

NOTE

**DETERMINATION OF FLUORIDE BY ALIZARIN
COMPLEXONE SPECTROMETRY IN TEA
SAMPLES AND THE WASTES OF TEA
FACTORIES IN IRAN**

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ABSTRACT

The purpose of this investigation was to study the fluoride content of tea samples consumed in Iran and of waste samples from the tea factories. The wastes analysed were tea dust, tea fluff and tea stalk which were rejected during the production of black tea. Alizarin complexone spectrometry was used after a method of steam distillation. Generally the fluoride content of the samples varied from 10-21 mg F 100 g⁻¹. The corresponding values of the waste samples were between 10-15.5 mg F 100 g⁻¹.

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تعیین فلوئورید با استفاده از آلزارین کمپلکسون اسپکترومتری در نمونه های چای و پس مانده های کارخانه های چای سازی ایران

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چکیده

مهمترین نمونه های چای که قسمت اصلی چای مصرفی ایران را شامل می شود، از طریق اداره کل تمرکز و ذخیره سازی چای کشور تهیه شد. یک نمونه ساقه چای و دو نمونه از محصولات فرآیند تهیه چای یعنی "خاک چای"، و "غبار چای" و نیز یک نمونه برگ سبز چای شمال (منطقه رامسر) در این مطالعه به کار رفت. غلظت فلوئورید نمونه ها با یک روش سه مرحله ای تهیه خاکستر، تقطیر با بخار آب و استفاده از آلزارین کمپلکسون اسپکترومتری که بر اساس واکنش فلوئورید و یک ماده رنگی زیرکونیم می باشد، اندازه گیری شد. میانگین ارقام بدست آمده برای فلوئورید در نمونه های چای ۱۰-۲۱ میلی گرم در ۱۰۰ گرم را نشان داد، و نمونه های ساقه چای، "خاک چای" و "غبار چای" نیز دارای ۱۰-۱۵/۵ میلی گرم در ۱۰۰ گرم بود.

INTRODUCTION

It is generally accepted that adequate fluoride intake may help to reduce dental caries. Although the mechanism of this reduction is not yet completely known, it has been stated that fluoride strengthens the enamel by forming fluoroapatite, and inhibits the adsorption of salivary protein onto

the enamel. It also has antimetabolic effects on microorganisms through inhibition of glycolytic pathway and thus reduction in the conversion of sugar to acids (11).

The majority of foods contain 0.2-0.3 mg F/kg but tea and sea foods are exceptions (8). Many plants tend to accumulate fluorides in various forms, siliceous plants as SiF_4 , plants with calcium as CaF_2 , in some other plants and tea leaves as KF. Typical fluoride content of some foods are: spinach (22 mg/kg) (6), potatoes (0.21-0.77 mg/kg) (3), milk (0.15 mg/kg) and bottled vichy water (10.6 mg/kg) (1). Potable waters mostly suffer from the lack of fluoride throughout the world. A study of the fluoride content of potable waters in Iranian cities showed a range of 0.13-0.53 mg/kg (9). Water fluoridation as well as application of fluoride in the form of fluoride solutions, toothpaste, tablets and drops can be useful (11).

Tea being a major drink in Iranian diets and can be a very good source of fluoride (5).

The extraction of fluoride in infused tea has been studied by other researchers (5,12). Harrison found that 80-100% of the fluoride in tea could be extracted from a 2% infusion in 5 min (7). In the present study, the fluoride content of commonly used teas and tea wastes in Iran was studied in both dry samples and infusions.

MATERIALS AND METHODS

Most of the tea consumed in Iran is a blend of 60% Iranian product with 40% imported tea. In this work, the following samples were analysed: 2 types of pure Iranian tea (black tea and green tea leaves), one sample of tea bag, Iranian brand, 3 brands of pure imported tea and three waste samples (tea dust, tea fluff and tea stalk). All samples were kindly provided by the Iranian Tea Organization.

One infusion was also prepared from an Iranian brand. To do this, one gram of tea was infused in 100ml of distilled water for 5min, then filtered. The specifications of samples are given in Table 1.

Table 1. Specifications of tea samples.

Sample No.	Name	Standard No	Grade	Company
1	Tata Tea ¹	213	TGFOP ₁ ²	Tata Tea ³
2	C.T.C ⁴	408	BOP ⁵	Shiraz
3	C.T.C. FOF ⁶	50	BOP	Haj Ahmad Bangladesh
4	Iranian Tea	-	-	Iranian Tea Organization
5	Tea dust	-	-	-
6	Tea fluff	-	-	-
7	Tea stalk	-	-	-
8	Green tea leaves	-	Iranian	-
9	Tea bag	-	Mixture of Iranian, Indian	Iranian Tea Organization
10	Tea infusion	-	Iranian tea No. 4	-

1. Tata Tea is imported by Tata Tea Company.
2. TGFOP₁, Tipy Golden Flowery Orange Pekoe One.
3. Samples No.1 and No. 2 are from India and No. 3 is from Bangladesh.
4. C.T.C., Cutting Tearing Cording is one of the methods of tea preparation.
5. BOP, Brocken Orange Pekop (Barooti Kind).
6. FOF, Flowery Orange Fanning (Shekaste Kind).

The fluoride content of all samples was estimated colorimetrically, using a method of steam distillation (2, 10, 11). The analytical methods were as follows: an exact weight of a powdered tea sample(1-3 g, mesh size 60) was mixed with 20 ml of 100g l⁻¹ Ca (OH)₂ in a nickel container. The mixture was thoroughly blended with a glass rod and kept overnight, then dried at 110-120° C and heated at 600° C for 1 hr. After cooling, 2g sodium hydroxide

was added and the mixture was heated again for 1 to 2 hrs at 600°C until it melted out. The residue was transferred into a distillation flask with a small amount of water. Twenty five ml of 60% perchloric acid, glass beads or SiO₂ and 5 mg of Ag₂SO₄ were added and the mixture was treated by steam distillation. After about 200 ml distillate was collected at 135 ± 3°C, the volume was adjusted with double distilled water to 250ml. Finally, the fluoride concentration was determined by the method of alizarin complexone spectrometry (10).

RESULTS AND DISCUSSION

The fluoride contents of tea samples are given in Table 2.

Table 2. Fluoride content of tea samples.

Sample No.	No. of Analysis	Mean mgF/100g	Standard deviation	Coefficient of variation % C.V.
1	6	10	4.36	40.40
2	4	11.5	6.07	52.43
3	3	10	3.5	35
4	6	21	12.35	59.04
5	4	13	7.37	56.19
6	7	10	4.02	39.97
7	3	15.5	3.5	22.58
8	9	19	6.20	32.25
9	7	18.5	10.12	54.52
10	3	14.8	7.58	51.14

The results for samples 1-4 give a range of 10-21 mg F 100 g⁻¹, which, in comparison with the values obtained in one investigation (10.25-15.25 mg F 100 g⁻¹) (5), show a greater variation, but it is within the range reported by Cook (4) (12.1-26 mg F 100 g⁻¹), Garber (6) (5-40 mg F 100 g⁻¹) and Zimmerman *et al.* (12) (13.1-17.8 mg F 100 g⁻¹). For samples 1-3 (imported teas) the range of fluoride was 10.0-11.5 mg F 100 g⁻¹ and the analysis of

sample 4 (pure Iranian tea) showed a value of 21 mg F 100 g⁻¹, which is higher than those for other samples.

Analysis of the three waste samples of tea showed that they also contain fluoride in amounts close to the tea samples (tea dust, 13 mg F 100 g⁻¹, tea fluff, 10 mg F 100 g⁻¹ and tea stalk, 15.5 mg F 100 g⁻¹).

Sample No. 10 was a tea infusion which showed 14.8 mgF/100g. The average amount of fluoride extracted into infusion was 77.7% of the original amount present in the tea. Harrison (7) was found that 80-100% of the fluoride in tea was extracted into a 2% infusion in 5 min but in a later work it was reported that the extraction rate was 68.85-86.83% (5), indicating close agreement of the present data and those in the literature.

Considering the optimal intake of fluoride (1-1.5mg/day) suggested for prevention of dental caries, it may be said that drinking 7-10 cups of tea/day provides the required amounts, without considering the fluoride content of water or other sources.

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