Salient Visionary
Publications

Assessment of Iron Intake and Risks from Iron Present in Infusions of Herbal Chamomile Tea Consumed by Preschool Children in Travnik Municipality

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ABSTRACT

As an essential element, iron plays a significant role in the human body, and one of the most important is the transfer of oxygen through the blood from the lungs to all cells. As a consequence of insufficient iron intake, anemia occurs, which represents a major public health problem, and one of the most vulnerable groups of the population are developing children. As insufficient intake of iron can have negative consequences for the human body, so can excessive intake, which is confirmed by Paracelsus' (1493-1541) famous claim that "a dose makes a substance poison".

One of the most important public health tasks in the whole world when it comes to food and drink is to ensure a high degree of protection of human life and health, and the measures applied to achieve the stated goal should be based on risk assessment. The risk to human health depends on the amount of contaminant present in food or drink, the exposure of the human body to such food or drink, and the toxicity of that contaminant. Based on an anonymous survey of 200 preschool children from the Travnik municipality, data was collected on age, body mass, and the frequency and amount of consumption of herbal chamomile tea infusions. Analyzing 20 samples of herbal chamomile tea for Fe content using atomic absorption spectrophotometry (AAS), it was found that the average concentration of Fe in infusions of herbal chamomile tea, which were prepared by keeping the filter bag in pure distilled water heated to 85°C for 5 minutes was 0,01265±SD=0,016765 mg/kg. The average daily intake of Fe (I_{Fe}) by consuming infusions was 0.00012162 ±0.00001913 mg/kg BW/day, and the values of the average daily intake decreased with the age of the surveyed children and were lower than the values of the oral reference dose of iron, therefore the values of iron hazard coefficients (HQ_{Fe}) in relation to age decreased and were <1. It was established that, by consuming the analyzed infusions of herbal chamomile tea, the surveyed children ingest the iron necessary for the functioning of their organism in quantities that do not have a harmful effect on their health.

INTRODUCTION

After water, infusions of herbal teas are the most consumed beverage in the world, and it is estimated that 18 to 20 billion cups of tea are drunk worldwide every day [1]. This can be attributed to their pleasant taste and smell, but also to their health effects [2]. Chamomile herbal tea is one of the most researched medicinal plants. Its chemical composition contains over 300 ingredients, and the most important active ingredients are flavonoids, phenolic compounds, essential oils, bitter substances, inositol, vitamins, minerals, etc. [3]. The health properties of this herbal tea are mainly attributed to phenolic compounds, and considering that they have the ability to lower the pH value in the mouth, it is especially important for preventing caries in preschool children [4,5]. Iron is a heavy metal that belongs to the essential elements for the human body and is one of the most important trace minerals for maintaining normal functions in the human body [6,7]. It is a very important element for the normal development and functioning of the neurological system in early preschool children, and as a cofactor of enzymes for the synthesis of serotonin and dopamine, it plays an important role in the emotional and psychomotor development of preschool children [8].

Back in the 16th century, Paracelsus (1493-1541), who is considered the founder of modern toxicology, declared that „a dose makes a substance a poison" [9], so excessive intake of biogenic substances in the human body can have negative health effects. Excessive intake of iron in the child's organism acts as a catalyst for the reaction of the formation of free radicals, which cause damage to cells, tissues and organs [8]. The excess of ingested Fe is deposited in the human body, mostly in the liver cells, where more than 60% is stored. For children aged 4 to 8 years, the recommended daily intake of iron is 10 mg [10].

MATERIALS AND METHODS

In the territory of the municipality of Travnik, 20 samples were sampled on the free market in the original packaging of herbal chamomile tea from different manufacturers. Infusions were prepared from the mentioned samples by keeping the same filter bags in 200 ml of pure distilled water heated to a temperature of 85°C for 5 minutes. After the specified time, the filter bags were removed and the infusions were cooled to room temperature, after which the infusion samples were ready to measure iron concentrations in each of the 20 prepared infusions using the atomic absorption spectrophotometry (AAS) method, as well as in a blank test. Standard iron solutions with concentrations of 0.001, 0.05 and 1 mg/l were used for AAS calibration (standard Fe solution for AAS, Fluka Analytical, 1000 mg/l ± 4 mg/l).

By randomly selecting 200 children of preschool age from the area of the municipality of Travnik, data on body mass, age, and the amount and frequency of consumption of the aforementioned infusions of herbal chamomile tea were collected through an anonymous survey.

As an instrument for the quantitative assessment of the risk to the health of anonymously surveyed children from the intake of Fe by consuming the analyzed infusions of chamomile herbal tea, the hazard coefficient of iron was

obtained as the ratio of the average daily intake of iron (I_{Fe}) and the corresponding oral reference dose for iron (R_fD) :

$$HQ_{Fe}=I_{Fe}/R_fD \qquad (1)$$

To calculate the average daily intake of iron by consuming infusions of the mentioned herbal tea, data obtained by anonymous surveying and analysis of infusions of sampled chamomile herbal teas for iron content using the AAS method are required, according to the formula:

$$I_{Fe} = \frac{C x C_r x E_f x E_d}{B_w x A_t} \quad \text{(mg/kg BW/day)} \qquad (2)$$

Where: I_{Fe}-average daily intake of iron (mg/kg BW/day); C – the average concentration of iron in the analyzed samples of chamomile herbal tea infusions expressed in (mg/kg); C_r – the average amount of chamomile herbal tea infusion consumed (ml/day); E_f – average frequency of consumption of chamomile herbal tea infusions (days/year); E_d – duration of exposure expressed in years; B_w – average body mass of surveyed children (kg); A_t – the average exposure period of the organism expressed in days.

RESULTS AND DISCUSION

The results of the analysis of samples of infusions of chamomile herbal tea for iron content, shown with IC1 to IC20, are given in **(Table 1)**.

Table 1. Iron concentrations in samples of herbal chamomile tea infusions

| Sample	Concentration Fe (mg/kg)	Sample	Concentration Fe (mg/kg)
IC1	0,075	IC11	0,024
IC2	0,009	IC12	0,016
IC3	0,000	IC13	0,000
IC4	0,011	IC14	0,011
IC5	0,000	IC15	0,000
IC6	0,000	IC16	0,016
IC7	0,000	IC17	0,018
IC8	0,008	IC18	0,016
IC9	0,000	IC19	0,020
IC10	0,010	IC20	0,019
Mean=0,01265 mg/kg, SD=0,016765			

*IC-infusion of chamomile herbal tea

On the basis of the following obtained average values for the parameters that are necessary to estimate the daily intake of Fe by consuming the analyzed samples of chamomile herbal tea infusions collected by surveying and analyzing the samples are: C=0.01265 mg/kg, C_r=0.2 ml, E_f=281 days/ year, E_d=2, B_w=21,395 kg, A_t=730 (2 years) days, the value of the average daily iron intake (I_{Fe}) was calculated by consuming the analyzed samples of chamomile herbal tea infusions (Table 2).

Table 1. Average daily intake of iron by consumption of herbal chamomile tea infusions in relation to the age of the surveyed children

Age of surveyed children (years)	Average daily intake of Fe (mg/kg BM/day)
4	$1{,}5256 \times 10^{-4} \pm 0{,}000010996$
5	$1{,}3051 \times 10^{-4} \pm 0{,}000015083$
6	$1{,}1312 \times 10^{-4} \pm 0{,}000015786$

In **(Diagram 1),** the values of the average daily intake of iron by consuming infusions of herbal chamomile tea, prepared by holding filter bags in water for 5 minutes, are shown graphically, in relation to the age of the surveyed children.
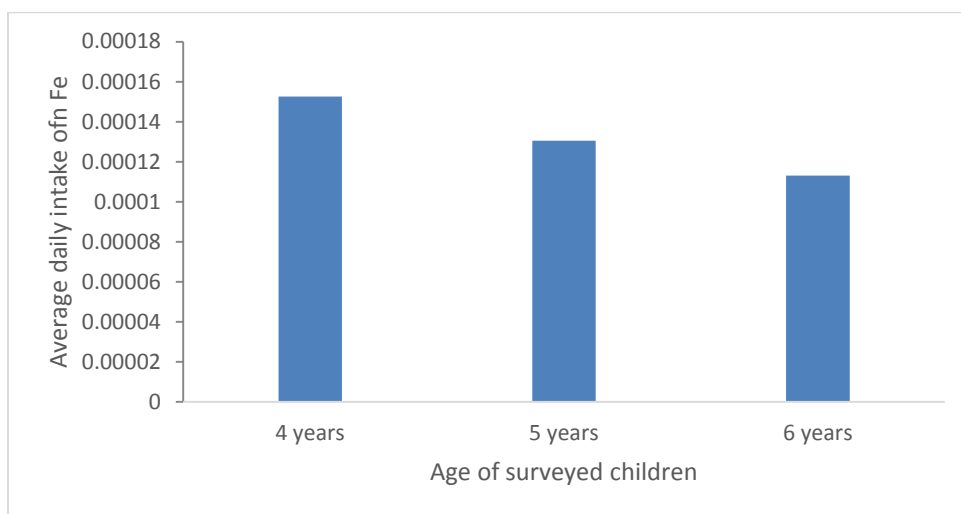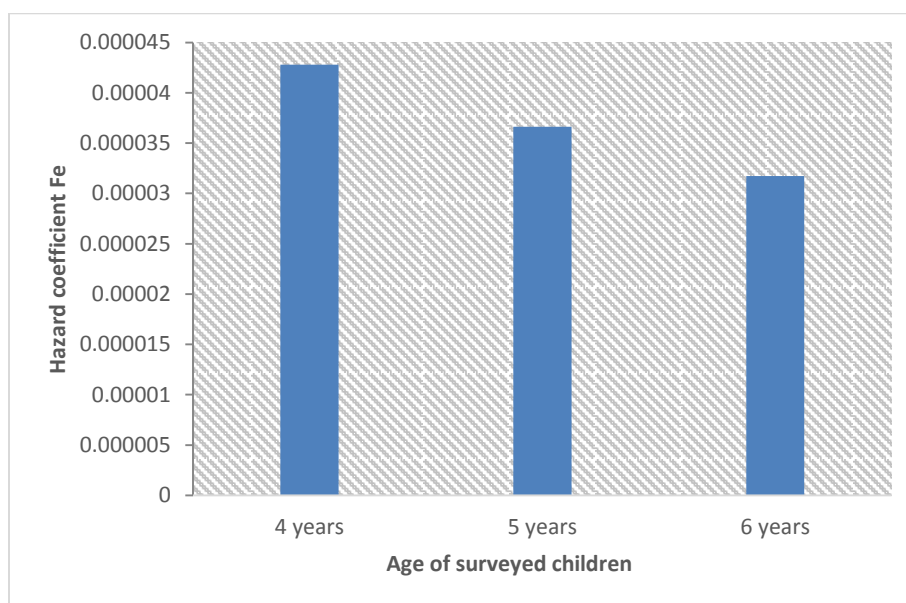

Based on the value of the average daily intake and tabular data for the oral reference dose (R_fD) for iron, prescribed by the European Food Safety Agency (EFSA), the value of the non-carcinogenic hazard coefficient for iron (HQ_{Fe}) was calculated in relation to the age of the surveyed children **(Table 3)**

Table 3. Values of the oral reference dose for iron and hazard coefficients in relation to the age of the surveyed children

Age of surveyed children (years)	RfD (mg/kg BM/day)	Hazard coefficient of Fe HQFe
4	5,0	$4{,}281 \times 10^{-5} \pm 0{,}0000031$
5	5,0	$3{,}662 \times 10^{-5} \pm 0{,}0000042$
6	5,0	$3{,}174 \times 10^{-5} \pm 0{,}0000044$

In **(Diagram 2)**, the values of the hazard coefficients of iron by consuming infusions of herbal chamomile tea, prepared by keeping filter bags in water for 5 minutes, are graphically presented, in relation to the age of the surveyed children.

Diagram 2. Graphic representation of HQ(Fe) values in relation to the age of the surveyed children

CONCLUSION

The results of this research showed that the average daily intake of iron (I_{Fe}) by consuming infusions of herbal chamomile tea decreases with age, because body mass and body surface area of children increase with age. By reducing the average daily intake of iron, the hazard coefficients of iron (HQ_{Fe}) ingested by consuming infusions of herbal chamomile tea also decrease with age. Given that the values of the hazard coefficients of iron (HQ_{Fe}) are <1, that is, the values of the average daily intake were less than the oral reference dose of iron (R_fD), children by consuming the analyzed infusions of herbal chamomile tea ingest the iron necessary for the functioning of their organism, without risking their health.

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