Fluoride and Calcium in Tea Leaves

Kazuyoshi Takiyama and Yuuko Ishii

Food Environmental Science Institute, 4-25-8 Oimazato, 
Higashinari-ku, Osaka 537 Japan
+Mukogawa Women's University, Nishinomiya 663 Japan

Abstract: The determination of fluoride and the nutritious calcium in infusion of teas are explained. Tea leaves were pulverized and were immersed in boiling water. The solution was filtered and fluoride, calcium and oxalic acid were determined by the ion chromatography. The quantities of fluoride, calcium and oxalate ions extracted from 100 g of tea leaves were calculated. Tea leaves were also immersed in 0.5M hydrochloric acid and extracted oxalate and calcium ions were analyzed. The free oxalic acid and calcium were extracted in boiling water and the total ones were extracted in hydrochloric acid. The quantity of calcium oxalate was calculated from the total and the free oxalic acids. The free calcium was estimated to be nutritious.

Keywords: Tea leaves, Fluoride, Nutritious calcium, Oxalic acid in tea leaves, Extraction of fluoride and calcium

1. Introduction

Various kinds of tea, such as green tea, black tea, oolong tea are produced from the similar tea plant. It is said that drinking tea is generally effective for keeping health of people [1]. Tea belongs to camellia group and contains a large quantity of fluoride [2-5]. Analysis of fluoride has been carried out by the distillation method. The sample was dried and pulverized. The powder was mixed with milk of lime and heated to ashes. The
ashes were mixed with sulfuric acid and fluoride ion was distilled. Fluoride was analyzed by aluminum-hematoxyline colorimetry. It was found that fluoride ion in tea leaves was extracted in water[6]. In the present investigation the authors analyze fluoride ion by extraction in boiling water.

Calcium is generally contained in leaves and stalk of vegetable, grass and tree. Calcium in plant exists as free ion, calcium oxalate and complex with protein, amino acid, etc. The free calcium was extracted in boiling water and the total calcium was extracted in 0.5 M hydrochloric acid[7]. In the present investigation calcium in tea leaves are analyzed and the nutritious calcium extracted in infusion of tea is obtained.

2. Experimental

2.1. Material and pretreatment

Several kinds of green teas, a black tea, an oolong tea, a coffee and several kinds of imitation teas, which were obtained in the market, were used for the investigation. Tea leaves were pulverized in cooking mixer for making dry powder just before analysis.

2.2. Extraction of fluoride ion

Five grams of the sample powder of tea leaves were put into 200 ml of boiling water in a tall beaker. After 5 min to 4 h boiling, a part of the solution was removed and cooled in a small flask immersed in ice water. The solution was filtered with a DISMIC-25 to remove suspended matter and then the filtrate was filtered with MOLCUT-L to remove protein.

2.3. Determination of fluoride ion with ion chromatography

Determination of fluoride ion was carried out with DIONEX Ion Chromatograph 2000i/SP. IC analysis was carried out using the eluent, which was diluted with water as 10 times. The extract from tea leaves was diluted with water as 10 times before application to IC.

2.4. Determination of calcium

Extraction of calcium from tea leaves has been done by boiling water and hydrochloric acid. Extraction of calcium in boiling water was carried out by the same method as that of fluoride ion and calcium and oxalate ions were analyzed with IC. Five grams of pulverized tea leaves were immersed in 200 ml of 0.5 M hydrochloric acid for one night. The solution was filtered and calcium and oxalate ions were analyzed with IC.

3. Results and discussion

3.1. Analysis of fluoride ion with IC

The authors used an old type of IC, DIONEX 2000i/SP. The elution peak of fluoride overlapped with peaks of silicate and acetate. The eluent, which was diluted with water as 10 times, was used to elute fluoride and the peak of it could be separated from those of silicate and acetate.

3.2. Extraction rate of fluoride

The concentration of fluoride ion in the extract gradually increased and reached a maximum after about 20 min of boiling and was maintained at almost constant value for 4 h as shown in Fig. 1.
Fluoride and Calcium in Tea Leaves

It is estimated that all of fluoride ion was extracted from tea leaves in boiling water in 30 to 40 min.

3.3. Extraction of fluoride ion in tea infusion

Extraction of fluoride ion was carried out according to the tea service. Ten grams of tea leaves (Yamecha Tea) were immersed in 200 ml of water at 80°C for 2 min. The solution was filtered and the content of fluoride ion was analyzed. The extraction and analysis were repeated several times and the results are shown in Fig. 2. After five times extraction, all of fluoride was extracted.

3.4. Determination of nutritious calcium

Determination of calcium in vegetables has been carried out by extraction method [8]. Calcium is estimated to exist in vegetables as free calcium, calcium oxalate and complex compounds with protein, amino acid etc. In boiling water the free calcium and oxalic acid could be extracted and in 0.5 M hydrochloric acid all of calcium and oxalic acid, which was the free acid and the combined oxalic acid with calcium, were extracted. From the total and free oxalic acids the content of calcium oxalate could be calculated. Calcium combined with oxalate and protein was not extracted in boiling water. Then only free calcium could be extracted in infusion of tea.

3.5. Fluoride ion and calcium contents in tea leaves

The content of fluoride ion in tea leaves determined by the extraction method are shown in Table 1. Teas produced from the similar tea plant contained around 100 to 200 mg fluoride ion in 100 g of tea leaves. Karigane tea contained relatively a large quantity of fluoride ion because the tea was mixed with stalk of tea plant, which contained a lot of fluoride. Korean Red Ginseng contained a small quantity of fluoride ion, because it was not tea leaves. Nutritious calcium in tea leaves was around 20 to 30 mg in 100 g of tea leaves. So called "Health Tea" contained a large quantity of nutritious calcium, because the original plants probably contained a lot of free calcium.

3.6. Effect of drinking tea

Nowadays tap water contained almost no fluoride ion, e.g., tap water of Osaka contained less than 0.03 ppm fluoride ion. By drinking tea, people can take in fluoride ion to protect from decay of teeth. The usual green tea and black tea
Table 1. Contents of fluoride ion and calcium in tea leaves

<table>
<thead>
<tr>
<th>Sample</th>
<th>F</th>
<th>H₂C₂O₄ Free</th>
<th>H₂C₂O₄ Total</th>
<th>CaOₓ¹</th>
<th>Ca Free²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yamecha Tea</td>
<td>165</td>
<td>766</td>
<td>1186</td>
<td>697</td>
<td>445</td>
</tr>
<tr>
<td>Shizuoka Sencha</td>
<td>224</td>
<td>1064</td>
<td>1106</td>
<td>70</td>
<td>150</td>
</tr>
<tr>
<td>Uji Gyokuro</td>
<td>156</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uji Karigane</td>
<td>310</td>
<td>792</td>
<td>1392</td>
<td>996</td>
<td>278</td>
</tr>
<tr>
<td>Uji Karigane roasted</td>
<td>370</td>
<td>560</td>
<td>1492</td>
<td>1546</td>
<td>371</td>
</tr>
<tr>
<td>Uji Bancha</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oolong Tea</td>
<td>182</td>
<td>480</td>
<td>1156</td>
<td>1122</td>
<td>213</td>
</tr>
<tr>
<td>Black Tea</td>
<td>164</td>
<td>700</td>
<td>1364</td>
<td>1102</td>
<td>478</td>
</tr>
<tr>
<td>Coffee</td>
<td>99</td>
<td>60</td>
<td>67</td>
<td>11</td>
<td>140</td>
</tr>
<tr>
<td>Korean Red Ginseng</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Rooibos Tea</td>
<td>21</td>
<td>154</td>
<td>157</td>
<td>5</td>
<td>181</td>
</tr>
<tr>
<td>Ashitaba Tea</td>
<td>184</td>
<td>123</td>
<td>750</td>
<td>1040</td>
<td>1454</td>
</tr>
<tr>
<td>Moroheiya Tea</td>
<td>126</td>
<td>281</td>
<td>3952</td>
<td>6091</td>
<td>2400</td>
</tr>
<tr>
<td>Aloe Tea</td>
<td>55</td>
<td>179</td>
<td>688</td>
<td>893</td>
<td>1620</td>
</tr>
<tr>
<td>Tochucha Tea</td>
<td>101</td>
<td>62</td>
<td>125</td>
<td>106</td>
<td>1856</td>
</tr>
<tr>
<td>Stinking herb Tea</td>
<td>71</td>
<td>3162</td>
<td>5792</td>
<td>4363</td>
<td>1258</td>
</tr>
</tbody>
</table>

¹:CaOₓ=CaC₂O₄+H₂O  ²:Free Ca=Nutritious Ca

are not utilized for taking in calcium, but some of the healthy teas give a large quantity of nutritious calcium.

4. Conclusion

Tea leaves were immersed in boiling water and 0.5 M hydrochloric acid and fluoride ion and the free and total calcium were determined. Various tea leaves contained relatively a large amount of fluoride ion and by drinking tea people can be protected from decay of teeth. Some of the tea contain relatively a large amount of free calcium and the drinking tea helps to take in nutritious calcium.

References