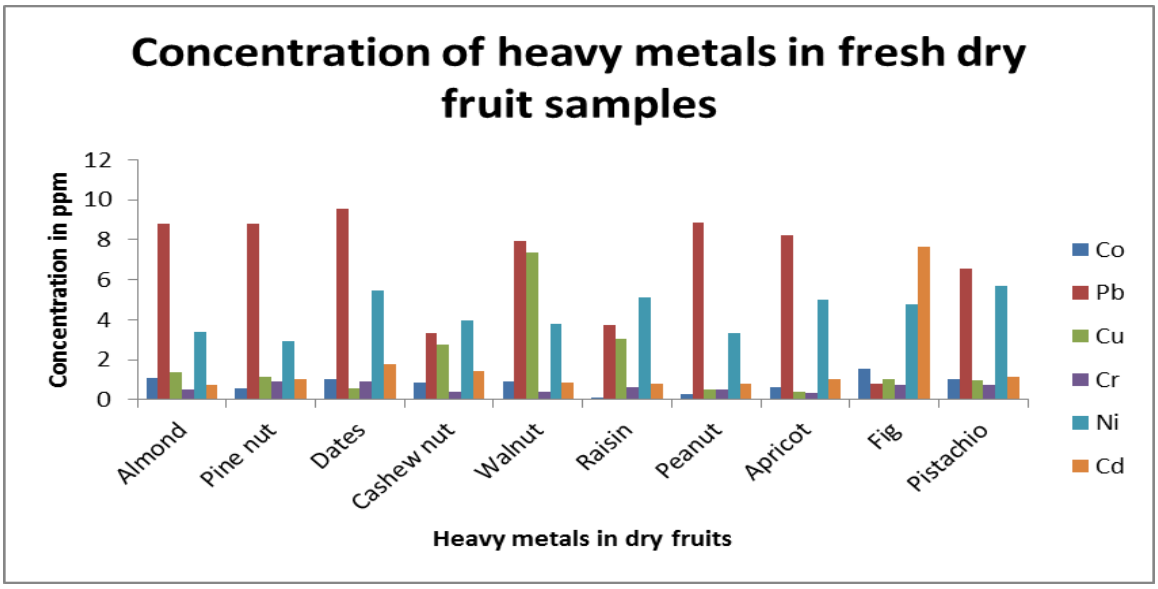

Fig. 1. Concentration of heavy metals in dry fruits

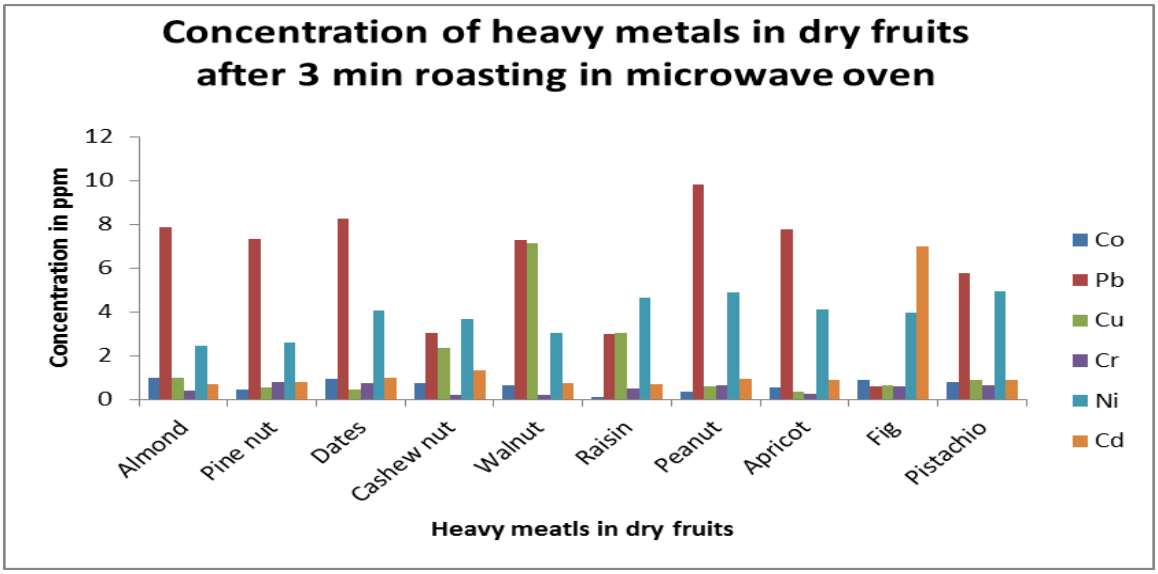

Fig. 2. Concentration of heavy metals in dry fruits

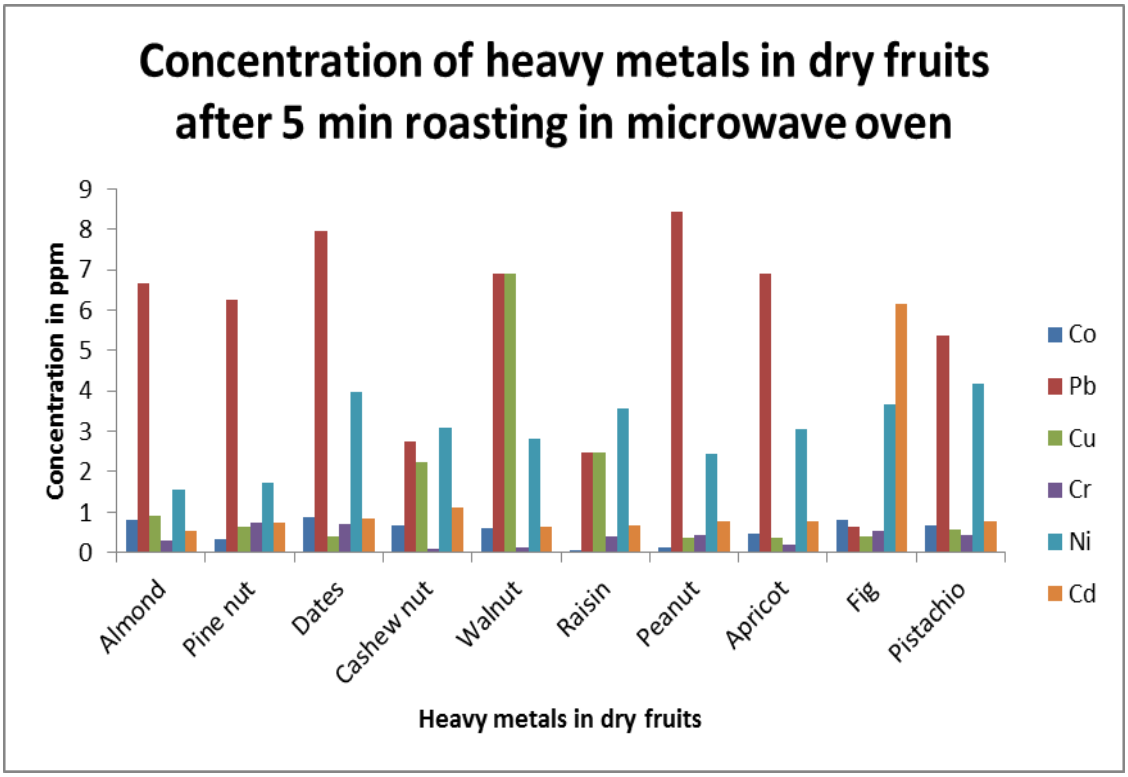

Fig. 3. Concentration of heavy metals in dry fruits

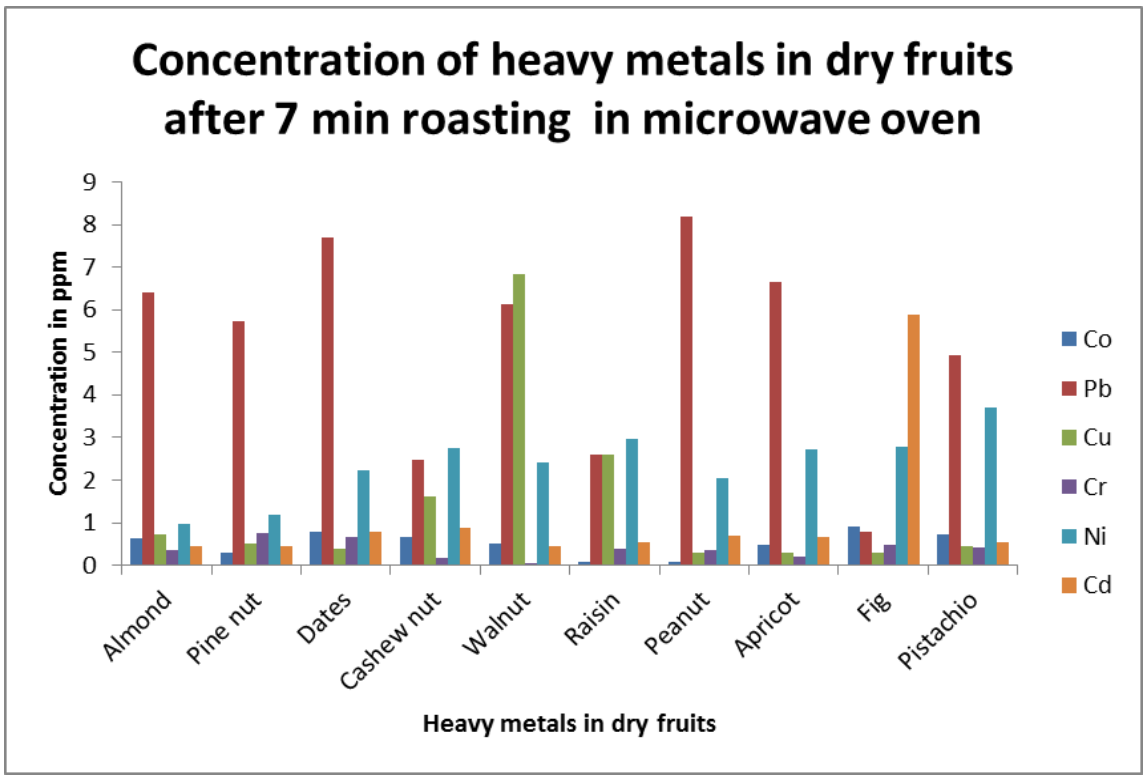

Fig. 4. Concentration of heavy metals in dry fruits

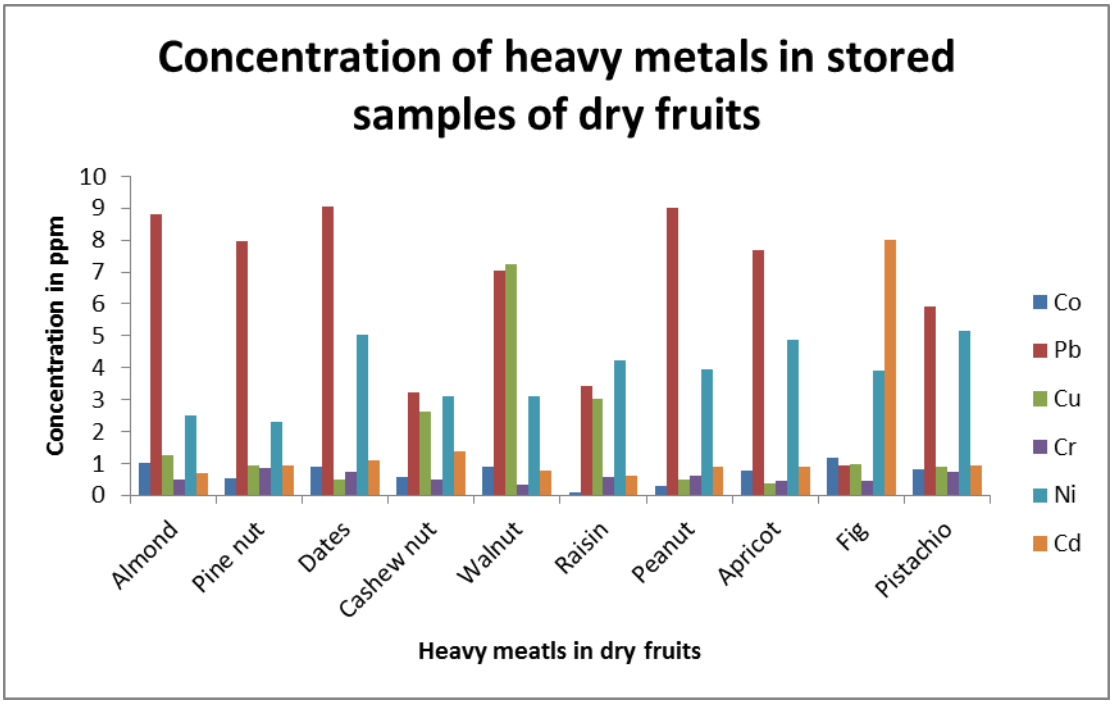

Fig. 5. Concentration of heavy metals in dry fruits

The estimated daily intake of lead is 2.96 mg/day. The highest concentration of lead is find in dates (9.566 ppm) and least in fig (0.593 ppm). Copper metal play important role in oxidative defense system, enzyme functioning, to enhance the free radical regulation and its deficiency increase in lipoprotein peroxidation, mitochondrial fragmentation and myofibrillardisarray.

According to WHO/FAO, daily intake of copper is 2.5 mg/day. In my results contents of copper is in permissible range, maximum concentration in walnut 2.772 ppm and lowest in dates 0.390 ppm. As per earlier reports the concentration of lead as determined has very less value (0.018 ug/g) in dates [15]. Chromium metal plays an important role in human body. Its deficiency causes glucose intolerance and eminent serum cholesterol level. The result of heavy metals does not indicate much variation by roasting in microwave oven. The concentration of chromium is minimum in apricot sample and maximum in pine nut samples. Cadmium is one of most poisonous heavy metals that cause the heart diseases. The concentrations of cadmium in all samples under investigation are under the permissible concentration of cadmium by (FAO/WHO). The high concentration of cadmium might be due to the use of Cd containing fertilizers, growing practices of plant in soil having sewage sludge or both. The descending order of heavy metals by roasting the sample in microwave oven and storage is not much appreciable. Maximum concentration in fig is 9.900 ppm. Among heavy metals, nickel concentration has highest value in peanut 4.983 ppm and lowest in almond 0.959 ppm. The results reveal wide variation in heavy metals contents among different dry fruit samples but have no appreciable concentration change after roasting in oven or storage [13-15].

4. Conclusions

Ten samples of dry fruits i.e Almond *(P. amygdalus)*, Hazelnut *(C. vellanus)*, Dates *(Phoenix dactylifera)*, Cashew nuts *(Anacardium occidentale)*, Walnuts *(Juglans nigra)*, Raisins *(Vitis vinifera)*, Peanuts *(Arachis hypogeaea)*,, Apricot *(Prunus armeniaca)*, Figs *(F. macrophylla)* and pistachio *(P. vera)* was collected and studied the effect of microwave roasting and storage on heavy metal concentration. The concentration of Cu ranges from 0.522-2.633 ppm, Co 0.01-1.001 ppm, Cr 0.02-0.909 ppm, Ni 2.550-5.990 ppm, Pb 1.001-10.002 ppm, Cd 0.722-8.332 ppm. Microwave roasting and storage has not appreciable effect on the metal concentration of selected dry fruits.

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References

[1] M.N. Stefanut, I. David, Z. Stanoiev, C. Macarie. The monitoring of heavy metals in fruits. Chemical Bulletin of "POLITEHNICA" University of Timisoara Romania. 52(66): 147-151.

[2] I. Mohammadzai, Z. Shah, H. Hkan, I. Ihsanullah. (2011). Mineral composition of date palm fruit and pit by atomic absorption spectrophotometry. Journal of the Chemical Society of Pakistan. 32(1) 87-90.

[3] R. Nadeem, M.A. Hanif, M. Riaz, A.A. Azhar, T. Iqbal, T.M. Ansari. (2010). Kinetic and equilibrium modeling of Cu (II) and Ni (II) sorption onto physically pretreated *Rosa centifolia* distillation waste biomass. African Journal of Biotechnology. 9(53) 9051-9062.

[4] M. Riaz, R. Nadeem, M. Asif, T. Mehmood, K.U. Rehman. (2009). Pb (II) biosorption from hazardous aqueous streams using *Gossypium hirsutum* (Cotton) waste biomass. Journal of Hazardous Materials. 161(3) 88-94.

[5] F. Sen, K.B. Meyvaci, U. Aksoy, M. Emekci, A.G. Ferizli. (2009). Effects of the post-harvest application of methyl bromide alternatives on storage pests and quality of dried fig. Turkish Journal of Agriculture and Forestry. 33: 403-412.

[6] G. Dugo, L. La-Pera, V.L. Turco, E. Mavrogeni, M. Alfa. (2003). Determination of selenium in nuts by cathodic stripping potentiometry (CSP). Journal of Agricultural and Food Chemistry. 51(13) 3722-3725.

[7] E. Zahir, I.I. Naqvi, S.M. Uddin. (2009). Market basket survey of selected metals in fruits from Karachi City (Pakistan). Journal of Basic and Applied Sciences. 5(2) 47-52.

[8] M.A. Gondal, Z.S. Seddigi, M.M. Nasr, B. Gondal. (2010). Spectroscopic detection of health hazardous contaminants in lipstick using laser induced breakdown spectroscopy. Journal of Hazardous Materials. 175(1) 726-732.

[9] A. Dhiman, A. Nanda, S. Ahmad. (2011). Metal analysis in *Citrus sinensis* fruit peel and *Psidium Guajava* leaf. Toxicology international. 18(2) 163.

[10] A. Maleki, M.A. Zarasvand. (2008). Heavy metals in selected edible vegetables and estimation of their daily intake in Sanandaj, Iran. Southeast Asian Journal of Tropical Medicine and Public Health. 39(2) 335-340.

[11] N. Jittrepotch, T. Kongbangkerd, K. Rojsuntornkitti. (2010). Influence of microwave irradiation on lipid oxidation and acceptance in peanut (*Arachis hypogaea* L.) seeds. International Food Research Journal. 17: 173-179.

[12] T. Anjum, A. Javaid, M.B.M. Shah. (2006). Correlation between plant growth and arbuscular mycorrhizal colonization in some rainy season grasses. Pakistan Journal of Botany. 38(3) 843-849.

[13] I.M. Aldjain, M.H. Al-Whaibi, S.S. Al-Showiman, M.H. Siddiqui. (2011). Determination of heavy metals in the fruit of date palm growing at different locations of Riyadh. Saudi Journal of Biological Sciences. 18(2) 175-180.

[14] H. Ciftci, A. Ozkaya, E. Kariptas. (2009). Determination of fatty acids, vitamins and trace elements in *Pistacia terebinthus* coffee. Journal of Food Agriculture Environment. 7(3-4) 72-74.

[15] Z.A.A. Othman. (2010). Lead contamination in selected foods from Riyadh city market and estimation of the daily intake. Molecules. 15(10) 7482-7497.