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Original Article

Estimation of Oxalic Acid in Drinks

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The levels of oxalic acid in commercially obtainable drinks were estimated using ion chromatography. Variability of oxalic acid contents in many drinks was observed. Large amounts of oxalic acid were contained in Maccha. That amount was about 6 times that in green tea. The difference of oxalic acid contents in tea by infusion time was examined. The maximum concentration of oxalic acid in distilled water was reached in 4 minutes. Oxalic acid concentration by water used for infusion, distilled water and tap water, were compared. The difference in the two results can be regarded as significant. There was a significant difference in the oxalic acid concentration in distilled water and in tap water ($p < 0.05$).

Key Words: oxalic acid, ion chromatography, distilled water, tap water, green tea, black tea

Introduction

Oxalic acid and oxalates occur naturally in varying degrees in plants and animals. Oxalic acid is produced by the human body from other substances such as vitamin C [1]. It can also be ingested into the human body from foods consumed. These substances are found in fairly high concentrations in such foods as, berries, spinach, beet greens, and parsley. Okra, leeks, and collard greens are also known to be high in oxalic acid.

For most people on a balanced diet, oxalic acid will have no appreciable effect on health or longevity. However, for people with kidney stones, gall stones or severe calcium deficiency problems oxalic acid intake should be severely restricted. In the body, oxalic acid combines with metals such as calcium to form oxalate crystals which can irritate the gut and kidneys. The most common kind of kidney stone is made of calcium oxalate [2].

Oxalic acid seems to assist in the formation of crystals in the body by combining with calcium and various metals. The precipitate is referred to as an oxalate. Oxalic acid also inhibits calcium absorption by the body. Even so, most of the foods that are high in oxalates have many beneficial effects that more than offset the negative effects of the organic acid. Also, it is not currently known if oxalic acid has some other beneficial effect on the system. Since the body can produce oxalic acid from excess vitamin C, it is not wise to take extremely large doses of the vitamin for extended periods of time.

It is known that cooking has little effect on the oxalic acid content of food. About 10 to 15 percent reduction is common at normal temperatures and cooking times. Cooking foods longer or hotter will have an overall detrimental effect by destroying the good nutrients [3].

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The objectives of this study were to estimate the levels of oxalic acid in commercially obtainable drinks using ion chromatography. Further, the present work described the effect of infusion time on the oxalic acid content when making black a tea from tea bag, and the influence of the water used to infuse on oxalic acid concentration.

Materials and Methods

Samples and Chemicals

Drinks were purchased from local supermarkets. All chemicals were analytical grade and the water was deionized prior to distillation.

Preparation of black tea

One bag of black tea was put into a cup and steeped in distilled water or tap water for 2 minutes.

The difference of infusion times was examined from 1 to 10 minutes.

Preparation of Maccha tea

Maccha was prepared by adding boiled tap water to powdered green tea and agitating.

Preparation of coffee

Coffee was prepared by adding boiled tap water to ground beans and filtering.

Ion chromatography system

All samples were diluted 10-fold in distilled water and injected to ion chromatography through a 0.45μm pore size cellulose acetate filter.

The ion chromatography system used in this study consisted of a Dionex 2000i/SP ion chromatograph, a Dionex HPIC-AS4A column (4×250 mm) with a IonPac AG4A guard column (4×50 mm) and a Chromatocorder 12 integrator. The mobile phase was composed of 1.8 mM sodium carbonate, 1.7 mM sodium hydrogencarbonate at a flow rate of 1.0 ml per min at 30℃. Oxalic acid content was calculated from the standard curve prepared with standard oxalic acid solution.

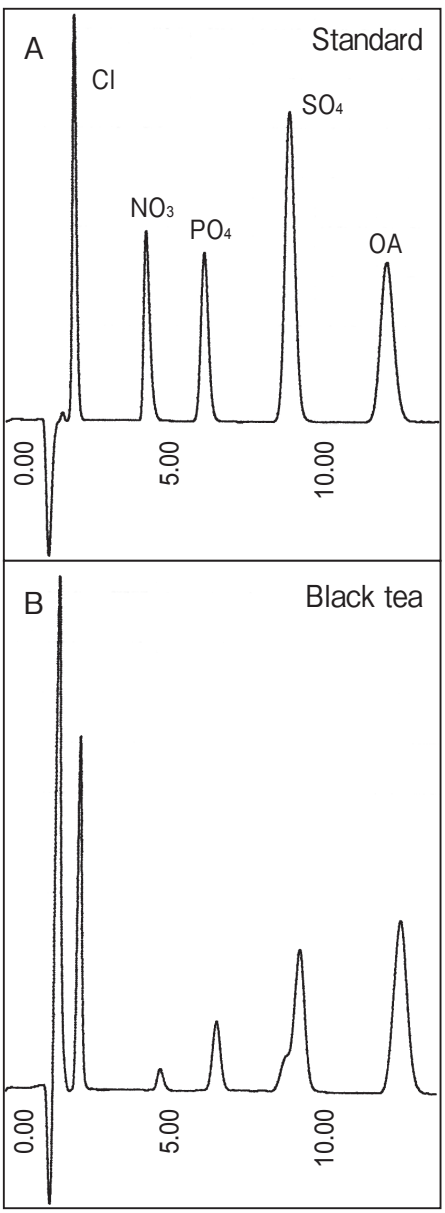

Fig. 1 Chromatograms illustrating the measurement of oxalic acid by ion chromatography.
Standard (A) : Cl (0.2mg/100ml), NO_3 (0.25mg/100ml), PO_4 (0.5mg/100ml), SO_4 (0.5mg/100ml), OX (oxalic acid, 0.5mg/100ml).

Results and Discussion

Fig. 1 shows a typical ion chromatogram of standard and black tea. Oxalic acid was eluted at 12.5 minutes and was completely separated from other peaks. The ion chromatography method was analytically superior in estimating low values of oxalate. It can be expected that another direct technique for analyzing oxalic acid in foods, gas liquid chromatography, would also be suitable for the analysis of oxalic acid in foods, but it would require a derivatization step to make oxalic acid volatile, thus increasing the assay time.

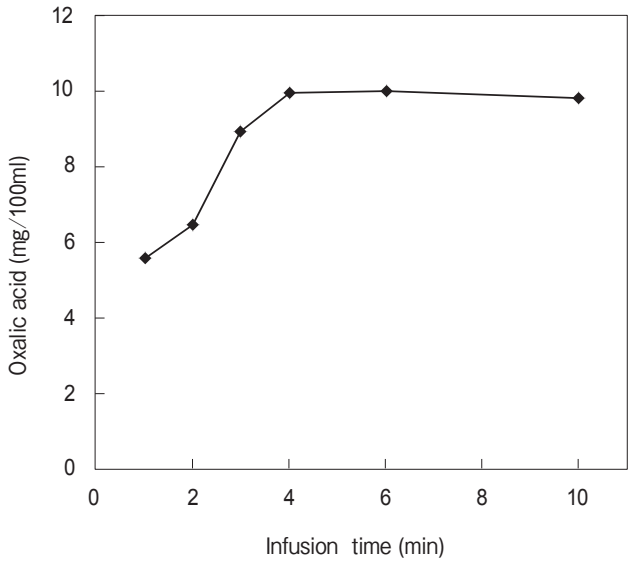

Fig. 2 The difference of oxalic acid contents from tea bags by infusion time.

The difference of oxalic acid contents by infusion times of 1, 2, 3, 4, 6 and 10 minutes from tea bags was examined (Fig. 2). The maximum concentration of oxalic acid in distilled water was reached in 4 minutes, it did not increase after that. A common time to make a cup of black tea is two minutes. Oxalic acid concentration for the infusion time of 2 minutes was approximately 65% of that with the infusion time of 4 minutes. Therefore, an infusion time of more than 2 minutes is not good from the perspective of oxalic acid concentration.

Oxalic acid concentration according to by water used for infusion, distilled water and tap water, were compared (Table 1). The difference in the two results can be regarded as significant. There was a significant difference in the oxalic acid concentration in distilled water and tap water ($p < 0.05$). Oxalic acid found in tap water was about 16% lower than that in distilled water.

Tap water contains calcium and various metals. Oxalic acid in black tea seems to assist in the formation of crystals by combining with calcium and various metals in tap water.

We use tap water in our homes to make black tea. It seems to be effective in reducing the concentration of oxalic acid.

Table 1 Oxalic acid concentration from water used for infusion, distilled water and tap water.

	Oxalic acid (mg/100 ml)	
Distilled water	7.04 ± 0.09	**
Tap water	5.90 ± 0.25	

Values are the mean ± SD (n=3).
Difference between distilled water and tap water was significant (** : $p < 0.01$).

Table 2 Oxalic acid contents in drinks.

	mg/100 ml
Maccha	32.38*
Black tea (Infusion)	5.90**
Green tea (Infusion)	5.69
Oolong tea (Infusion)	2.87
Vegetable juice	1.90
Tomato juice	1.73
Beer	1.44
Coffee (Infusion)	0.92**
Barley tea (Infusion)	0.72

* Maccha is the mixture obtained by adding hot water to green tea powder and stirring.
**These drinks were infused by tap water.
Others were purchased at a supermarket.

The results of examining the amount of oxalic acid contained in a variety of drinks is shown in table 2. Variability of oxalic acid contents in many drinks was observed. Large amounts of oxalic acid were contained in Maccha. The amount was about 6 times that found in green tea.

Maccha is the mixture obtained by adding hot water to green tea powder and stirring. Green tea is the infusion from tea leaves. Although the tea leaves have a very high concentration of oxalic acid, there is little quantity extracted from a leaf when brewed.

Excessive intake of oxalic acid may lead to the formation of renal calcium stones [4] and also decreases calcium absorption [5, 6].

The main sources of dietary oxalic acid are plants and plant products, principally seeds and leafy plants related to spinach and rhubarb. Spinach is a good

source of vitamin A, B_1, B_2 and C as well as minerals such as iron and magnesium. However, it is an oxalic acid-accumulating plant [7].

Some idiopathic calcium oxalate stone-formers are due to increased absorption of oxalate by the intestine, which may be due to a reduction in intraluminal calcium concentration. Therefore, when oxalic acid is taken in the diet, it is necessary to ingest calcium at the same time.

The estimation of the oxalic acid content of foods will permit a more accurate assessment of the oxalate intake of individuals and its impact on urinary oxalic acid excretion and calcium oxalate stone formation.

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