



Determination of essential and non-essential elements in some medicinal plants by polarised X ray fluorescence spectrometer (EDPXRF)

Donatella Desideri*, Maria Assunta Meli, Carla Roselli

Institute of General Chemistry, Urbino University, "Carlo Bo", P.zza Rinascimento 6, 61029 Urbino, Italy

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ABSTRACT

Polarised X ray fluorescence spectrometer (EDPXRF) is employed for the determination of essential and non-essential elements in the parts (leaves, fruits, seeds, roots, flowers, barks, berries, and thallus) of thirty-five medicinal plants used in Italy generally as remedies. The quality of data was assured by calibrating the instrument with certified reference materials. The elements are found to be present in different plants in various proportions depending on soil composition and the climate in which the plant grows.

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1. Introduction

In recent times, focus on plant research has increased all over the world and a large body of evidence has been collected to show the immense potential of medicinal plants used in various traditional systems. The therapeutic effect of these plants for the treatment of various diseases is based on the chemical constituents present in them [1,2].

Although the efficacy of herbs for curative purposes is often accounted for in terms of its organic constituents (essential oil, vitamins, glycosides, etc.) it has been established that there exists a relationship between the chelating of metals and some chemotherapeutic agents [3]. Trace elements play a very important role in the formation of the active chemical constituents present in medicinal plants and are there responsible for their medicinal as well as toxic properties; in fact, it has been pointed out that not all natural therapies or products related to complementary or alternative medicine are free from adverse effects [4]. The role of inorganic elements in animal and plant metabolism has long been established, but the effect and influences of these elements on administration of medicinal plant have received relatively little attention. The administration of medicinal plant, traditionally has been largely indiscriminate without due regard to possible side effects. Diet has long been considered as the major source of human exposure to trace elements and consequently the levels in basic foodstuff, but medicinal uptakes

are of greater interest from the toxicological and nutritional points of view [5].

Thus, a quantitative estimation of various essential or toxic element concentrations is necessary for determining the effectiveness of the medicinal plants in treating various diseases and also to understand their pharmacological action. Moreover, such an assessment would be helpful in regulating their use as certain elements are toxic at elevated levels. It is interesting to note that comparison of the elemental contents of these medicinal herbs with that of usual plants (non-medicinal) as rice, tomato, field bean and edible bitter herb shows that medicinal plants are more rich in elemental content than usual plants with a few exceptions [6].

This study aimed to evaluate the elemental composition of some medicinal plants used in Italy by polarised X ray fluorescence spectrometer (EDPXRF). EDPXRF is a simultaneous, reliable, sensitive, quantitative multielemental and non-destructive technique, suitable for routine analysis due to minimal sample preparation. This technique has been used successfully by various authors for the characterization of different complex matrices.

The elements taken into account are 23 subdivided into essential (macro and micro) and non-essential or toxic. An element is considered essential if the plant fails to grow normally and to complete its life cycle, if grown in a medium adequately removed from the element, whereas in the presence of the suitable chosen concentration of the element it grows and reproduces normally [7]. Among the essential elements estimated in the present work we found the micro and trace elements (Mn, Fe, Co, Cu, Zn, Ni, Cr, Cl, Br, and I) and macro elements (K, Mg, Ca, P, and S); along the non-essential elements and the toxic elements Al, Rb, Sr, As, Cd, Sn, Pb and Hg are taken into account.

* Corresponding author. Tel.: +39 0722 303307; fax: +39 0722 303306.
E-mail address: donatella.desideri@uniurb.it (D. Desideri).

Table 1
Details of the medicinal plants under study.

Botanical name (Common name)	Part used	Origin – crop year	Cultivation
<i>Malva sylvestris</i> L. (Mauve)	Leaves	Italy 2007	Organic farming
<i>Salvia officinalis</i> L. (Sage)	Leaves	Italy 2007	Organic farming
<i>Mentha piperita</i> L. (Peppermint)	Leaves	Italy 2007	Organic farming
<i>Melissa officinalis</i> L. (Balm-mint)	Leaves	Italy 2007	Organic farming
<i>Fraxinus excelsior</i> L. (Ash)	Leaves	Hungary 2006	Spontaneous
<i>Thymus serpyllum</i> L. (Thyme)	Leaves	Albania 2007	Spontaneous
<i>Calendula officinalis</i> L. (Calendula)	Flowers	Slovakia 2006	Cultivated
<i>Matricaria recutita</i> Rausch (Chamomile)	Flowers	Italy 2006	Organic farming
<i>Lavanda angustifolia</i> Miller (Lavander)	Flowers	Italy 2007	Cultivated
<i>Helichrysum stoechas</i> (Elicriso)	Flowers	Hungary 2006	Cultivated
<i>Humulus Lupulus</i> (Hops)	Flowers	Far East 2007	Cultivated
<i>Plantago arenaria</i> (Nero psyllium)	Seeds	Italy 2007	Cultivated
<i>Foeniculum vulgare</i> Miller (Fennel)	Seeds	Turkey 2007	Cultivated
<i>Linum usitatissimum</i> L. (Flax)	Seeds	Italy 2007	Organic farming
<i>Elettaria cardamomum</i> (Cardamom)	Seeds	–	Cultivated
<i>Cynodon dactylon</i> Pers. (Dog's-tooth)	Roots	China 2007	Spontaneous
<i>Taraxacum officinale</i> (Dandelion)	Roots	Poland 2007	Cultivated
<i>Arctium lappa</i> L. (Burdock)	Roots	Italy 2007	Organic farming
<i>Glycyrrhiza glabra</i> L. (Liquorice)	Roots	Italy 2007	Cultivated
<i>Rosa canina</i> L. (Rosehip)	Fruits	Chile 2007	Spontaneous
<i>Illicium verum</i> (Star anise)	Fruits	Far East 2007	Cultivated
<i>Capsicum FR</i> (Pepper)	Fruits	India 2007	Cultivated
<i>Vitex agnus castus krus</i> (Lilac chastetree)	Fruits	Albania 2007	Cultivated
<i>Salix alba</i> (White willow)	Barks	–	Spontaneous
<i>Frangula alnus</i> Miller (Alder buckthorn)	Barks	Poland 2006	Cultivated
<i>Rhamnus purshiana</i> (Bearberry)	Barks	USA 2007	Cultivated
<i>Ulmus campestris</i> L. (Elm)	Barks	Italy 2007	Spontaneous
<i>Cinnamomum Zeylanicus</i> (Cinnamon)	Barks	Sri Lanka 2007	Cultivated
<i>Vaccinium myrtillus</i> L. (Blueberry)	Berries	Hungary 2007	Cultivated
<i>Cupressus sempervirens</i> (Cypres)	Berries	Italy 2007	Cultivated
<i>Juniperus communis</i> (Juniper)	Berries	Italy 2007	Cultivated
<i>Abies pectinata</i> (Spruce)	Berries	Italy 2007	Spontaneous
<i>Spirulina maxima</i> (Alga Spirulina)	Thallus	–	–
<i>Laminaria cloustonule</i> (Alga Laminaria)	Thallus	France 2007	Spontaneous
<i>Fucus vesiculosus</i> L. (Bladder wrack)	Thallus	France 2006	Spontaneous

Table 2
Concentration (mg kg⁻¹_{dry}) of essential macroelements in the studied medicinal plant.

Botanical name	Part used	K	Mg	Ca	P	S
<i>Malva sylvestris</i> L.		27153.0	3340.5	19477.4	3468.3	5140.9
<i>Salvia officinalis</i> L.		17314.0	2309.3	10821.9	1390.4	1735.9
<i>Mentha piperita</i> L.	Leaves	18855.3	1597.6	16820.5	2839.3	3899.5
<i>Melissa officinalis</i> L.		22517.4	2236.7	9100.0	2636.4	3912.5
<i>Fraxinus excelsior</i> L.		10683.9	1446.6	12927.0	639.6	1900.0
<i>Thymus serpyllum</i> L.		14891.9	1132.9	13305.1	791.3	1248.9
<i>Calendula officinalis</i> L.		23178.0	714.6	6683.2	2851.3	1700.2
<i>Matricaria recutita</i> Rausch	Flowers	23664.7	947.0	4724.2	3179.5	2057.3
<i>Humulus lupulus</i>		24452.8	1847.5	9296.2	4567.5	1380.4
<i>Lavanda angustifolia</i> Miller		12979.7	790.1	7526.3	712.8	779.5
<i>Helichrysum stoechas</i>		10973.6	<500	4573.0	1060.4	722.8
<i>Plantago arenaria</i> Wald. et Kit.		5510.6	688.4	2651.8	2264.1	1019.5
<i>Foeniculum vulgare</i> Miller	Seeds	22853.5	1188.1	7054.2	1835.6	1966.1
<i>Linum usitatissimum</i> L.		8820.0	1067.7	1930.0	3370.8	1294.4
<i>Elettaria cardamomum</i>		25298.8	813.3	17689.1	1186.3	8782.1
<i>Cynodon dactylon</i> Pers.		5164.1	<500	244.2	695.2	1427.5
<i>Taraxacum officinale</i> Weber	Roots	10038.4	<500	1681.0	1269.9	693.2
<i>Arctium lappa</i> L.		22760.8	1103.8	4867.3	1117.1	1002.0
<i>Glycyrrhiza glabra</i> L.		6502.6	1806.8	12835.1	352.0	739.7
<i>Rosa canina</i> L.		15310.0	560.6	5587.7	431.5	304.3
<i>Capsicum FR</i>	Fruits	22158.2	<500	890.1	1521.7	1451.0
<i>Vitex agnus castus krus</i>		9198.2	1519.2	4939.9	3006.4	1166.1
<i>Illicium verum</i>		10030.3	819.2	815.5	1132.6	3164.9
<i>Ulmus campestris</i> L.		3713.1	<500	27560.6	568.6	249.5
<i>Cinnamomum Zeylanicus</i>		5930.1	691.3	9580.3	359.1	4549.1
<i>Salix Alba</i>	Barks	3072.2	<500	28756.3	580.5	315.1
<i>Rhamnus purshiana</i>		2870.6	816.2	10770.8	460.7	387.8
<i>Frangula alnus</i> Miller		1817.2	508.3	12967.9	356.1	237.2
<i>Juniperus communis</i>		8344.1	624.5	2543.5	737.1	490.8
<i>Abies pectinata</i>	Berries	4636.8	<500	407.7	673.4	478.0
<i>Vaccinium myrtillus</i> L.		6699.6	<500	1387.7	831.8	455.4
<i>Cupressus sempervirens</i>		10727.9	581.0	5263.8	522.6	751.2
<i>Laminaria cloustonule</i>		99839.2	1278.1	20019.0	3771.5	12261.6
<i>Fucus vesiculosus</i> L.	Thallus	31742.3	<500	10218.0	547.8	8425.1
<i>Spirulina maxima</i>		12608.8	2553.3	1208.9	9773.6	5273.1

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