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COMPARATIVE STUDIES ABOUT CAFFEINE CONTENT IN ROASTED GROUND COFFEE AND IN CHINA BLACK TEA

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Abstract

Caffeine (1,3,7-trimethyl-xanthine) is the most important molecule of the alkaloids being present in green and roasted coffee beans (1-2%), tea leaves (5%) kola nut (3%), and other tropical plants. Dried green coffee beans have a weight of 300 mg to 330 mg. The content of caffeine is between 1 % (w/w) and 2,5 % (w/w of dry green coffee). The content of caffeine does not change during maturation of green coffee beans.

The aim of this study was the comparative studies about caffeine content in roasted ground coffee and in China black tea. Isolation was done by liquid-liquid extraction using chloroform as an extracting solvent. A simple and rapid spectrophotometric method is described for the determination of caffeine in coffee and tea.

Key words: *caffeine, roasted ground coffee, china black tea*

INTRODUCTION

Coffea is a large genus (containing more than 90 species) of flowering plants in the family *Rubiaceae.* They are shrubs or small trees, native to subtropical Africa and southern Asia (Belitz and Grosch, 1987). Seeds of several species are the source of the beverage coffee. The seeds are called "beans" in the trade. Coffee beans are widely cultivated in tropical countries in plantations for both local consumption and export to temperate countries. Coffee ranks as one of the world's major commodity crops and is the major export product of some countries (Ciulei et al,1993).

Caffeine is an alkaloid of the methylxanthine family. In its pure state, it is an intensely bitter white powder. Its chemical formula is $C_8 H_{10} N_4O_2$, its systematic name is 1,3,5-trimethylxanthine (Clifford and Kasi, 1997).

The world's primary source of caffeine is the coffee bean (the seed of the coffee plant), from which coffee is brewed. Caffeine content in coffee varies widely depending on the type of coffee bean and the method of preparation coffee). The content of caffeine does not change during maturation of green coffee beans (Clifford and Ramirez-Martinez, 1991).

Tea is another common source of caffeine. Tea usually contains about half as much caffeine per serving as coffee, depending on the strength

of the brew. Certain types of tea, such as black and oolong, contain somewhat more caffeine than most other teas (Mumin et al., 2006)

Caffeine is a central nervous system and metabolic stimulant, and is used both recreationally and medically to reduce physical fatigue and restore mental alertness when unusual weakness or drowsiness occurs. Caffeine stimulates the central nervous system first at the higher levels, resulting in increased alertness and wakefulness, faster and clearer flow of thought, increased focus, and better general body coordination, and later at the spinal cord level at higher doses. Once inside the body, it has a complex chemistry, and acts through several mechanisms as described below (Nehlig et al, 1992).

MATERIALS AND METHODS

The laboratory examination were performed at the Food Biochemistry laboratory of the Faculty of Environmental Protection of the University of Oradea in 2008.

The determination was made on 5 roasted and ground samples of Arabica coffee, and 5 samples of Chinese Black Tea. The samples were collected from local market.

For the spectrophotometrical determination we used UV-Visible mini – 1240 Shimadzu spectrophotometer at 277 nm wavelength.

Isolation of caffeine from coffee and tea:

Chloroform is the best caffeine extracting solvent and the results obtained becomes satisfactory and reproducible.

In case of coffee - 0.35 g coffee was taken into a 500 ml beaker and subsequently 40 ml Chloroform and 1.5 ml NH_3 was added. The mixture was boiled for 30 min using a water bath. The extract obtained was cooled and purified using elution with chloroform in a column with activated alumina. The eluate was collected in a ccolumetric flask of 100 ml (Alpdogan et al, 2002).

In case of tea - 5g of tea was taken into a beaker and subsequently 25 ml ethanol was added. The mixture was refluxed using a water bath for 4 hours and than we added 2 g MgO in 15 ml water. The extract obtained was then heated for a short period for dryness using a water bath (Cotrău et Proca, 1988). The solid, yellow-green mass was refluxed with 25 ml of water, was heated to boil and centrifuged while still hot. The clear liquid was drained and the greenish precipitate was refluxed with 15 ml of water, repeating the extraction and separation process (Islam et al, 2002).

Preparation of Calibration Curve in chloroform.

0.01g of pure caffeine was dissolved in 25 ml chloroform to obtain the standard solution. From this solution the following volumes were pipetted (tabel 1):

Tabel 1.

Preparation of Calibration Curve in chloroform:

Nr. sample	Caffeine sol. (ml)	$CHCl_3$ (ml)	Sample Conc. (g 10^5/ml)
0	0,0	25,0	0
1	0,2	24,8	8
2	0,4	24,6	16
3	0,6	24,4	24
4	0,8	24,2	32
5	1,0	24,0	40
6	1,2	23,8	48
7	1,4	23,6	56

The sample solutions were measured at 277 nm wavelength and by the graphic representation of the extinction depending on the concentration of the sample, the calibration curve of caffeine in chloroform was obtained (fig.1).

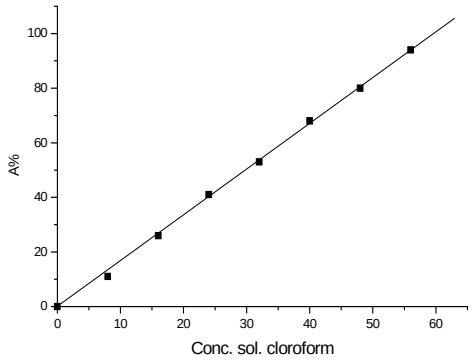

Fig. 1. Graphic representation of calibration curves in chloroform.

Preparation of Calibration Curve in water

0.01g of pure caffeine was dissolved in 25 ml water to obtain the standard solution. From this solution the following volumes were pipetted:

Tabel 2

Preparation of Calibration Curve in water.

Nr. sample	Caffeine sol. (ml)	H_2O (ml)	Sample Conc. (g 10^5/ml)
0	0,0	25,0	0
1	0,2	24,8	8

2	0,4	24,6	16
3	0,6	24,4	24
4	0,8	24,2	32
5	1,0	24,0	40

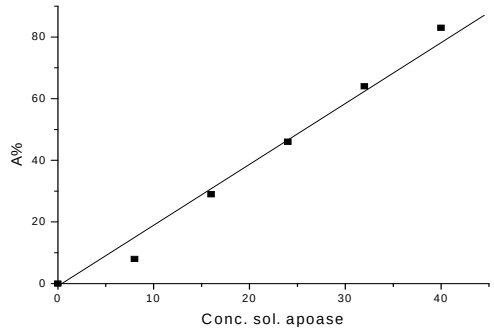

Fig.2. - Graphic representation of calibration curves in water.

The samples solutions was measured at 277 nm wavelength and by the graphic representation of the extinction depending on the concentration of the sample, the calibration curve of caffeine in water was obtained (fig.2).

RESULTS AND DISCUSSION

The coffeine content determination from samples using calibration curves in chloroform

- 4 – 4.5 ml from coffe extract or
- 2.5 ml of tea extract,

were brought to a final volume of 25 ml with chloroform. The obtained sample was spectrophotometrically analyzed and the value of the extinction at 277 nm was marked. From this value the concentration of the sample was obtained using the calibration curve, and then the caffeine content of the sample was determined (Newton, 1979):

$$\% \text{ caffeine} = \frac{25 \cdot c \cdot 10^4}{m \cdot V}$$

where: c – the concentration of caffeine obtained from the calibration curve (g 10^5/ml sample);

m – the mass of weighed ground coffee (g);

V – pipetted volume from 100 ml extracted eluate (ml).

The caffeine content determination from samples using calibration curves in water

-4 – 4.5 ml coffe extract;
-2.5 ml tea extract.

These extract volumes was evaporated in a water bath, and the residue was refluxed with water for solubilization, introduced in a volumetric flask of 25 ml and completed with distilled water. The obtained samples were spectrophotometrically analyzed and the extinction at 277 nm was marked. Then the content of caffeine was determined using the calibration curve of caffeine in distilled water. Finally the results obtained were compared with the ones from the calibration curve with chloroform.

After the analysis made for determining the caffeine content in the roasted ground coffee and in the black tea samples we recorded values of the caffeine content between 1.24 and 1.48% for roasted ground coffee (C. Arabica), and between 2.88 and 2.94 % in black tea using the calibration curve in chloroform. When using the calibration curve with distilled water the proportion was maintained even though the values were lower with 4.1% than when using the calibration curve with chloroform: between 1.19 and 1.44% for the coffee samples and between 2.84 and 3.01% in the black tea samples.

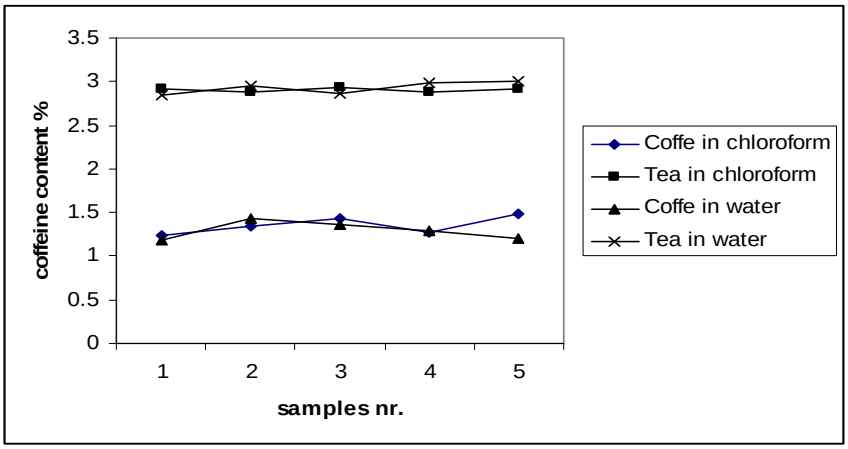

Fig.3 – The caffeine content in coffee and tea samples in case of utilization of calibration curves in chloroform and in water.

CONCLUSIONS

The results obtained for the spectrophotometric analysis of caffeine in different types of coffee and tea led to the following conclusions:

- the caffeine concentration in roasted coffee is lower than the caffeine concentration in black tea (an average 1.36% in comparison with 2.91% - caliber solution in chloroform;

1.34% in comparison with 2.92% - caliber solution in distilled water)

- the spectrophotometric methods are suitable and fast for these types of determinations, regardless if the solvent used to dissolve caffeine is chloroform or distilled water.

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