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The Effect of Sodium Bicarbonate on the Mg and P Concentrations in Turkish Black and Green Tea

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***Abstract*—**Tea is one of the most consumed beverages all over the world. Especially, black and green teas are preferred to consume. In Turkey, some local tea houses use sodium bicarbonate (SB) to obtain more infusion by using less than the amount of tea. Therefore, the addition of SB to black and green teas affects element concentrations of these teas. In this study, determination of magnesium (Mg) and phosphorus (P) contents in black and green teas aimed for conscious consumption, after the addition of SB. Inductively coupled plasma optical emission spectrometry (ICP-OES) was used for these analysis. The results of this study showed that the concentrations of Mg and P decreased by adding SB from 11.020, 21.915 to 10.009, 17.520 in black tea and from 12.605, 14.550 to 8.118, 9.425 in green tea, respectively. The addition of SB on analyzed teas is not recommended to cause reducing intake percentages of Mg and P from the essential elements.

***Keywords*—**Elements, ICP-OES, sodium bicarbonate, tea.

I. Introduction

TEA (*Camellia sinensis*) has been one of the most popular drinks in the world for over 4,000 years. More than three million hectares worldwide have been used for planting tea [1]. Turkey in 2011 ranks fifth in world production of tea after China, India, Kenya and Sri Lanka, according to the Food and Agriculture Organization of the United Nations (FAO) statistics [2]. *Camellia sinensis* varieties arise from numerous selections and hybridizations. Tea can be cultivated in many regions that have a high humidity, fair temperature, and acidic soils, from sea level to high mountains. Freshly harvested tea leaves must be processed to inactive enzymatic oxidation for green tea production, or to control the oxidation by the leaf enzymes for the production of Oolong and black teas. Traditionally, tea was drunk to improve blood flow, eliminate toxins, and improve resistance to diseases. Many reports support that tea can improve gastrointestinal function, ethanol metabolism, kidneys, liver, pancreas, stomach injuries, protects skin and eyes, alleviate arthritis, allergies, diabetes, and prevent infections, dental caries. The beneficial effects of tea on neurological and psychological health have also been reported [3]. Turkish people drink a great deal of tea all day long, especially at breakfast and in the evening and drinking tea after a meal is a traditional practice in Turkey [4].

Mg is a physiologically essential constituent playing an important role in different vital processes occurring in the human body. Being a cofactor in almost all phosphorylation reactions involving ATP, Mg is considered as an indirect antioxidant. It is not only a major component of the bones, but furthermore, it influences the nervous system and muscle activity. Habitually low intakes of Mg are associated with etiologic factors in cardiovascular and nervous diseases, bone deterioration and stress [5], [6].

P is an essential element for all forms of life on earth. It is a primary constituent of deoxyribonucleic acid (DNA) and adenosine triphosphate (ATP) which is responsible for the encoding of genetic instructions and intracellular energy transfer within living cells [7].

In some Turkish local tea houses, SB is added to obtain a higher infusion from teas, when tea infusions are prepared. The density difference of tea infusions with SB and without SB is shown in Fig. 1 that infusion increased after the addition of SB. There are various studies about element contents of teas. Shen and Chen (2008) studied on the Mg content of Taiwan black and green teas, Natesan and Ranganathan (1990) studied on the Mg contentof Indian black tea, Sofuoglu and Kavcar (2008) studied on Mg content of turkish black tea, Malik et al. (2008) studied on the Mg and P contents of Czech black and green teas [8]-[11]. Furthermore, the SB effect on elements that are found in teas, have not been studied ever.

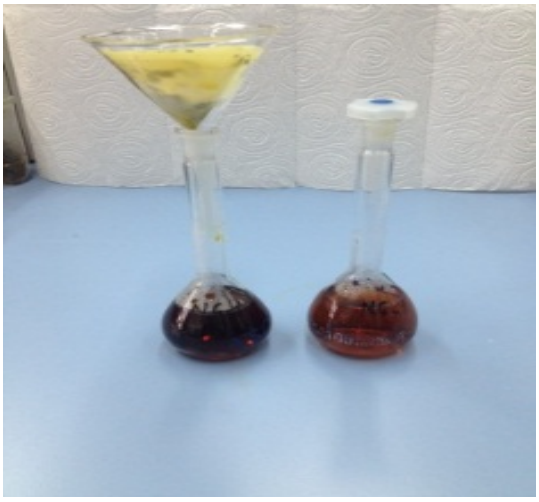

Fig. 1 Tea infusions with SB and without SB

This study aimed SB effect on concentrations of Mg and P elements in black and green teas by using ICP-OES.

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II. Experimental Procedure

A. Preparation and Infusion of Teas

Black tea, green tea and SB are purchased from the local market in Istanbul, Turkey. Infusions of teas are prepared by the brewing method according to ISO 3103 [12]. Firstly, the teas and the SB were weighed as 2 ± 0.0005 g and 0.125 g ± 0.0009 into beakers, respectively, then 100 ml distilled water (0.07 µs cm^{-1}) boiled to 100°C added to the beakers and the extraction was carried out during 5 min. The same method is repeated without the addition of SB. After extraction, the infusions were filtered through Macherey-Nagel blue ribbon filter paper. The brewing process is shown in Figs. 2 and 3.

Fig. 2 Brewing procedure of the tea samples

Fig. 3 The color difference of the teas without SB and with SB

B. Preparation of the Calibration Sets and Elemental Analysis of the Tea Samples

Calibration sets conducted by using Mg and P standard solutions [13].

ICP-OES is an important technique to study the trace elements at the molecular level in various biological samples and it has high sensitivity for detecting the major trace elements [14].

Perkin-Elmer Optima 2100 DV model ICP-OES equipped with an AS-93 auto sampler was used in the experiments (Fig. 4). The measured samples are given in Fig. 5.

Measurement conditions were adjusted to a power of 1.45 kW, plasma flow of 15.0 L min^{-1}, auxiliary flow of 0.8 L min^{-1} and nebulizer flow of 1 L min^{-1}.

III. Results

The some essential element concentrations of the teas and the SB effect of these elements are shown in Fig. 6, Tables I and II.

Fig. 4 Perkin-Elmer Optima 2100 DV, ICP-OES

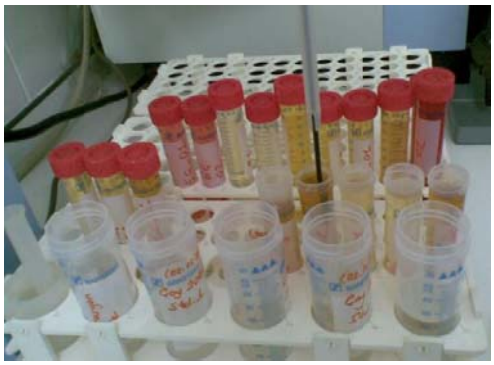

Fig. 5 Measured tea samples

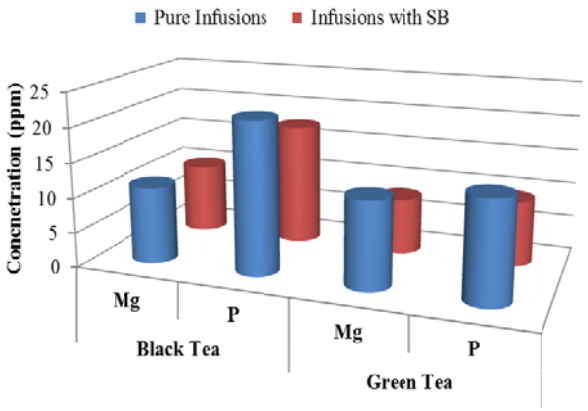

Fig. 6 Mg and P contents of the tea samples

TABLE I
The Comparison of Elements Concentrations

Tea Types	Black Tea		Green Tea	
Elements	Mg	P	Mg	P
Pure Infusion Concentrations (ppm)	11.020	21.915	12.605	14.550
Infusion Concentrations with SB (ppm)	10.009	17.520	8.118	9.425

In according to data of the results, Mg and P decreased in black and green tea after the addition of SB. Distilled water was used for the experiments and pH of distilled water was measured as 4.14 by Hanna HI 2211 pH/ORP Meter. After SB was added, pH of distilled water was measured again and was found as 6.88, the alkalinity of distilled water increased

because of the addition of SB. This reason about pH affected on these elements concentrations.

TABLE II
THE EFFECT SB ON ELEMENTS CONTENTS

Tea Types	Black Tea		Green Tea	
Elements	Mg	P	Mg	P
The Percentages of Change (%)	9.174	20.055	35.597	35.223
The Types of Change	↓	↓	↓	↓

The Mg and P contents of green tea were affected more than the black teas by the SB addition, is shown approximately with a value of 35% in Table II. The percentages of change in element contents of teas are as follows from high to low; Mg in green tea, P in green tea, P in black tea and Mg in black tea, respectively.

IV. DISCUSSION AND CONCLUSIONS

The addicted person consumes daily at least 5 cup teas (1 cup is equal to 100 ml). The intake of Mg and P elements from 5 cups is calculated with (1) and shown in Table III.

$$m(mg) = C\left(\frac{mg}{l}\right) \times \frac{l}{1000ml} \times 100ml \times 5 \quad (1)$$

where 'm' is the element contents of five cups of tea, "C" is the element concentration.

In according to results, the P content of green tea decreased more than the others by the addition of SB.

TABLE III
THE CONTENTS OF ELEMENTS IN 5 CUPS OF THE TEAS

Tea Types	Black Tea		Green Tea	
Elements	Mg	P	Mg	P
In Pure Infusion (mg)	5.510	10.958	6.303	33
In Infusion Concentrations with SB (mg)	5.005	8.760	4.059	4.713

Daily essential element requirements for human body in 19-50 ages are in Mg; maximum 420 mg day^{-1} for men and maximum 320 mg day^{-1} for women, in P; 700 mg day^{-1} for both of men and women [15]. These elements of intake percentages were calculated, is shown Table IV by using (2) and the values of daily requirements for human body.

$$DMI = m \times 100 / DRI \quad (2)$$

where 'DRI' is recommended dietary reference intakes.

TABLE IV
THE ELEMENTS OF INTAKE PERCENTAGES DAILY FROM THE TEAS FOR HUMANS IN 19-50 AGES

Tea Types	Black Tea		Green Tea	
Elements	Mg	P	Mg	P
Without SB (%)	1.312 (*1.722)	1.565	1.501 (*1.970)	1.039
With SB (%)	1.192 (*1.564)	1.251	0.966 (*1.268)	0.673

*Female intake percentages

According to the results obtained, the essential elements of intake percentages from these teas for humans by consuming daily 5 cup of tea, as follows; the major and minor percentages of Mg are with 1.970% (for male) in green tea without SB and with 0.966% (for female) in green tea with SB, respectively.

The major and minor percentages of P are with 1.565% (for both male and female) in black tea without SB and with 0.673% (for both male and female) in green tea with SB, respectively.

Based on this study, the addition of SB for getting more infusion by using less than the amount of tea is not useful for human body, because of decreasing the contents of Mg and P essential elements.

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