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Chromium in a Series of Portuguese Plants Used in the Herbal Treatment of Diabetes

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ABSTRACT

Chromium (Cr^{3+}) is an essential micronutrient for humans. Its main action is thought to be the regulation of blood sugar, because chromium deficiency is associated with diabetic-like symptoms, and chromium supplementation is correlated with increased glucose tolerance and insulin sensivity. Some Portuguese aromatic plants are utilized as tisanes by diabetic people as medicinal plants. Their active principle is not yet known, and the importance of their chromium content in the claimed therapeutic properties should not be discarded. Therefore, determination of chromium in some Portuguese medicinal plants was performed by flameless atomic absorption. All the analyzed plants contain chromium at the normal level for this element, but the plants used to prepare tisanes to help diabetic conditions contain higher levels (2.2 μg/g dry wt ± 0.88; n = 11) than the others (0.88 μg/g dry wt ± 0.18; n = 17).

Index Entries: Chromium, concentration in plants; Portuguese medicinal plants, concentration of chromium in; antidiabetic plants, concentration of chromium in; hypoglycemic plants, concentration of chromium in.

INTRODUCTION

A requirement for chromium to maintain normal glucose tolerance in rats was first observed in 1959 using a compound named glucose tolerance factor (GTF) isolated from brewer's yeast or pork kidney powder *(1)*. In human subjects, the effect of trivalent chromium supplements was also demonstrated to improve glucose metabolism *(2)*. Since then, many studies have been published related to the role of chromium in glucose

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and lipid metabolism. Critical reviews and papers on this subject have been presented *(3–8)*.

A good supply of chromium is important to assure an adequate daily intake of about 50 μg (range is 50–200 μg) *(9)*, and foodstuffs with known concentrations of chromium have been presented in a review *(10)*, as well as in a list of selected foods *(9)*. In Iraq, for example, bread from barley flour is traditionally used in the management of diabetes mellitus, and the high content of chromium (5.69 μ/g dry wt) in barley flour was postulated to explain its beneficial effect *(11)*.

In Portugal, some aromatic plants are consumed as tisanes by diabetic people to alleviate their health problems. In popular medicine, those plants are well known in relation to that therapeutic property, but the involved active principle is not known. Perhaps compounds containing chromium could be responsible for their pharmacological effect. On this premise, some Portuguese plants commonly employed to reduce sugar in the bloodstream were analyzed for this element using flameless atomic absorption spectrometry.

MATERIALS AND METHODS

Instrumentation and Analysis Conditions

A Shimadzu atomic absorption spectrophotometer (flameless atomic absorption spectrophotometer), model 6501, equipped with a Shimadzu graphite furnace, model 6FA-6000, a deuterium lamp background corrector, and an autosampling system model ASC-6000 were utilized in all determinations. As the light source, a hollow cathode lamp from Hamamatsu Photonics K.K. (Japan) was utilized, and pyrolytic coated graphite tubes were used as atomizers.

The conditions for the analysis were based on the instructions presented by the instrument manual. Samples of 10 μL were carried to the graphite tube by the autosampling system and submitted to the furnace established conditions (Table 1). The remaining parameters (slit = 0.5 nm, wavelength = 357.9 nm) were set according manual instructions.

Sample Preparation

Some plants were purchased from drugstores that sell them as having antidiabetic properties, but others were obtained in the school farm. Only the parts claimed to be active were used.

The first step in sample preparation was drying at room temperature, followed by grinding in a porcelain vessel, avoiding manipulation with stainless steel to prevent contamination. The obtained powder was further dried at 105°C for 3 h. After cooling, 0.5 g of material was calci-

Table 1
Furnace Conditions

Stage	Temp., °C	Times	Heat
Drying	120	10	Ramp
Drying	120	10	Step
Ashing	600	10	Ramp
Ashing	600	10	Step
Atomization	2400	3	Step
Atomization	2400	3	Step

nated at 500°C for 3 h (in triplicate) in a porcelain capsule. To the resulting ash, 10 mL of a mixture of suprapure $HCl:HNO_3:H_2O$ (1:1:8) were added, and after boiling for 2 min, the cooled solution was quantitatively transferred to a 25-mL volumetric flask to be used without further dilutions. This procedure was performed according Curtius and Campos *(12)*, and each sample was calcinated at least two times (always in triplicate) resulting in six acid solutions for repeated further analysis on different days.

Chromium Analysis

Direct determination of the chromium concentration in the prepared samples was performed by comparison with aqueous standard chromium (Titrisol, Merck). A stock chromium solution (50 ppm) was prepared and stored in a polyethylene container. Working aqueous standards were made fresh daily by volumetric dilution of the stock solution to desired concentrations with deionized H_2O. A calibration curve automatically prepared between 20 and 100 ppb of Cr^{3+} was obtained ($r_2 \simeq 0.9948$). To obviate errors arising from the sample matrix, the standard addition method was also applied, just for a few samples, to those whose Cr^{3+} measurements were closer to the mean value obtained with the standard calibration curve method.

RESULTS AND DISCUSSION

Chromium content in some medicinal plants with and without antidiabetic properties was measured according the standard calibration curve method. However, to obviate errors arising from the sample matrix, the standard addition method was also applied for two to three samples, those whose Cr^{3+} measurements were closer to the mean value obtained with the standard calibration curve method. Indeed, the addition proce-

Table 2
Chromium Concentration in the Studied Plants

Common name	Scientific name	µg/g dry wt A	µg/g dry wt B
Verbena*	*Verbena officinalis L.*	4.9 ± .50 (n = 18)	3.8 ± .21 (n = 3)
Carqueja (Brazil)*	*Bacharis, Genistelloides*	5.4 ± .41 (n = 15)	3.6 ± .20 (n = 3)
Erva de São Roberto*	*Geranium Robertianum L.*	3.5 ± .40 (n = 18)	2.8 ± .18 (n = 3)
Cajú*	*Anacardium occidentale L.*	4.9 ± .52 (n = 20)	2.4 ± .18 (n = 3)
Carqueja (leaves)*	*Pterospartum tridendatum L.*	4.5 ± .45 (n = 12)	2.3 ± .15 (n = 3)
Sargacinha*	*Lithospermum diffusum Lag.*	2.1 ± .30 (n = 28)	2.0 ± .14 (n = 2)
Sempre Noiva*	*Polygonum aviculare L.*	4.5 ± .45 (n = 18)	2.0 ± .21 (n = 3)
Serpão*	*Thimus Serpyllum L.*	3.5 ± .50 (n = 10)	1.6 ± .25 (n = 2)
Arando*	*Vaccinium Myrtillus L.*	2.7 ± .10 (n = 18)	1.3 ± .10 (n = 3)
Estrelas do Egipto*	*Coreopsis tinctoria Nutt.*	2.9 ± .26 (n = 24)	1.3 ± .11 (n = 3)
Tília (leaves)	*Tília sps*	3.0 ± .43 (n = 12)	1.2 ± .10 (n = 3)
Tília (flowers)	*Tília sps*	2.1 ± .44 (n = 14)	1.2 ± .10 (n = 3)
Maracujá*	*Passiflora*	2.4 ± .30 (n = 17)	1.1 ± .09 (n = 3)
Salva Brava	*Teucrium Scorodonia L.*	2.4 ± .15 (n = 18)	1.1 ± .10 (n = 2)
Esteva	*Cistus Ladanifer L.*	2.6 ± .30 (n = 18)	1.0 ± .09 (n = 2)
Urtiga branca	*Lamium Album L.*	2.4 ± .24 (n = 16)	1.0 ± .09 (n = 2)
Fel da Terra	*Erythraea Centaurium L.*	2.3 ± .32 (n = 24)	.92 ± .09 (n = 3)
Coentro	*Coriandrum sativum L.*	1.2 ± .16 (n = 15)	.91 ± .08 (n = 3)
Urze (Queiró)	*Erica Umbelata L.*	1.6 ± .29 (n = 18)	.91 ± .04 (n = 3)
Funcho	*Foeniculum vulgare Miller*	1.0 ± .25 (n = 13)	.83 ± .07 (n = 2)
Urze	*Erica Arborea L.*	.83 ± .16 (n = 20)	.82 ± .04 (n = 3)
Aipo	*Apium graveolens L.*	.73 ± .25 (n = 10)	.81 ± .07 (n = 3)
Alecrim	*Rosmarinus officinalis L.*	1.9 ± .34 (n = 16)	.81 ± .04 (n = 3)
Cipreste	*Cupressus sempervirens L.*	1.2 ± .22 (n = 17)	.81 ± .04 (n = 2)
Hipericão do Gerez	*Hypericum Androsaemum L.*	.68 ± .23 (n = 6)	.73 ± .09 (n = 2)
Carqueja (flowers)	*Pterospartum tridendatum L.*	1.0 ± .21 (n = 22)	.62 ± .03 (n = 2)
Rosmaninho	*Lavandula Stoechas L.*	.73 ± .10 (n = 19)	.62 ± .04 (n = 2)
Giesta branca	*Cytisus scoparius L.*	.47 ± .10 (n = 9)	.62 ± .08 (n = 3)

dure should always be used unless proven to be unnecessary *(13)*. Tomato leaves, NBS, which have a certified value of 4.5 ± 0.5 (μg Cr^{3+}/g dry wt) (addition method) were also utilized to check the procedure, giving values with <10% error (4.7 ± 0.4 μg Cr^{3+}/g dry wt).

Table 2 presents the results for chromium content (μg/g dry wt) as obtained using the calibration curve method (column A) and the standard addition method (column B) for a series of Portuguese plants, some of which are used in the herbal treatment of diabetes. The values obtained by the latter procedure were considered the most accurate *(13)* and were used to compare with results from Brazilian plants *(14)* also acquired by the same methodology.

Two groups of plants can be defined based on their chromium levels. The plants claimed to have hypoglycemic activity have a higher concentration [1.1–3.8 μg/g dry wt] [X_A = 2.2 ± 0.88] than the remaining ones, which present lower levels (0.62–1.2 μg/g dry wt) [X_B = 0.88 ± 0.18]. Those values are very similar to the ones obtained with Brazilian plants [1–4 μg/g dry wt and 0.5–1.5 μg/g dry wt], respectively, to hypoglycemic plants and for those with no known therapeutic properties *(14)*.

Chromium contents of individual foods vary widely, and are dependent on the introduction of that metal in the growing, transport, processing, and fortification of the food. Even well-balanced diets may contain insufficient quantities *(5)*, which can promote marginal chromium states. It is possible that tisanes prepared from the above-mentioned antidiabetic plants could be effective in those cases.

The starred plants in Table 2 are the ones that have been used with success as tisanes, but no studies with animals or humans have been published, except for their mention as antidiabetic plants *(15)* and in the oral reports of patients. It remains to be determined if chromium is the responsible for the medicinal properties of those plants. However, it is known that chromium supplemented in diets reverses symptoms of non-insulin-dependent diabetes in laboratory animals and in humans *(16,17)*, and that some chromium compounds are better absorbed than in the inorganic state *(18)*, which must be complexed with certain ligands to be fully active *(19,20)*.

Although the presented data do not prove chromium's claimed therapeutic properties, they indicate that this metal can be a factor to be considered. It may be used by the plant to produce metallocompounds, which could be the biologicaly active molecules. The nonstarred plants, not claimed to have medicinal properties, which have lower values of that metal, may also be active if chromium is also involved with adequate ligands to be well absorbed and used by the organism.

In conclusion, these results suggest that Portuguese plants used as active agents to alleviate diabetes may have such activity owing to their high levels of chromium, which should be in a complex form with organic compounds to have the best therapeutic effect.

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