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Chromium in Plants

Comparison Between the Concentration of Chromium in Brazilian Nonhypo and Hypoglycemic Plants

JUDITH FELCMAN* AND M. L. TRISTÃO BRAGANÇA

Pontifícia Universidade Católica do Rio de Janeiro, Department of Chemistry, Rua Marquês de S. Vicente, 225 22.453 Gávea, Rio de Janeiro RJ, Brazil

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ABSTRACT

Chromium is an essential trace element and is associated with some biological pathways, especially with glucose tolerance. For these reasons, we decided to determine the concentration of chromium in two sets of Brazilian medicinal plants. The first group consisted of plants that are considered as antidiabetic, whereas the second included plants that do not have this therapeutic property. The concentration of chromium was determined by flameless atomic absorption. All the plants analyzed contain chromium in the normal range for this element, but the hypoglycemic plants contain more chromium than the others (1–4 μg/g compared to 0.5–1.5 μg/g).

Index Entries: Chromium, concentration in plants; plants, concentration of chromium in; hypoglycemic plants, concentration of chromium in; Brazilian medicinal plants, concentration of chromium in; and chromium, comparison of the concentration in therapeutic plants.

*Author to whom all correspondence and reprint requests should be addressed.

INTRODUCTION

Chromium is considered an essential trace element for humans and animals. The first reports about chromium in biology appeared in 1954 (*1*) when it was verified that chromium had a stimulating effect on cholesterol synthesis. However, it was only in 1959 that this element was identified by Schwartz and Mertz as the active ingredient of "glucose tolerance factor" (GTF), obtained from purified fractions of brewer's yeast or pork kidney powder (*2*). Rats raised on some commercial rations showed low glucose removal rates that were prevented by dietary supplements of brewer's yeast or of GTF concentrates (*3*).

Since then, chromium deficiency has been associated with impairment in glucose, lipid, and protein metabolism. Some experiments led to the hypothesis that chromium acts as a cofactor enhancing insulin action (*4*). Successive experiments demonstrated that chromium supplement in diets reversed symptoms of non-insulin dependent diabetes both in laboratory animals and in humans (*5–9*).

Brazil has an enormous variety of plant species that are used popularly as medicines. Some of these are used for treatment of diabetes, but there are very few cases studied scientifically (*10*). These facts led to the decision to determine the concentration of chromium in some of the plants known to be anti-diabetic and to try to relate it with their therapeutic properties. With this in mind, the plants were grouped into two sets, corresponding to nonhypo and hypoglycemic species.

Since it is known that there are difficulties in analyzing chromium in biological materials, and since recent observations indicate that this could be because of the existence of volatile chromium compounds (*7*), attempts were made to find an appropriate initial work procedure that would avoid the use of temperatures above 600°C during the digestion process. The concentration of chromium was determined by flameless atomic absorption.

EXPERIMENTAL

Instrumentation

A Varian Techtron atomic absorption spectrophotometer, model AA6, equipped with a Varian graphite furnace model CRA-90, an H_2 lamp background corrector model BC6, and an autosampling system model ASD-53 was used for all measurements.

Plant Species

All plants used were commercial ones, from drugstores that sell them as medicines and so, only parts of the plants (leaves, bark, or seeds) that have therapeutic value were used.

Sample Preparation

The procedure of Curtius and Campos (*11*) was used for sample digestion. A portion of the plant was ground in a porcelain vessel, to avoid contamination with stainless steel, and dried at 105°C for 3 h. Subsequently, 0.5–1.0 g of material was weighed and calcinated at 500°C for 3 h in a porcelain capsule. The ash was treated with 20 mL of a mixture of HCl conc.; HNO_3conc.; H_2O 1:1:8). After boiling, the cooled solution was transferred to a 25 mL volumetric flask.

Each sample was treated, at least in duplicate. A NBS standard no. 1573 "tomato leaves" was used to check the procedure.

Instrumental Conditions

The optimal temperature for the atomization process was determined from ashing and atomization profiles (Fig. 1), obtained by measuring the atomic absorption signal for 0.2 ng of chromium in the digestion medium.

The maximum ashing temperature with minimum loss of chromium was found to be 800°C. With atomization temperatures up to 2200°C, the absorption signal is invariable. The atomization conditions are given in Table 1.

Other parameters, such as slit width and wavelength, were set according to the instrument manual. Nitrogen was used as a purge gas and pyrolytically coated graphite tubes were used as atomizers.

PROCEDURE

A sample volume of 5 μL was introduced into the graphite tube with the autosampling system. Readings were made at peak mode.

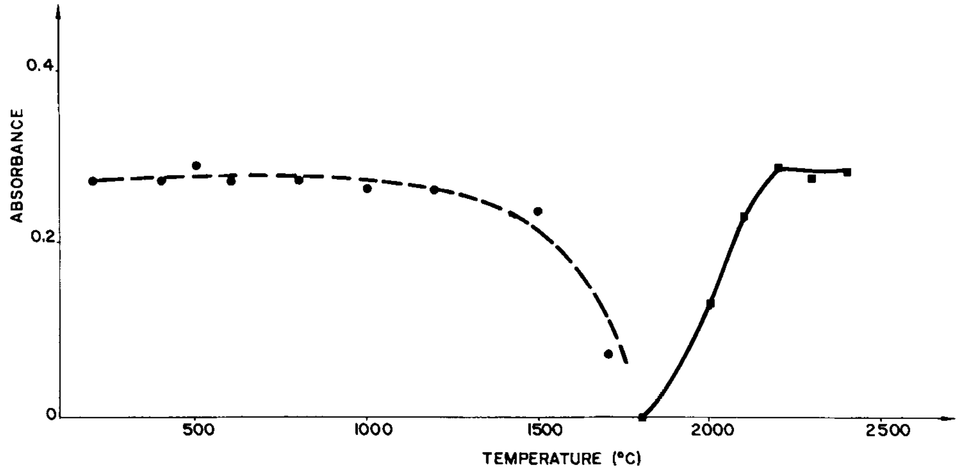

Fig. 1. Atomic absorption signals profiles for the ashing (--) and atomization (-) steps.

Table 1
Atomization Conditions[a]

	Dry	Ash	Atomization
Temperature, °C	100	500	2200
Time, s	30	30	2
Ramp rate, °C s^{-1}	—	—	400

[a]Readings in peak mode.

To overcome possible interference problems relative to the matrix, the standard addition method was applied for all determinations.

RESULTS AND DISCUSSION

The usual concentration of chromium in plants used as food is about 0–10 μg/g (*12*). Although the real requirement of chromium has not been determined yet, it is probably very small or lower than for most essential elements (*13*). Therefore, any increase in concentration could be important.

The chromium levels found in the different plants analyzed are presented in Table 2. The results are the mean value from at least two determinations. To prevent any doubt about the procedure, five determinations of chromium were done on the NBS "tomato leaves" reference material. The results are in agreement with the certified value (*see* Table 2).

As can be seen, all species contained chromium in the normal range for this element. But if these plants are divided into two groups according to their medicinal characteristics, it can be observed that the hypoglycemic plants contain from 1–4 μg/g of chromium, whereas those that do not have this therapeutic indication have a lower concentration of 0.5–1.5 μg/g. There is one exception in the second group (*Casca preciosa*), but this does not invalidate these observations. Even though the plant is not considered to be antidiabetic, it is possible that further studies could reveal such activity. It remains to be determined if chromium is the agent responsible for the antidiabetic properties. In fact, several experiments demonstrated that some chromium complexes are better absorbed by the organism than inorganic chromium (*13*) and, furthermore, that the biological activity depends on the ligands complexed (*14–15*), or even on the donor atoms of the coordinated ligands (*16*).

For these reasons, our data do not permit the conclusion that the hypoglycemic effect of these plants is because of chromium, but they indicate that this is a factor that must be considered. One effect of the larger amount of chromium may be to react with some substance present in the plant, forming a stable complex, and this substance or the complex could be the biologically active agent.

Table 2
Concentration of Chromium in the Analyzed Plants

Popular name	Scientific name	Mean value, μg/g
Tomato leaves, NBS		4.8 ± 0.3[b]
Pau ferro[a]	*Caesalpinia ferrea* Mart.	2.7
Carqueja[a]	*Baccharis,* genistelloides	4.2
Pata de vaca[a]	*Bauhinia,* aculeata	2.3
Cajueiro[a]	*Anacardium occidentele* L.	1.5
Bagirú[a]	*Chrisobalanus iccaco* L.	4.1
Pedra Hume Kaá[a]	*Myrcia,* Sphaerocarpa	0.9
Pau tenente[a]	*Simaruba,* officinalis	1.4
Cascas anti-diabéticas[a] (commercial mixing)		2.7
Carapanaúba	*Aspidosperma sp.*	0.2
Juca	*Jucca,* gloriosa	0.2
Angico Amargo	*Pipladenia sp.*	1.8
Casca preciosa	*Aniba,* firmula	2.5
Quina-quina	*Cascarilla undata* Warb.	0.8
Pepita		0.6
Ypê-roxo	*Tabebuia,* heptaphylla	0.5
Salva de Marajó	*Hyptis crenata* Pohl	1.7
Barba-timão	*Stryphnodendron,* barbatimao	0.8
Marapuana	*Ptycohopetalum olacoides* E. Anselmino	0.7
Sucumba	*Hymatanthus sp.*	1.1

[a]Antidiabetic plants.
[b]Certified value 4.5 ± 0.5.

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