



## Tea – natural source of fluoride compounds

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### ABSTRACT

Tea has come to be regarded as a very popular drink, and is nowadays consumed in almost the same amounts as water. Tea has antioxidant properties, influences the organism's antioxidant status and prevents oxidative stress. Tea constitutes a very rich fluoride source. In the paper the influence of fluorides on human organism, soft and hard dental tissues and occurrence of dental and skeletal fluorosis was discussed.

**Keywords:** Tea, fluorides, skeletal fluorosis, dental fluorosis, caries, dental prophylaxis

Tea has come to be regarded as a very popular drink, and is nowadays consumed in almost the same amounts as water. In different parts of the world some kinds of tea, like green tea, black tea, Oolong or herbal tea, are more popular than others. The first mention of tea appeared as early as in 3 B. C. China is considered to be the homeland of tea, next it reached Japan and, at the beginning of the 17<sup>th</sup> century, Europe [12, 17]. Tea, also referred to as “Chinese beverage”, possesses several properties advantageous for human organism. These properties result from the content of tea, which includes flavonoids (polyphenols), theine, tannin, theanine, vitamins and minerals, including fluoride compounds. Tea has antioxidant properties, influences the organism's antioxidant status and prevents oxidative stress [17, 23]. It also shows antineoplastic properties, prevents cardio-vascular diseases, coronary heart disease, diabetes, the occurrence of obesity and premature death. Tea positively influences the function of the digestive system, urinary system and probably decreases the risk of cerebral infarction. Moreover, tea has antihistamine, anti-inflammatory, antibacterial and antiviral properties. [17, 19].

It should be stressed that tea also prevents the diseases of hard and soft dental tissues. Thanks to polyphenols, tea decreases the number of *Mutans Streptococci* and *Lactobacilli* bacteria, reduces saliva acidity, and inhibits the

process of formation of bacterial biofilm in both in vivo and in vitro conditions, thus displaying anticariogenic properties. Tea also plays a role in carious disease prevention. The mixture of tannic acid and fluoride compounds has the strongest (98%) inhibitory effect on the process of calcium release in acidic environment. Thus, it is important that not only fluoride compounds present in tea but also organic compounds can increase the enamel's resistance to acid. What is more, it has been suggested that they play the most important role in the resistance of dental hard tissue – enamel [1, 10, 11, 13, 14, 24, 25, 37, 38].

Tea constitutes a very rich fluoride source [2]. Fluoride is an element characterized with significant biological activity influencing many processes taking place in living organisms; however, its function is not entirely clear. Fluoride compounds influence the process of protein biosynthesis, play an important role in carbohydrate and lipid transformation pathways. They also play an inhibitory role in the processes responsible for intracellular metabolism and modify some biological functions of living organisms. The influence of fluorides on the metabolism of dental plaque bacteria and the carious disease development has been thoroughly studied. It has been well established that they:

- inhibit the process of demineralization,
- promote the process of remineralization,
- reduce and prevent the occurrence of proton gradient,
- reduce the bacterial cells tolerance for acids,
- inhibit the activity of bacterial enolase,
- influence cell membrane permeability,

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- reduce the production of extracellular polysaccharides,
- limit the creation of sugar deposits in the bacterial biofilm, and
- affect the ratio of glucans and fructans in the plaque [9, 27, 33].

Fluoride compounds can be detected in the plant of brick, black, green, orange pekoe, oolong tea and *Camellia sinensis* [7, 15]. It has been established that fluoride content in tea leaves is in the range from 82 ppm to 371 ppm, while fluoride concentration in brew is from 0.73 ppm to 3.46 ppm. In case of teas containing caffeine, in brews, there is, on average, 1.50 ppm of fluorides, while, in herbal teas, the content of these compounds is small (0.05 ppm). In decaffeinated teas, it is 3.19 ppm. The difference between teas containing and not containing caffeine is probably connected with the process of the preparation of the latter – the process of decaffeination in course of which pure spring water is used under high temperature and pressure. Such water has naturally high fluoride content. Because tealeaves can release high amounts of fluoride compounds and the process is rather rapid, the highest concentration of fluoride is observed within the first 5 to 10 minutes after preparation of the brew [5, 8, 9, 32, 33]. Tea brews are characterized with high fluoride content. Malinowska et al. found that fluoride content in black tea is in the range of 0.32 – 4.54 mg/l, in white tea from 0.37 to 0.54 mg/l, and in herbal teas from 0.02 to 0.09 mg/l [22]. According to other authors, fluoride content in black tea is at the level of  $8.64 \pm 2.96$  mg/l [20]. It should be stressed that it is generally assumed that fluoride compounds constitute from 52 to 210 mg/kg of tealeaves dry mass. In the process of brewing 40 to 90% of fluoride compounds are lost [27].

Taking the above-mentioned facts into account, tea may be treated as a brew with anticariogenic properties. Suyama et al. conducted studies concerning the influence of fluoride extracted from green tea included in sugar-free chewing gum. The studies involved 45 volunteers, in whom intraoral appliances with human demineralized gum were used. In their work, the authors established mineral change value. They found that in subjects who chewed gum containing fluoride extracted from green tea, the remineralization process was accelerated and they were more resistant to acid activity. Suyama et al. suggested therefore that this might be an efficient method of caries prevention [30]. Magalhães et al. showed that green tea extract helps to reduce the process of dentin erosion – abrasion. Nevertheless, it should be pointed out that the mechanism beyond this phenomenon has not been fully explained [21].

Opydo – Szymaszek and Opydo established that in some beverages containing tea extracts, the level of fluoride compounds was in the range of 0.35-1.14 ppm,

which, in turn, contributed to increased exposure to fluoride compounds. In children, this can lead to dental fluorosis [26].

The results of studies performed by Cao et al. showed that dental fluorosis, which occurred in Gansu province in China was positively correlated with consumption of tea with milk brewed using brick tea. It is even more curious due to the fact that the concentration of fluoride in drinking water was in the range of 0.11 to 0.32 mg/l, while in this type of tea with milk it was as high as 2.58 to 3.69 mg/l fluoride. Simultaneously performed multiple regression analysis demonstrated that other food, including milk, did not have anything to do with the occurrence of fluorosis [3].

It was found that fluoride content in instant tea is higher than in loose tea [28]. Therefore, establishing the daily dose of fluoride compounds intake one cannot exclude tea consumption [36]. It is also thought that fluorised sugar and beverages containing fluoride, including tea, as well as mineral water rich in fluoride have limited caries prevention significance but they can be very effective in individual cases [18].

Excessive tea consumption may lead to chronic poisoning with fluoride compounds, while acute poisoning with the compounds has not been described. Malinowska et al. observed that consumption of 5 cups of tea daily lead to increased intake of fluoride compounds. Thus, in case of adults, this amount of tea constitutes 8 – 303%, and in case of children 12-303% of Polish Safe and Adequate Daily Intake Standard for Fluoride [acc. to 22]. Exceeding the safety threshold may lead to dental and skeletal fluorosis [22]. It is thought that tea consumption before reaching the age of 7 constitutes an independent risk factor of the occurrence of dental fluorosis [31].

Excessive habitual tea consumption may also lead to bone diseases, pain sensations in the extremities, increased level of alkaline phosphatase, the occurrence of digestive system symptoms (vomiting, nausea), body mass loss, compromised kidney function, renal failure, dental and skeletal fluorosis [4, 6, 9, 27, 33]. In case of dental fluorosis, it is manifested by enamel opacity leading to severe hypoplasia of hard dental tissues – enamel and dentin. Skeletal fluorosis may occur in several forms and may be characterized with histopathological changes, bone density increase, morphometric changes, exostosis, and in the final stage it may lead to disability [34]. The amount of fluoride deposited in bones and the severity of skeletal fluorosis are related to the age at the time of exposition to fluoride compounds, duration of the exposition, dose, condition of kidneys and nutritional status [29].

A case of a 48 years old American woman was described, in whom increased level of fluoride was detected in plasma, urine and nails accompanied by vitamin D deficiency. It was believed that the reason for these findings

was the consumption of significant amounts of brewed tea [15]. A case of 49 years old woman was also described. The woman drank 2 gallons of strong instant tea brew a day since the age of 12, that is for 37 years, which led to the increase of the level of fluoride in plasma, urine, nails and, in consequence, to osteosclerosis [35].

Without denying the positive impact of tea on human health, it should be emphasized that due to possible adverse impact of certain substances it contains, including fluoride compounds, it is advisable to set standards for safe amount of tea consumption, taking into account the type, brew strength, the origin (instant, leaf), and the way of making [16, 17].

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