Analysis of Different Types of Tea Leaves by X-Ray Flourescence Technique

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Abstract

Samples of tea leaves (Green tea, Gugarate tea and Black tea used commonly in Iraq) are dried, grinded, pressed and submitted for the elemental analysis by x-ray fluorescence technique (XRF). The concentrations of major, minor and trace elements are determined. The major elements were Na, Mg, Al, K, Si, Ca, Mn, Fe, S and P. Of these elements, Ca, concentration in Gugarate tea leaves is three times, it's level in the other types of tea. Titanium, Cl, Rb and Sr are found as minor elements, while other elements such as Cu, Zn, V, Cr, Co, ...etc are found as trace elements. Of these trace elements considerable concentration values are found for some toxic elements Hg, Cd, Pb and As. Green tea contains 1.1 ppm Hg and 4.4 ppm Pb. Gugarate tea contains 0.8 ppm Hg, 5.8 ppm Pb and 6 ppm As. Black tea contains 2.4 ppm Pb. Chromium, Zinc and Copper found in considerable concentrations with respect to the other trace elements in all analysed samples.

Introduction

Tea is a small tree called scientifically Camellia sinensis. It contains (depending on it's type), oil glands, vitamins and minerals such as Ca, Mg, K, Fe, Cu, Zn, Se and F. It contains also contains bimolecules compounds such as thiamine, butylated hydroxyanisol and amino butyric acid. Moreover, it contains polyphenols which are anticancer agent inhibitors of ornithine decarboxylase enzyme encharge of the growth of benign and cancer cells (1,2,3).

Tea is always in association with relaxation and research; it indicates its significant health benefits, it provides vitamins, minerals and antioxidants.

Black tea contains small amounts of vitamins. Carotene is a precursor to vitamins having antioxidant properties. Thiamin, Riboflavin and Nicotinic acid are necessary for metabolism to release energy from food.

Ascorbic acid (Vitamin C) has is essential for a healthy immune system. It is proved also that tea a role in reducing certain cancer risks and reducing the size of tumor. Moreover, It prevents heart diseases. Roselle tea (Cugarate) has been analyzed and the volatiles were determined by Gas Chromatography (9).

Trace elements are minerals that are needed by the body in very small amounts. Most people meet the daily requirements (1,2,3). of trace elements from their food as a part balanced diet. Previous studies have shown that tea consumption can impair trace elements. The characters of green, black and other types vary according to their growing areas.

Tea *Camellia sinesis* has the ability to accumulate high concentration of elements. A daily intake of 3-5 cup of tea contains the following daily recommended allowances 16% Ca, 10% folic acid and Zinc, 9 % B_1, 25% B_2 and 6% B_6. It also includes many elements such as Mn, K, F, Cu, I, Se, Fe, etc. Research proved that these elements concentration in young and old leaves are the same.

X-ray fluorescence (XRF) is one of the powerful techniques for analysis of trace elements in biological and other materials especially the low Z numberd elements. It is a nondestructive technique, depends on the excitation of the electron in the inner orbitals and ejected from the inner shell creating vacancies. Electrons from the outer shell transferred to inner shell and in this deexcitation process gives off a characteristic X-ray whose energy is characterized of each elements.

XRF technique has been employed for the analysis of Iraqi vegetables such as, okra, carrot, cabbage ...etc. (4). Ramadan has determined the trace elements in different types of vegetables using XRF technique (5) and many other researches have analyzed their local vegetables by different analytical methods (6, 7). Al-Hadidi has analyzed different types of natural and artificial milk using XRF technique (8). The concentration of major, minor and trace elements have been presented . In the present work , green , gugarate and black tea leaves have been analyzed for the first time using XRF techique.

Experimental

Sample preparation: Tea leaves samples of 4 types were kept in an oven (vector type) at 60 °C for 2 hours for drying. The dried samples were grounded to fine homogeneous powder using an electric agate mortor. Samples were prepared in pellets by pressing them using 10 tons pressing machine giving a pellets of a diameter of 32 mm.

Analysis: A Germany system Spectro Xepos XRF was used for the analysis, containing Si(Li) X-flash type detector , which does not need liquid nitrogen for cooling, because the system can be operated at (0-25)C, it has a source as a tube form with Beryllium window using three targets (Pd , Ti ,W) to provide x-ray with different energies, in order to cover the large range of spectrum. Using vacuum system with pressure of 10 mmHg helped in getting more efficiency of analysis especially for light elements. The total exposure time was 900 s. for three targets (300 s. for each target). Then all information about the data analysis or spectrum of the samples are driven from a computer that was added to the system that compared with known standard samples.

Results and Discussion

Drinking 4-5 cups of tea has an effect by reducing both high blood cholesterol and pressure. Black tea is loaded with antioxidant flavonoide that reduces the stroke clotting and hardening of the arteries. Green tea has five times the amount of antioxidant as black tea and if the tea is kept under vacuum or in sealed containers has two years shelf time.

The biological role of trace elements differ from element to another. Zinc plays a central role in growth and development and proper functioning of immune system. It is present in animal protein and dairy products. Copper involved in synthesis of hormones and protect the body from heart diseases. It is present in sheel fish, green vegetables, nuts and liver. Iron deficiency causes anemia and decrease resistance to infection and work performances. It is present in red meet, eggs, whole meal bread, spanich and others.

Chromium plays a key role in processing fats and carbohydrates effecting the working of the insuline. It is present at small amounts in most foods, especially potatoes (with skin), mushrooms, butter and seafood.

Iodine is essential for normal thyroid functioning and the development of nervous system. Its main sources is seafood and dairy products.

Selenium is a powerful antioxidant helping to ride your body of free radicals, protect body against toxic substance. It is important also in production of sperm and sperm mobility. It is found in bread, milk, eggs, meat and fish. (1,2,3)

Samples of green tea, Gugarate and black tea have been submitted for analysis by XRF technique. The concentration of major elements (Na, Mg, Al, Si, P, S, K, Ca, Mn and Fe), minor elements (Cl, Rb, Sr and Ti) and trace elements (Cu, Zn, V, Cv, Co, Ni, Ga, As, Se, Br, Te, I, Ba, Hg, Pb, Bi and Th)have been determined and presented in tables (2, 3, 4), respectively. Other elements such as Y, Mo, Ag, Cd, Sn, Ge, Sb, W, Tl, and U where also determined and found to be below detection limits (bdl).

The samples presented in the table are numberd as follows:

Number	Type of samples
1	Black tea (July, 2002)
2	Black tea (September, 2002)
3	Green tea
4	Roselle tea (Gugarate)

From table (2), it is clear that K concentration was the highest in all samples, Ca concentration is higher in gugarate tea. We can conclude that the concentration of the major elements in black tea is lower than that in other types of tea, except for P (the concentration is the same).

Gugarate tea shows remarkably high concentrations of Si. Going through table (3) we find that Cl, Sr, Ti concentrations are the same for the black and the green tea, while their concentration in gugarate is high. Black tea and green tea show a higher concentration for Rb compared with gugarate tea.

Table(4), which present the concentration of trace elements, indicates a serious problem associated with the presence of Pb, Hg and As, especially for gugarate tea and green tea samples.

The same applies for Co, Ni, Ge, Se, Br, Ba and Bi; their concentration values are higher for gugarate tea. The concentration of Br in gugarate is 325 ppm compared to 2-5 ppm for the other types of tea, Te also shows a value of 72 ppm for gugarate tea. Iodine was present in black tea (1) at high concentration (18.5 ppm).

We made calculations based on assumption that a male drinks 4 cups of tea a day while a female drinks 2 cups of tea a day. And on the

basis of our results, the daily intake of elements through drinking of tea
has been calculated for the elements, especially the trace elements, and presented in table (5)
Table(5) shows that P, K, Ca, Cl, Cu, Zn and Cr supplied to humans by tea is lower than the RDA for male while that of Mg, Mn and Fe supplied by tea in amounts higher than RDA.
Of course the body and through metabolism accumulated certain elements is amounts required by the body and release the remaining amounts through different activities. It is quite clear that tea is a main source of elements essential for the body and it is the richer compared with other types of food.
It is concluded also that there are much differences in elemental content between black and green tea. Although Iron (Fe) indicated the reverse, but still giving the required Iron (Fe) supply to the body.

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Table (1) Recommended dietary allowances (RDA) for some minerals {1, 2, 3}

Elements	Male (18-64) years	Female (18-64) years	Pregnant women
Fe	10 mg/ day	14 mg/ day	15 mg/ day
Zn	9.5 mg/ day	7 mg/ day	20 mg/ day
Cu	1.1 mg/ day	1.1 mg/ day	1.1 mg/ day
I	130 □g/ day	130 □g/ day	130 □g/ day
Se	55 □g/ day	55 □g/ day	55 □g/ day

Table (2) Major elements % concentration

Elements	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4
Na	< 0.1	< 0.1	< 0.096	0.542
Mg	0.263	0.299	0.324	0.765
Al	0.150	0.130	0.240	0.357
Si	0.080	0.129	0.364	1.516
P	0.229	0.246	0.256	0.211
K	1.484	1.698	1.509	1.927
Ca	0.448	0.418	0.535	1.921
Mn	0.073	0.101	0.122	0.020
Fe	0.039	0.042	0.207	0.186
S	0.257	0.314	0.308	0.371

Table (3) Minor elements (% concentration)

Elements	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4
Ti	bdl	0.00186	0.00449	0.0129
Cl	0.0521	0.0517	0.0568	0.862
Rb	0.00804	0.01668	0.00857	0.00162
Sr	0.00577	0.00174	0.00257	0.01829

bdl: bellow detection limit

Table (4)Trace elements (ppm)

Elements	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4
Cu	23.4	26.0	20.8	12.3
Zn	26.0	33.7	30.7	43.3
V	bdl *	16.7	17.4	bdl *
Cr	8.4	13.1	7.6	15.7
Co	bdl *	bdl *	6.2	5.1
Ni	4.2	bdl *	6.3	7.9
Ga	bdl *	bdl *	bdl *	0.5
As	bdl *	bdl *	bdl *	0.6
Se	bdl *	bdl *	bdl *	0.5
Br	3.3	5.4	2.8	325
Te	bdl *	bdl *	bdl *	26.9
I	18.5	bdl *	bdl *	bdl *
Ba	bdl *	bdl *	441	32.3
Hg	bdl *	bdl *	1.1	0.8
Pb	2.2	2.4	4.4	5.8
Bi	bdl *	bdl *	0.4	0.8
Th	3.0	2.4	1.7	0.5

(bdl) below detection limit

Table (5) Calculated data for elemental daily supply and RDA for male (mg/day)

Elements	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	RDA
Mg	34.19	38.870	42.12	99.45	10-18
P	29.77	31.980	33.28	27.43	240-1200
K	192.92	220.7	196.2	250.5	350-5625
Ca	58.24	54.340	69.55	249.7	360-1200
Mn	9.490	13.130	15.86	2.6	0.5-5
Fe	5.070	5.460	26.91	24.18.	10-15
Cl	6.773	6.721	7.384	112.06	275-5100
Cu	0.304	0.338	0.270	0.150	0.5-3
Zn	0.338	0.438	0.399	0.563	9.5-20
Cr	0.109	0.170	0.099	Nill	0.01-0.2

RDA: - Recommended dietary allowances

تحليل أنواع مختلفة من أوراق الشاي باستخدام تقنية الاشعة السينية المتفلورة

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الخلاصة

الشاي أوراق صغيرة تسمى علمياً Camellia Rinensis تحتوي هذه الاوراق (بالإعتماد على نوعها) على الغدد الدهنية والفيتامينات والمعادن حيث أمكن الكشف على أكثر من 35 عنصرا مثل Zn, Cu, Fe, K, Mg, F, Ca, Se, كما تحتوي أيضاً على بعض المركبات الحيوية مثل الثيامين والهيدروكسيل والبيوتيلايت والحامض الاميني البيوتيري فضلا عن ذلك تحتوي البوليثينولات التي هي عامل مضاد لمرض السرطان لأنزيم أورثيلين دي كاربوكسيليز وهو الانزيم المسؤول عن نمو الخلايا السرطانية.

لأجل التحليل لمعرفة العناصر التي يحتويها النموذج بتقنية الاشعة السينية المتفلورة تجفف أوراق الشاي (الشاي الاخضر وشاي الكوجرات والشاي الاسود الاكثر إستخداماً لدى المواطن العراقي)، ثم تطحن لتحويلها إلى مسحوق يكبس على شكل أقراص. وذلك لغرض تحديد تراكيز العناصر الرئيسة والثانوية والعناصر النزرة.

لقد أمكن تحديد العناصر الاتية كعناصر رئيسة وهي: Na, Mg, Al, K, Si, Ca, Mn, Fe, S,P . إلا أن من هذه العناصر وجد أن Ca في أوراق شاي الكوجرات اكثر بثلاث مرات في التركيز مما هو عليه في النوعين الآخرين، في حين كانت العناصر الثانوية Ta, Cl, Rb, Sr اما العناصر الاتية Cu, Zn, V, Cr, Co.... الخ فتمثل

العناصر النزرة، ان تراكيز بعض هذه العناصر قد اخذت بنظر الاعتبار قيمها من الناحية السمية اد تمثلت بالعناصر As, Pb, Cd, Hg.

تحتوي أوراق الشاي الاخضر على 1.1ppm من الزئبق و 4.4ppm من الرصاص، في حين بلغت تراكيز أوراق شاي الكوجرات القيم 0.8ppm من الزئبق و 5.8ppm من الرصاص و 6ppm من As. أما أوراق الشاي الاسود فقد احتوت على 2.4ppm من الرصاص، بينما العناصر التي أظهرت القيم الاكثر تراكيز في أغلب النماذج والتي خضعت للتحليل هي الكلور والنحاس.