ORIGINAL PAPER

MINERAL COMPOSITION OF *LAVANDULA ANGUSTIFOLIA* FLOWERS AND *HIPPOPHAE RHAMNOIDES* FRUITS EXTRACTS

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Manuscript received: 07.08.2017; Accepted paper: 12.09.2017;
Published online: 30.12.2017.

Abstract. *The aim of this work is to study the mineral content of Lavandula Angustifolia flowers and Hippophae Rhamnoides fruits extracts. The influence of the extraction techniques (ultrasound-assisted extraction and rapid extraction under pressure with different extraction solvents) on the mineral content was investigated. The minerals determined were Na, Mg, K, Ca, Cr, Mn, Fe, Cu and Zn. The results of the mineral analysis showed that the extracts obtained by the ultrasound-assisted extraction technique had the highest concentration of Mg (2895.23±9.14 µg/g; 2098.29±9.56 µg/g), no matter what the type of extraction solvent is. Also, the extracts obtained by rapid extraction under pressure had the highest concentration of Zn (14.09±0.50 µg/g; 18.59±0.60 µg/g) and Cr (1.32±0.15 µg/g; 1.96±0.05 µg/g), no matter what the type of extraction solvent is. For other minerals, the concentration depends on the extraction methods and on the extraction solvents.*

Keywords: *Lavandula Angustifolia, Hippophae Rhamnoides, ICP-MS.*

1. INTRODUCTION

It is well known that minerals are very important to the human body, being necessary in carrying out the vital processes. The human body can't produce the necessary minerals, taking the necessary minerals from foods. The extracts prepared from fruits, leaves or flowers of plants are commonly consumed in the world for their recognized positive physiological functions [1, 2]. The extraction techniques as well as the extraction solvents can influence the mineral composition of the extracts [3-5]

Lavandula Angustifolia and *Hippophae Rhamnoides* are popular plants in Romania used as medicinal plants with well-known medicinal properties which are attributed to their strong antioxidant activity [6, 7]. The extracts obtained from *Lavandula Angustifolia* flowers and *Hippophae Rhamnoides* fruits can have a considerable contribution to the minerals content from human body. In this work the mineral content of the *Lavandula Angustifolia* flowers and *Hippophae Rhamnoides* fruits extracts was determinate and the influence of the ultrasound-assisted extraction and rapid extraction under pressure techniques on the mineral

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content of these extracts was investigated. The minerals determined were Na, Mg, K, Ca, Cr, Mn, Fe, Cu and Zn. A strong correlation was found between K and Ca, Mn, Fe ($p<0.05$).

2. EXPERIMENTAL

PREPARATION OF PLANT EXTRACTS

For both ultrasound-assisted extraction (US) and rapid extraction under pressure at 6.7 bar (T), dried flowers of Lavandula *Angustifolia* (L.f.) and fruits of *Hippophae Rhamnoides* (H.f.) were crushed in a mill type TP2 and sieved by using a stainless sieve with 4 mm size. Ultrasound-assisted extraction was carried out using a Sonomatic Langford ultrasonic bath, equipped with the possibility to control the temperature of the solvent (35 °C) and ultra-sonication time. Rapid extraction under pressure at 6.7 bar was performed in Timatic Micro C extractor at 35 °C. The extractive solutions consist in 50 % water - 50% solvent ratio as follows: water a (pH=5)-alcohol (A.a.); water b (pH=9)-alcohol (A.b.); water a (pH=5)-glycerin (G.a); water b (pH=9) – glycerin (G.b); water a (pH=5) - propylene glycol (PG.a) and water b (pH=9) - propylene glycol (PG.b). Waters (a) and (b) were obtained using Kangen equipment; glycerin and propylene glycol were of pharmaceutical grade. For both extraction methods the time of extraction was 16 minutes for each sample for a ratio crush dried fruit: solvent = 1:10.

EXTRACT SAMPLE PREPARATION AND INSTRUMENTATION FOR MINERAL CONTENT DETERMINATION

In generally, the mineral content of plants (vegetables, medicinal plants, aromatic plants) can be determined by techniques as follow: Particle Induced X- ray Emission (PIXE), X-ray Fluorescence (XRF), Atomic Absorption Spectrometry (AAS), Inductively Coupled Plasma (ICP-AES, ICP-OES or ICP-MS) [8-11]. The mineral contents of the studied extracts were determined using the iCAP™ Q ICP-MS spectrometer [12-18]. For ICP-MS measurements the extract samples were digested using a TOPwave microwave digestion system for 30 minutes. After digestion process the obtained solutions were cooled, filtered and transferred into 25 mL calibrated flasks. The quality control of ICP-MS measurements was provided by using the standard reference material SRM 1571 - orchard leaves (National Institute of Standards and Technology-NIST production). The standard reference sample was prepared using the same sample preparation procedure and the ICP-MS measurements were performed using the same instrumental parameters. The measured concentrations of Na, Mg, K, Ca, Cr, Mn, Fe, Cu and Zn were within the recommended values and the recovery of the elements ranged between 87.8% and 102.5%.

3. RESULTS AND DISCUSSION

The results of the analysis of Na, Mg, K, Ca, Cr, Mn, Fe, Cu and Zn concentrations in *Lavandula Angustifolia* flowers and *Hippophae Rhamnoides* fruits extracts are presented in Table 1. Using the Pearson correlation analysis a strong correlation was found between K and Ca, Mn, Fe; Zn and Cr ($p<0.05$). A good correlation was found between Mg and Ca, Fe. The results of correlation analysis are shown in Table 2.

Table 1. The concentrations of the minerals in *Lavandula Angustifolia* flowers and *Hippophae Rhamnoides* fruits extracts.

Extract type	Minerals concentration (μg/g)								
	Na	**Mg**	**K**	**Ca**	**Cr**	**Mn**	**Fe**	**Cu**	**Zn**
1.H.f.A.a US	2943.22 ±11.12	2809.29 ±9.32	8643.32 ±9.66	2737.29 ±8.75	1.15 ±0.25	21.61 ±0.90	348.21 ±11.10	6.61 ±0.16	13.13 ±0.65
2.H.f.A.b US	2956.47 ±9.53	2895.23 ±9.14	8614.12 ±9.75	2707.27 ±8.55	1.19 ±0.05	21.89 ±0.50	352.31 ±11.25	6.83 ±0.25	13.19 ±0.60
3.H.f.G.a US	2145.37 ±9.02	2583.26 ±8.95	6220.34 ±8.65	2240.39 ±8.15	1.08 ±0.02	20.56 ±0.56	322.68 ±11.55	6.38 ±0.65	12.24 ±0.55
4.H.f.G.b US	2165.43 ±9.55	2576.41 ±9.75	6223.25 ±8.35	2288.44 ±8.54	1.09 ±0.05	20.51 ±0.85	328.23 ±11.15	6.34 ±0.44	12.22 ±0.65
5.H.f.PG.a US	2044.55 ±10.55	2111.16 ±9.35	6177.19 ±8.25	2109.13 ±8.34	1.06 ±0.15	20.22 ±0.75	318.33 ±11.37	6.31 ±0.20	11.18 ±0.45
6.H.f.PG.b US	2076.19 ±9.75	2112.10 ±9.55	6178.55 ±8.35	2106.21 ±8.50	1.05 ±0.20	20.19 ±0.55	319.11 ±11.24	6.31 ±0.15	11.14 ±0.50
1.L.f.A.a US	2224.37 ±7.45	2049.23 ±9.35	2455.23 ±9.34	2637.29 ±8.45	1.44 ±0.07	27.62 ±0.80	614.54 ±8.21	15.23 ±0.41	19.23 ±0.65
2.L.f.A.b US	2256.33 ±7.33	2098.29 ±9.56	2478.12 ±8.90	2787.21 ±9.56	1.59 ±0.04	25.46 ±0.83	612.66 ±9.52	14.88 ±0.45	18.96 ±0.70
3.L.f.G.a US	2034.37 ±7.02	2081.23 ±9.45	2215.36 ±7.65	2341.39 ±9.11	1.21 ±0.05	21.12 ±0.65	575.12 ±7.34	8.35 ±0.25	11.43 ±0.53
4.L.f.G.b US	2011.55 ±6.54	2034.44 ±9.33	2234.22 ±8.45	2389.44 ±8.34	1.19 ±0.01	21.34 ±0.50	569.89 ±5.98	8.22 ±0.30	11.27 ±0.59
5.L.f.PG.a US	2021.59 ±6.58	2092.15 ±8.45	2147.11 ±8.22	2355.43 ±8.34	1.04 ±0.01	20.92 ±0.55	564.11 ±6.34	6.13 ±0.21	10.28 ±0.54
6.L.f.PG.b US	2017.79 ±6.35	2054.18 ±8.32	2178.30 ±7.34	2321.25 ±8.55	1.09 ±0.02	20.89 ±0.57	563.12 ±6.11	6.77 ±0.25	10.03 ±0.43
1.H.f.A.a T	3122.16 ±13.15	2817.21 ±9.55	8934.55 ±9.63	2855.20 ±9.75	1.32 ±0.15	21.19 ±0.50	367.78 ±11.47	6.93 ±0.23	14.11 ±0.55
2.H.f.A.b T	3156.17 ±12.52	2815.27 ±9.64	8914.53 ±9.43	2867.21 ±9.55	1.31 ±0.15	21.12 ±0.50	379.32 ±11.55	6.87 ±0.26	14.09 ±0.50
3.H.f.G.a T	1845.22 ±9.72	2087.46 ±8.45	5224.78 ±9.66	1840.39 ±8.75	1.18 ±0.12	19.33 ±0.45	345.61 ±11.60	6.18 ±0.35	13.34 ±0.55
4.H.f.G.b T	1825.23 ±9.85	2096.55 ±9.45	5214.20 ±7.77	1888.54 ±9.54	1.17 ±0.15	19.51 ±0.76	348.72 ±11.55	6.13 ±0.34	13.32 ±0.35
5.H.f.PG.a T	1644.52 ±10.33	2010.86 ±9.55	5197.14 ±8.48	1112.44 ±8.39	1.16 ±0.17	19.02 ±0.55	342.56 ±11.28	6.01 ±0.25	11.67 ±0.45
6.H.f.PG.b T	1648.33 ±9.85	2012.77 ±9.65	5192.05 ±8.36	1109.71 ±9.50	1.13 ±0.20	19.01 ±0.65	345.69 ±11.25	6.01 ±0.25	11.65 ±0.60
1.L.f.A.a T	1234.96 ±6.12	2011.09 ±7.15	1487.29 ±7.34	1437.15 ±5.77	1.64 ±0.08	28.15 ±0.60	442.34 ±5.13	12.87 ±0.31	18.44 ±0.55
2.L.f.A.b T	1256.43 ±5.17	2018.11 ±7.05	1422.98 ±7.90	1487.55 ±5.06	1.96 ±0.05	28.34 ±0.63	452.91 ±6.21	12.81 ±0.25	18.59 ±0.60
3.L.f.G.a T	1004.30 ±6.01	1983.13 ±6.21	1215.35 ±6.61	1241.32 ±5.23	1.34 ±0.05	24.32 ±0.61	395.02 ±5.98	7.22 ±0.25	15.46 ±0.45
4.L.f.G.b T	1010.52 ±6.54	1956.55 ±6.72	1209.28 ±6.15	1285.66 ±5.11	1.32 ±0.02	24.39 ±0.50	399.13 ±6.05	7.20 ±0.40	15.39 ±0.55
5.L.f.PG.a T	909.22 ±5.51	1935.71 ±6.05	1124.19 ±6.02	1250.13 ±5.32	1.21 ±0.03	23.62 ±0.45	328.67 ±6.15	5.19 ±0.25	14.18 ±0.65
6.L.f.PG.b T	904.31 ±5.25	1946.22 ±6.30	1126.30 ±5.04	1201.05 ±5.55	1.27 ±0.02	23.59 ±0.52	323.44 ±6.10	5.17 ±0.35	14.21 ±0.45

Table 2. Pearson correlation coefficients between element concentrations in studied extracts

	Mg	K	Ca	Cr	Mn	Fe	Cu	Zn
Mg	**1**	0.79	0.92	0.90	0.89	0.93	0.82	0.89
K	0.79	**1**	**0.97**	0.94	**0.97**	**0.97**	0.91	0.85
Ca	0.92	**0.97**	**1**	**0.96**	**0.98**	**0.99**	0.92	0.95
Cr	0.90	0.94	**0.96**	**1**	**0.99**	**0.98**	**0.98**	**0.99**
Mn	0.89	**0.97**	**0.98**	**0.99**	**1**	**0.99**	**0.97**	0.92
Fe	0.93	**0.97**	**0.99**	**0.98**	**0.99**	**1**	0.90	0.89
Cu	0.82	0.91	0.92	**0.98**	**0.97**	0.90	**1**	0.86
Zn	0.89	0.85	0.95	**0.99**	0.92	0.89	0.86	**1**

Coefficients marked in boldface are statistically significant at $p<0.05$.

The results of the mineral analysis showed that the extracts obtained by the ultrasound-assisted extraction technique had the highest concentration of Mg, no matter what the type of extraction solvent is. In Fig. 1, the diagramme of the variation of Mg concentration in

Hippophae Rhamnoides fruits extract depending on extraction technique and extract solvent type, is presented.

Also, the extracts obtained by rapid extraction under pressure had the highest concentration of Zn and Cr, no matter what the type of extraction solvent is. In Fig. 2, the diagramme of the variation of Zn concentration in *Hippophae Rhamnoides* fruits extract, depending on extraction technique and extract solvent type, is presented.

For other minerals, the concentration depends on the extraction methods and on the extraction solvents. In Fig. 3, the diagramme of the variation of Na concentration in *Hippophae Rhamnoides* fruits extract, depending on extraction technique and extract solvent type, is presented.

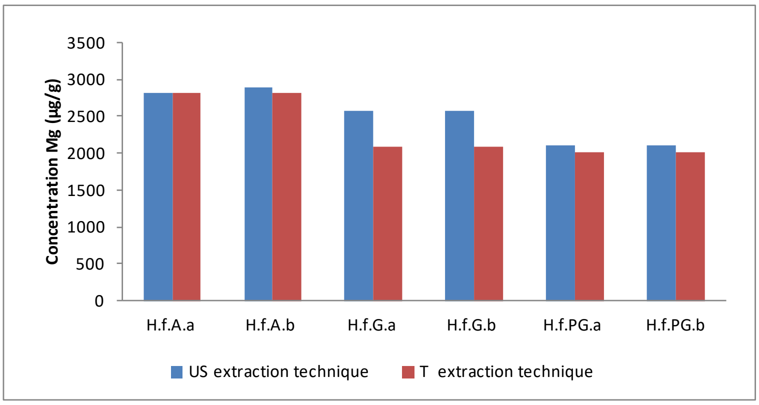

Figure 1. Variation of Mg concentration in *Hippophae Rhamnoides* fruits extract.

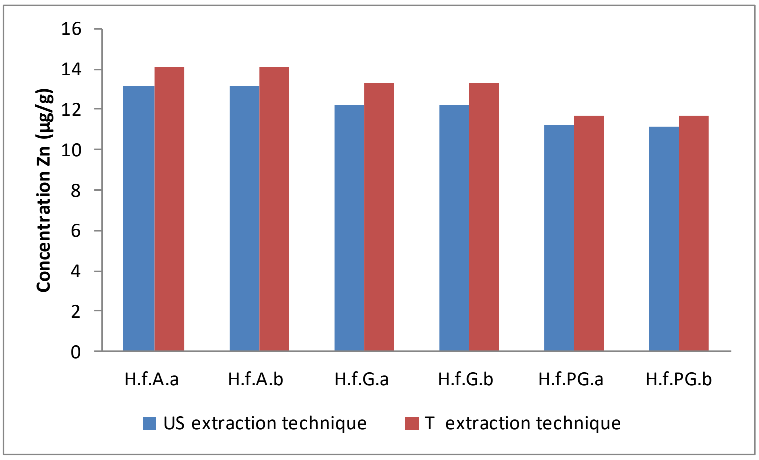

Figure 2. Variation of Zn concentration in *Hippophae Rhamnoides* fruits extract.

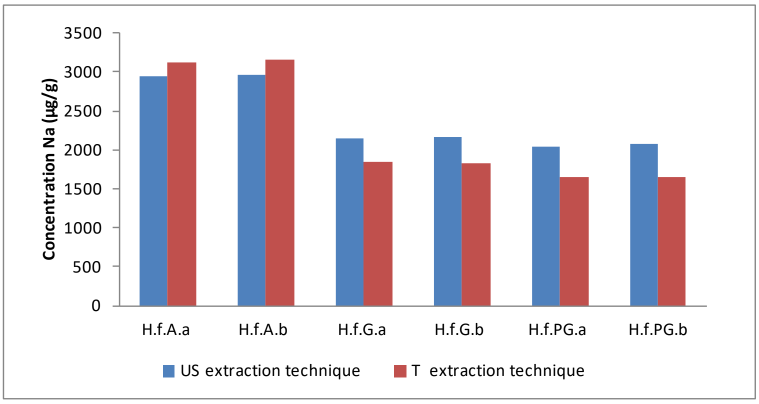

Figure 3. Variation of Na concentration in *Hippophae Rhamnoides* fruits extract.

4. CONCLUSION

The mineral content of the Lavandula Angustifolia flowers and Hippophae Rhamnoides fruits extracts was determinate and the influence of the ultrasound-assisted extraction and rapid extraction under pressure techniques on the mineral content of these extracts was investigated. The extracts obtained by the ultrasound-assisted extraction technique had the highest concentration of Mg, no matter what the type of extraction solvent is. The extracts obtained by rapid extraction under pressure had the highest concentration of Zn and Cr, no matter what the type of extraction solvent is. For other minerals, the concentration depends on the extraction methods and on the extraction solvents. However, in other to obtain adequate concentrations for all the minerals, a combination of extraction techniques may be required.

Acknowledgements: *This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS-UEFISCDI, project number PN-II-RU-TE-2014-4-2801. Authors hereby acknowledge the structural founds project PRO-DD (POS-CCE, O.2.2.1., ID 123, SMIS 2637, No 11/2009) for providing the infrastructure used in this work.*

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