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A Comparative Study of Some Nuts And Seeds Constituents Available in Local Market at Misurata City-Libya

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Abstract
The aim of this study was to estimate and compare some of chemical constituents in nuts and seeds consumed as snacks and available in the local market of Misurata city in Libya. 18 kinds of local and imported raw and roasted nuts and seeds samples were randomly collected from stores distributed across the city, with 3 - 4 replicates of each kind, in order to estimate the concentrations of some chemical components and heavy elements, which were lead (Pb), cadmium (Cd), Iron (Fe), copper (Cu), chromium (Cr), manganese (Mn), cobalt (Co), zinc (Zn), nickel (Ni), moisture, ash, total solids and protein. The dry digestion method was used to prepare the samples for heavy metals determination using Flame Atomic Absorption Spectrometer. Also, moisture, ash and total solids contents were determined, and Kjeldahl method was used to estimate proteins. The results showed that the average concentrations of heavy metals varied significantly with sample kind. The levels of the studied metals were as follows: 0.075 - 1.167, 31.50 - 116.00, 0.325 - 1.325, 9.425- 71.00, 0.025-3.87, 8.325- 24.825, 0.175- 1.250, 0.050- 0.750, 43.00- 98.325 mg/kg, for Co, Zn, Ni, Mn, Pb, Cu, Cr, Cd, and Fe, respectively. Also, levels of moisture contents, ash contents, total solids contents, and protein levels were: 4.0 - 8.5%, 2.0 - 11.39%, 91.5 - 96.0%, and 11.8 - 33.2%, respectively. Most of the obtained results were consistent with the previous studies and within the permissible limits.

Keywords
Nuts; Seeds; Heavy Metals; Chemical Constituents.

1. INTRODUCTION

Nuts Industry like almonds, walnuts, pistachios, cashews, hazelnuts, peanuts, and some sorts of roasted seeds, which are produced in more than forty countries but they are consumed in all the world. The World Nuts Association, which is a non-governmental organization that works to support this market, and its mission is to expand a global consumption range of all types of nuts. The work of this association began in 1994 and had published a lot of scientific articles for highlighting the positive role of nuts and seeds on human health and their ability to reduce some diseases such as cardiovascular diseases, and they have proven that nuts are a good nutritional supplement [1]. Most studies have found that nuts and seeds have the ability to prevent heart disease, cholesterol and cancer, and they are a source of fats, minerals and vitamins, [2-4]. Various nuts sorts like hazelnuts, cashew, almonds, pistachios, walnuts, and as well as peanuts, are nutritional foods each with a distinctive components. Generally, these diets contain proteins, vitamins like E and K, minerals; like Mg, Cu, K, and Se, beneficial monounsaturated and polyunsaturated fatty acid profiles, soluble and insoluble fibers, and medically effective substances such as antioxidants, xanthophyll carotenoids, and phytosterols compounds, with well-known benefits to human health [5].

Heavy metals could be divided into toxic (such as lead, cadmium, and arsenic) and essential (such as zinc, iron, and copper) and therefore have positive and negative effects on the human health [6]. People are subjected to heavy metals in several methods such as; by consumption of polluted water and food, and by breathing of air impurities or polluted soil particles [7]. Continuing contacts to toxic metals can be very dangerous still at low levels but the consumption of excessively essential metals can similarly cause toxic effects [8,9]. The importance of chemical analysis for nuts, shows the extent of contamination of this type of food and the possibility of using it as an important source for some nutrients. Contamination of nuts with heavy metals could occur from surrounding planting areas or during the production process. The Environments is the main cause of heavy metal contamination in the

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food chain and determination of heavy metal element level is an important task in nutrition and toxicity analysis [4, 10].

Several techniques were used to determine the levels of heavy metals in biological samples such as flame atomic absorption spectrometry, atomic fluorescence spectrometry, and inductively coupled plasma optical emission spectrometry [11, 12]. Flame atomic absorption spectrometry (FAAS) is a suitable and commonly utilized method for the routine evaluation of trace metals because its selectivity, simplicity, availability, and its inexpensive compared with other methods [13]. In our previous work we have evaluated various chemical and physical constituents in different types of biological samples [14-16].

The aim of the current research is to estimate heavy metals, moisture contents, total solid contents, ash contents, and protein contents in different kinds of seeds and nuts sold in the local markets to assess its nutritional value as well as the extent of contamination with some toxic metals.

2. EXPERIMENTAL

2.1. Samples Collection

18 of different types of nut and seed samples were collected randomly; which are widely sold in the local markets in Misurata city, as shown in Table 1. 3 replicate samples were analyzed for each kind. The samples were then dried and crushed with mortar, and 2 g were taken for the analysis, which was used to estimate moisture, total solids, ash and protein. The same weight was used for the determination of heavy metals after digestion process.

Table 1. Kinds of nuts and seeds analysed in the study.

No.	Sample Type
1	Roasted Iranian pistachios
2	Roasted Turkish hazelnut
3	Iranian pistachio shiny yellow roasted
4	Local peanuts
5	Roasted American pistachios
6	White Chinese peanuts
7	American almonds
8	Red Chinese peanuts
9	Australian almonds
10	Roasted Chinese Pumpkin Seeds
11	Local almonds
12	Roasted yellow Egyptian watermelon seeds
13	Peeled almonds
14	Roasted Egyptian Zucchini Seeds
15	American Walnuts
16	Roasted Canadian sunflower seeds
17	Roasted Indian cashews
18	Unroasted Canadian sunflower seeds

2.2 Reagents

All reagents and metal salts used were of Analytical Grade (BDH-UK). All standard solutions were prepared using deionized water. All glassware and polyethylene bottles were soaked in 1 M nitric acid for 24 h, and then washed several times with deionized water.

2.3. Digestion Method

Dry digestion method was used [17]. Exactly weigh 2.0 g of sample into a cleaned silica dish and heat gradually on a hot-plate to volatilize as much moisture and organic matter as possible. Frequently, distributed the sample out with a cleaned suitable rod to speed up the drying process. When the sample become completely dry, transfer to a dish to a muffle furnace adjusted at 700^{o}C and leave it for 4 h to accomplish the decomposition step. Then, remove it from the furnace, leave it to cool down and add 3 ml of 1 M nitric acid. Dissolve the sample ash from any insoluble residue. Transfer the contents quantitatively into a 50 ml volumetric flask complete to mark wit deionized water and mix thoroughly to ensure homogeneity.

2.4. Instrumentation

All heavy metals determinations were performed by Atomic Absorption Spectrophotometer Hitachi ZA-3000 with Zeeman Background Correction.

3. RESULT AND DISCUSSION

3.1. Cobalt Analysis

Fig. 1 showed that the average concentrations of cobalt in the studied samples ranged between 0.075 ± 0.025 mg/kg, which was in sample 15 (American walnut) and 1.167 ± 0.800 mg/kg which was found in sample 11 (local almond). By comparison with previous studies, it is noted that the concentrations are higher than that found in the study that was conducted in Beijing, China [18] and in Sweden [19] to estimate heavy metals in nuts.

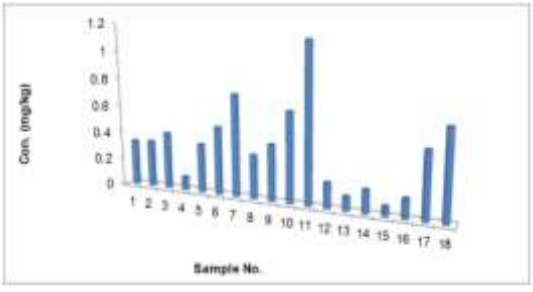

Fig. 1. Co levels in the studied samples.

However, all the results obtained in the current study agree with that found in the study conducted in Pakistan [20] in which it was stated that the levels of cobalt were ranged between 0.348 mg/kg in Peanuts and 1.075 mg/kg in almond. The higher level of cobalt in some samples could be attributed to the pollution of the environment in which the plant was grown or the

water in which it was irrigated. By calculating the amount of cobalt that consumed daily by eating 100 g of local almonds, we find that it is 116.7 µg, which is more than the daily needs, which were estimated at 25 µg cobalt level, and this amount might not be dangerous because the percent of cobalt absorbed in the body ranges between 15 and 30%.

3.2. Zinc Analysis

Fig. 2 showed that the average zinc levels in the investigated samples were ranged between 31.50 ± 1.50 mg/kg (roasted American pistachios) and 116.00 ± 2.50 mg/kg (Roasted Egyptian zucchini). However, these results presents that 67% of our samples fall within the permissible limits which specified by the World Health Organization at 60 mg/kg [21]. In comparison with other researches, it is observed that 83% of our results fallen within the same range as in the study conducted in Sweden [19]. Also 61% of the samples were consistent with those determined in the study conducted in Spain [10] and South Africa [22], in which the average levels of zinc were in the range 49.70 and 54.26 mg/kg, respectively. By calculating the quantity of zinc enters the human body by eating 100 g of roasted Egyptian pumpkin seeds per day, we found it was 1.160 mg, which is much less than the recommended limits specified by the US Food and Drug Administration (FDA), which is between 12 and 15 mg of zinc for an adult daily [18].

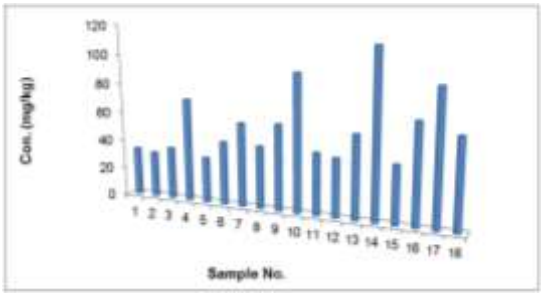

Fig. 2. Zn levels in the studied samples.

3.3. Nickel Analysis

The nickel concentrations in the samples under investigation were (as shown in Fig. 3) ranged between 0.325 ± 0.150 mg/kg, which was in roasted Turkish nuts and white Chinese peanuts, and 11.325 ± 1.05 mg/kg, which was in roasted Canadian sunflower seeds. It is also noted that there was a large variation in the nickel concentrations between the studied samples. The results of the current study were in agreement with those found in a study conducted in Iran [8], where nickel concentrations were ranged between 0.36 mg/kg and 13.80 mg/kg. But it was higher than the results obtained in the study conducted in Spain [10], where the concentrations were ranged between 0.10-0.64 mg/kg, on the other hand, they were less than the results of other studies [8, 20]. By estimating the intake amount of nickel that enters the human body by consuming 100 g of roasted Canadian sunflower seeds per day, we found that it reached 1132.5 µg, which is higher than the daily requirement, which was estimated between 100-300 µg [8].

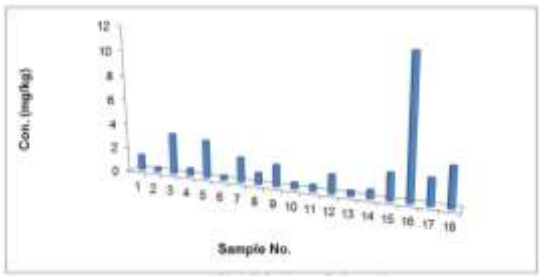

Fig. 3. Ni levels in the studied samples.

3.4. Manganese Analysis

The average manganese concentrations in the studied samples were varied from 9.425 ± 1.75 mg/kg in the roasted Iranian pistachios (sample 1), to 71.00 ± 19.625 mg/kg in the American walnut (sample 15), as displayed in Fig. 4. A significant variation in the manganese levels is observed for similar samples (nuts or seeds), with the exception of Iranian pistachio samples, which were close. It is noticed that 89% of our results were in agreement with those determined in previous studies [18, 19], and all the results of the current study were in consistent with those obtained in the study conducted in South Africa [22]. Also, these results indicated, together with previous studies, that most foods contain manganese at a level between 0.2-35.0 mg/kg [24]. By estimating the amount of manganese that enters the human body when consuming 100 µg of American walnuts per day, we found that it reaches 7100, which is higher than the recommended daily limits of 18-2300 µg / day [22]. On the other hand, it was also mentioned that the daily requirement of manganese is between 3500-7000 µg [24].

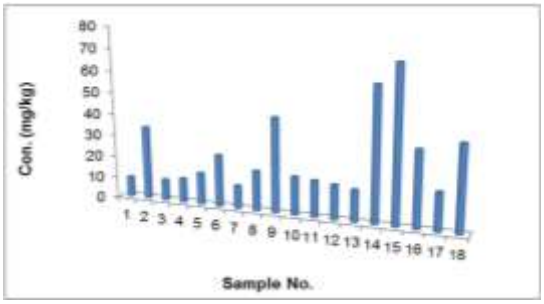

Fig. 4. Mn levels in the studied sample.

3.5. Lead Analysis

Fig. 5 displayed that the average concentrations of lead in the studied samples were ranged between 0.025 ± 0.0025 mg/kg, which was in the Iranian roasted pistachio samples (referred to as sample 1) and 3.875 ± 0.175 mg/kg in the American almond samples (sample 7). It is also noted that 39 % of the samples under investigation contained concentrations less than the limits allowed by the Chinese standards, which was 0.2 mg/kg [18]. On the other hand, it was found that 33 % of the samples 'results were agreed with those found in the study conducted in Beijing, China [18], while the rest of the samples contained higher concentrations. Also, all results were higher than those determined in the study conducted in Sweden [19], and 50% of them are consistent with those which determined in a previous study [10]. On the other hand, all results were less than those found in the study conducted in Pakistan [20]. By comparing the concentrations in the samples of each kind, it is noted that the average concentrations were similar in pistachios samples and dissimilar in almonds, walnuts, peanuts, and seeds. By calculating the amount of lead that enters the human body when consuming 100 g of the American almond per day, we found that it was 387.50 µg, and this is less than the permissible limits in some countries, as in US which is 400 µg / day, South Africa 500 µg / day. However, the World Health Organization (WHO) has determined it as 300 µg / day.

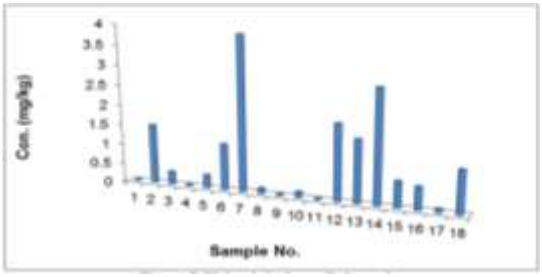

Fig. 5. Pb levels in the studied samples.

3.6. Copper Analysis

Fig. 6 showed that the average copper concentrations in the studied samples were ranged between 8.325 ± 0.525 mg/kg, which was in sample 6 (Chinese white peanut), and 24.825 ± 5.625 mg/kg, which was found in sample 17 (roasted Indian cashew). These results were lower than the copper intake limits for food which is 40 mg/kg [21]. When compared with previous studies, it was noted that 78% of the current study results were consistent with a study conducted in China [18], and that 94% of the results were consistent with a study conducted in Spain where the copper concentrations were ranged between 6.9 - 22 mg/kg [10]. In contrast, all copper levels in the current study were lower than those found in the South African, which was the highest copper concentration of 59.14 mg/kg [22]. By calculating the amount of copper that enters the human body after consuming 100 g of roasted Indian cashews per day, we found that it was 2482.5 µg, and this amount is sufficient for the daily needs of copper, which was previously mentioned as ranging between 1.5 mg (1500 µg) and 2.5 mg (2500 µg).

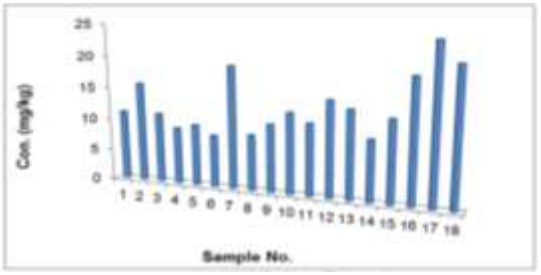

Fig. 6. Cu levels in the studied samples.

3.7. Chromium Analysis

Fig. 7 presented that the lowest average chromium concentrations in the samples under investigation were found 0.175 ± 0.075 mg/kg which was in the local peanut (sample 4), while the highest average concentrations were in the Iranian yellow roasted pistachios (sample 2) and it was 1.250 ± 1.100 mg/kg. These concentrations were consistent with those reported that most foods should contain chromium levels between 0.200-0.800 mg/kg [23]. However, this was in all samples except for the roasted and unroasted Iranian pistachio samples (samples 1 and 2). Compared with previous studies, it is noted that the results of the current study were consistent with a number of which were previously conducted [18, 22], and we also found that 67% of them were consistent with those were found in the study conducted in Spain (8), and others conducted in Pakistan [20]. By considering the chromium dosage which enters the human body while consuming 100 g of Iranian yellow roasted pistachios per day, we found that it was 125.0 µg and it is within the safe limits (50 -200 µg) [10], and this was the same amount that it is needed for adult per day (50-200 µg/day) [25].

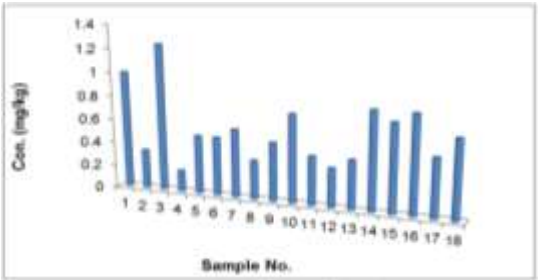

Fig. 7. Cr levels in the studied samples.

3.8 Cadmium Analysis

It was found, as shown in Fig. 8, that the lowest average cadmium concentrations in the studied samples was 0.025 ± 0.050 mg/kg (local peanut and the red Chinese peanut), while the highest average concentrations was 0.750 ± 0.500 mg/kg (American walnut). And it is agreed with that the cadmium levels in various foods should not be more than 1.0 ppm. In contrast, 89% of the results were below the permissible limits in fresh plants of 0.3 mg/kg [21]. In comparison between cadmium concentrations in similar samples (pistachio, almond, peanut and seeds), it is generally observed that cadmium concentrations are similar in these similar samples. Compared with previous studies, it is noted that 89% of the obtained concentrations are consistent with what were found in the study conducted in China [18], while cadmium concentrations were ranged between 0.02-0.24 mg/kg, as well as 83% of the results of the current study are agreed with what was found in the study conducted in Sweden [19]. However, 89% of the results of the present study were less than those found in the study conducted in Pakistan [20], in which it was found that the concentrations of cadmium in the studied samples were ranged between 0.456 mg/kg in peanut and walnut and 6.577 mg/kg in pistachio. It was also higher than that recorded in Spain [10]. By estimating the amount of cadmium that enters the body when eating 100 g of American nuts per day, we found that it was 75.0 µg, which is within the permissible limits of (0.004-0.084 mg / day) [26].

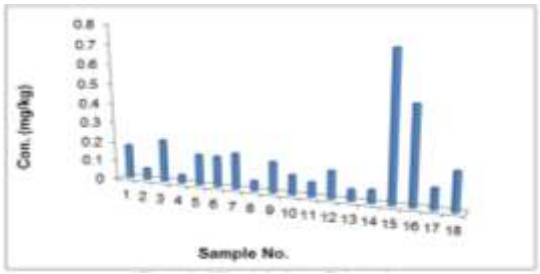

Fig. 8. Cd levels in the studied samples.

3.9 Iron Analysis

Fig. 9 showed that the average iron concentrations in the samples under investigation were ranged between 43.000 ± 12.925 mg/kg, which was in sample 6 (white Chinese peanuts) and 98.325 ± 3.125 mg/kg, which was found in sample 14 (roasted Egyptian zucchini seeds), and these findings were very consistent with previously mentioned iron content of seeds, which was determined between 15-80 mg/kg. However, it was higher than the permissible limits in Turkish food of 15 mg/kg [21]. Compared with previous studies, it was noticed that 67% of the current results were in agreement with those found in a number of previous studies [10, 22], and 83 % of these results were agreed with another study [19]. And all the current results are consistent with the extent of the results obtained in the study that was conducted in Korea [27]. By determining the amount of iron that enters the human body by eating 100 g of roasted Egyptian zucchini seeds per day it was 9832.50 µg (9.832 mg) and this falls within the range of daily needs specified by the Scientific Health Organization (WHO, 1984), which are between 7-14 mg and it depends on the age and gender of the person, and the recommended limits for adults ranges from 10 mg to 15 mg per day [10].

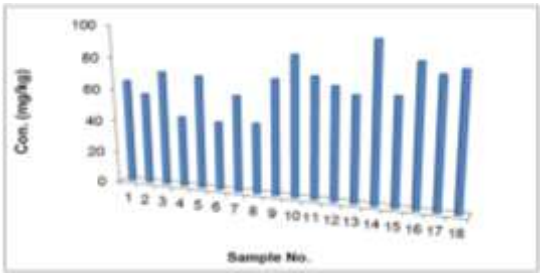

Fig. 9. Fe levels in the studied samples.

3.10. Moisture Content

The average percentages of moisture in the studied samples were ranged between 4.0% in sample 2 (roasted Turkish hazelnuts), and 8.50%, which was found in samples 8 and 18 (Chinese red peanuts and unroasted Canadian sunflower seeds), as shown in the fig. 10, and it is also noted that there was a variation in the percentage of moisture in the studied samples. Compared with some previous studies, it was found that the results obtained in the current study were consistent with a number of previous studies, as in the study conducted in Florida [28], where the moisture content of nuts ranged between 1.47-9.51%, and another conducted in Iraq [29], and others [27]. In general, the lower the humidity, the better it is for keeping the nuts in good shape and preventing the microbial growth [28].

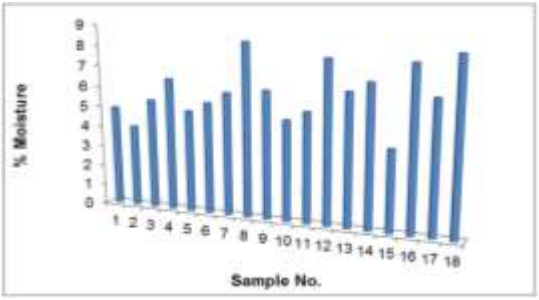

Fig. 10. Moisture content in the studied samples.

3.11. Total Solids Content

Fig. 11 showed that the average percentages of total solids in the studied samples were ranged between 91.50% that was found in samples 8 and 18 (Chinese red peanuts and unroasted Canadian sunflower seeds), and 96.0% in sample 2 (roasted Turkish hazelnuts), and a variation in the percentages of total solids were distinguished in the similar kind of samples. However, the total solids is an inverse approach to the moisture, so the higher of it, the better for the food sample because the moisture content will decrease.

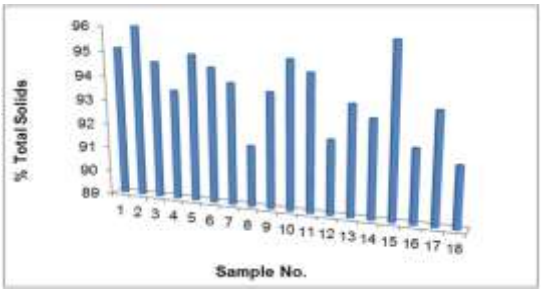

Fig. 11. Total solids content in the studied samples.

3.12. Ash Content

Fig. 12 showed that the ash percentages in the studied samples were ranged between 2.00 % in sample 2 (roasted Turkish hazelnuts), and 11.39 % that was found in sample 10 (roasted Chinese squash seeds), and the similarity in the ash percentage in the pistachio samples was notable, as well as in the seeds, except for the roasted Chinese zucchini seeds, which had the highest ash content in the studied samples. Compared with previous studies, it was noted that 94.44 % of the results obtained in the current study were agreed with those mentioned in previous studies [22]. It was found that 50% of them agree with the study conducted in Florida State [28].

The higher ash content indicates an abundance of minerals in nuts and seeds, which makes them a good food supplement and source of minerals for humans, provided they are free of toxic elements or contain less than the permissible limits.

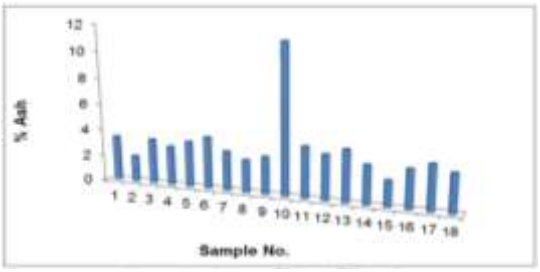

Fig. 12. Ash content in the studied samples.

3.13. Protein Content

Fig. 13 showed that the protein percentages in the investigated samples were ranged between 11.8% in the roasted Canadian sunflower seeds and 33.2% in the roasted Egyptian zucchini seeds. Compared with previous studies, it was noticed that the results obtained in the current study are consistent with those previously mentioned [28]. On the one hand, the protein percentages in the American walnut were agreed with those found in a study conducted in Iraq on the same type of nuts [30] which found that the protein percentage in some studied nuts and seeds range between 13.46 - 21.56%. Most of the results of the current study were agreed with those found in the study conducted in Korea [27], in which the protein contents in that study were ranged between 14.4-29.1% .

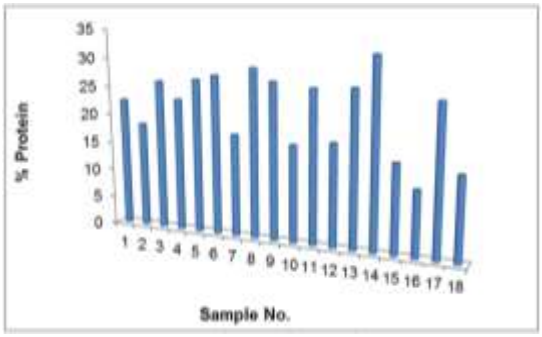

Fig. 13. Protein content in the studied samples.

4. CONCLUSION

Nuts and seeds are important healthy foods that are widely consumed all over the world because they contain an important valuable nutrients such as proteins, fiber, carbohydrates, various vitamins and minerals. In the present research, some heavy metals were evaluated in various types of nuts and seeds that are consumed in the local market. Also, some chemical components such as moisture, total solids, ash, and protein were also estimated. It was found that the concentrations of these components differ according to the type of nuts and seeds as well as their source, and there is a significant difference between the average concentrations of these metals in the studied samples.

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REFERENCES

[1] F.B. Hu and M.J. Stampfer, Nut consumption and risk of coronary health disease a review of epidemiologic evidence, *Curr. Atheroscler. Rep.*, 1 (1999) 205- 210.

[2] P.M. Kris-Etherton, S. Yu-Poth, J. Sabate, H. Ratcliffe, G. Zhao and T. Etherton, Nuts and their bioactive constituents effects on serum

lipids and factors that affects disease risk, Am. J. Clin. Nutr., 70 (1999) 504s – 511s.

[3] C. Chen and J. Blumberg, Phytochemical composition of nuts, Asia Pac. J. Clin. Nutr., 17 (2008) 329-32.

[4] K. Alexiadou and N. Katsilambros, Nuts: anti-atherogenic food, Eur. J. Intern. Med., 22 (2011) 141-6.

[5] R.G.M. de Souza, R.M. Schincaglia, G.D. Pimentel and J.F. Mota, Nuts and Human Health Outcomes: A Systematic Review, Nutrients, 9 (2017) 1311- 1334.

[6] L.R. Bordajandi, G. Gomez, E. Abad, J. Rivera, M.D. Fernandez-Baston, J. Blasco, and M.J. Gonzalez, Survey of persistent organochlorine contaminants (PCBs, PCDD/Fs, and PAHs), heavy metals (Cu, Cd, Zn, Pb and Hg) and arsenic in food samples from Huelva Spain: levels and health implications, J. Agric. Food Chem., 52 (2014) 992-1001.

[7] U. Celik and J. Oehlenschlager, High contents of cadmium, lead, zinc and copper in popular fishery products sold in Turkish supermarkets, Food Control, 18 (2007) 258-261.

[8] G. Davarynejad, M. Zarei and P.T. NAGY, Identification and Quantification of Heavy Metals Concentrations in Pistacia, Not. Sci. Biol., 5 (2013) 438-444.

[9] N. Jalbani, T.G. Kazi, M.K. Jamali, M.B. Arain, H.I. Afrid, S.T. Sheerazi and R. Ansari, Application of fractional factorial design and doehlert matrix in the optimization of experimental variables associated with the ultrasonic-assisted acid digestion of chocolate samples for aluminum determination by atomic absorption spectrometry, J. AOAC Int., 90 (2007) 1682-1688.

[10] C. Cabrera, F. Lioris, R. Gimenez, M. Olalla and M. Lopez, Mineral content in legumes and nuts: contribution to the Spanish, dietary intake, Sci. Total Environ., 308 (2003) 1-14.

[11] K.M. Elsherif and H.M. Kuss, Direct and Simultaneous Determination of Bismuth, Antimony, and Lead in Biological samples by Multi Element Electrothermal Atomic Absorption Spectrometer, Der Chem. Sin., 3 (2012) 727-736.

[12] K.M. Elsherif, R.A. Abu Khater and F.A. Hegaig, Determination of major and minor elements in dairy products produced in Misurata city – Libya, Maghrebian J. Pure Appl. Sci., 3 (2017) 9-17.

[13] K.M. Elsherif and H.M. Kuss, Simultaneous Multi-Element Determination of Bismuth (Bi), Antimony (Sb), and Selenium (Se), *Adv. Appl. Sci. Res.*, 3 (2012) 2402-2412.

[14] A.M. Alkherraz, O. Hashad and K.M. Elsherif, Heavy metals contents in some commercially available coffee, tea, and cocoa samples in misurata City–Libya, *Prog. Chem. Biochem. Res.*, 2 (2019), 99-107.

[15] M.A. Elbagermi, A.A. Bin Haleem and K.M. Elsherif, Physicochemical properties and nutritional values of pasteurized milk and long-life milk: A comparative study, *J. Anal. Sci. Appl. Biotechnol.*, 2 (2020), 38-45.

[16] M.A. Elbagermi, A.A. Bin Haleem and K.M. Elsherif, Evaluation of essential and heavy metal levels in pasteurized and long-life cow milk, *Int. J. Adv. Chem.*, 8 (2020) 6-14.

[17] S.B. Adeloju, Comparison of Some Wet Digestion and Dry Ashing Methods for Voltammetric Trace Element Analysis, *Analyst*, 114 (1989) 455-461.

[18] Y.L. Liang, T. Qing, S.X. Zhang, K.X. Yin and J.Y. Qin, Determination of Trace Elements in Edible Nuts in the Beijing Market by ICP-MS, *Biomed. Environ. Sci.*, 28 (2015), 449-454.

[19] I. Rodushkina, E. Engströma, D. Sörlinb and D. Baxterb, Levels of inorganic constituents in raw nuts and seeds on the Swedish market, *Sci. Total Environ.*, 392 (2008) 290 – 304.

[20] H.S. Manzoor, I.H. Bukhari, M. Riaz, N. Rasool, U. Sattar, G. Rehman and Q. Ul Ain, Effect of microwave roasting and storage on the extent of heavy metals present in dry fruits, *Int. J. Chem. Biochem. Sci.*, 3 (2013) 74-82.

[21] F. Zhu, L. Qu, W. Fan, M. Qiao, H. Hao and X. Wang, Assessment of heavy metals in some wild edible mushrooms collected from Yunnan Province, China, *Environ. Monit. Assess.*, 179 (2010) 191- 199.

[22] R. Moodley, A. Kindness and S.B. Jonnalagadda, Elemental composition and chemical characteristics of five edible nuts (almond, Brazil, pecan, macadamia and walnut) consumed in Southern Africa, *J. Environ. Sci. Health, Part B*, 42 (2007) 585–591.

[23] M. Soylak, H. Colak, O. Turkoglu and M. Dogan, Trace metal content of snacks and appetizers consumed in Turkey, *Bull. Environ. Contam. Toxicol.*, 76 (2006) 436-441.

[24] S.H. Zlotkin and B.E. Buchanan, Manganese Intakes in Intravenously Fed Infants, *Biol. Trace Elem. Res.*, 9 (1986) 271- 280.

[25] V. Kamar, R. Dagalp and M. Tastekin, Determination of Heavy Metals in Almonds and Mistletoe as a Parasite Growing on the

Almond Tree Using ICP-OES or ICP-MS, *Biol. Trace Elem. Res.*, 185 (2018) 226- 235.
[26] E.E. Santosa, D.C. Lauriab and C.L. Silveirac, Assessment of daily intake of trace elements due to consumption of foodstuffs by adult inhabitants of Rio de Janeiro city, *Sci. Total Environ.*, 327 (2004) 69–79.
[27] K.H. Chung, K.O. Shin, H.J. Hwang and K. Choi, Chemical composition of nuts and seeds sold in Korea, *Nutr. Res. Pract.*, 7 (2013) 82-88.
[28] M. Venkatachalam and S.K. Sathe, Chemical Composition of Selected Edible Nut Seeds, *J. Agric. Food Chem.*, 54 (2006) 4705- 4714.
[29] K.M. Mahmoud and R.T. Yasin, Quantitative Analysis of Some Metals in Alomond Kernel in Erbil City, *Int. J. Pharma Sci. Res.*, 7 (2016) 32 – 37.
[30] Q.A. Ibraheem, W.S. Ulaiwi and S. Eanas, The bioactivity and nutritional roles of some mineral and nutritive constituents of hazelnut Corylus avellana and walnut Juglans regia, *Anbar J. Agric. Sci.*, 10 (2012) 223-234.

مطالعه مقایسه‌ای بعضی ترکیبات مغزها و دانه‌های موجود در فروشگاه‌های محلی شهر میسوراتا در لیبی

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چکیده

هدف این مطالعه تخمین و بررسی بعضی ترکیبات شیمیایی موجود در دانه‌ها و مغزهای خوراکی موجود در فروشگاه‌های محلی شهر میسوراتا در لیبی می‌باشد. ۱۸ نوع مغز و دانه‌های خام و برشته بطور تصادفی (از هر نوع ۳ تا ۴ نمونه) از فروشگاه‌ها جمع‌آوری و غلظت بعضی از ترکیبات شیمیایی و عناصر سنگین مثل سرب، کادمیم، آهن، مس، کروم، منگنز، کبالت، روی، نیکل، میزان رطوبت، خاکستر و پروتئین کل دانه‌ها تعیین گردید. روش هضم خشک برای آماده‌سازی نمونه‌ها در تعیین عناصر سنگین با استفاده از جذب اتمی شعله بکار گرفته شد. همچنین، رطوبت، خاکستر و کل مواد جامد تعیین و کجلدال برای اندازه‌گیری مقدار پروتئین استفاده شد. نتایج نشان داد که غلظت متوسط فلزات سنگین در نمونه‌های مختلف بطور چشمگیری با یکدیگر متفاوت است. میزان عناصر مطالعه‌شده به قرار ۱,۱۶۷–۰,۰۷۵، ۱۱۶,۰۰–۳۱,۵، ۱,۳۲۵–۰,۳۲۵، ۷۱,۰۰–۹,۴۲۵، ۳,۸۷–۰,۰۲۵، ۲۴,۸۲۵–۸,۳۲۵، ۱,۲۵۰–۰,۱۷۵، ۰,۷۵۰–۰,۰۵۰، ۹۸,۳۲۵–۴۳,۰۰ میلی‌گرم بر کیلوگرم به ترتیب برای عناصر کبالت، روی، نیکل، منگنز، سرب، مس، کروم، کادمیم و آهن بدست آمد. همچنین، میزان رطوبت، خاکستر، کل مواد جامد و پروتئین به ترتیب ٪۸,۵–۴,۰، ٪۱۱,۳۹–۲,۰، ٪۹۶,۰–۹۱,۵ و ٪۳۳,۲–۱۱,۸ بدست آمد. اکثر نتایج بدست آمده با مطالعات قبلی سازگار و در حد مجاز می باشد.

واژه‌های کلیدی

مغزها؛ دانه‌ها؛ عناصر سنگین؛ ترکیبات شیمیایی.