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ARTICLE

# The effect of lemon on the essential element concentrations of herbal and fruit teas

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**Abstract** In this study, the effect of lemon addition to the element content of several herbal and fruit teas is investigated. Lemon addition to tea is a traditional cultural practice in many countries. For this purpose, fennel, mint, and sage are selected as herbal teas, and apple, lemon, and rosehip are selected as fruit teas. The essential elements of calcium, cobalt, copper, iron, potassium, magnesium, sodium, phosphorus, selenium, and zinc are determined in the aforementioned teas with and without lemon addition by using an inductively coupled plasma optical emission spectrometer. From the results of the experiments, the lemon addition caused different changes with respect to the tea type. Potassium (1178 ppm) in apple tea with lemon, sodium (215.1 ppm) in fennel tea with lemon, and calcium (81.88 ppm) and magnesium (53.83 ppm) in mint tea with lemon are found to be the four major essential elements in the teas. In general, the elemental contents are increased with the lemon addition for all of the tea types, except for Na in the sage tea.

**Keywords** Herbal tea · Fruit tea · Essential elements · Lemon effect

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## Introduction

*Camellia sinensis* is one of the most consumed beverages all over the world in the recent decades, but the popularity of so-called herbal or fruit teas (infusions of fruits or herbs) is increasing with the elevated ecological awareness and the trend for a healthier life style (Dufrense and Famworth 2001, Zeiner et al. 2013). Due to the growing interest in tea and learning the health benefits of tea, various types of tea are produced for medical purposes from herbs and fruits (Favell 1998).

Fennel, mint, and sage among the herbal teas are known as having wide-range benefits on human health. Fennel tea, traditionally used for the treatment of a variety of symptoms of the gastrointestinal and respiratory tracts in some areas of Europe and Asia (Raffo et al. 2011), is also useful for human health in treating urinary tract inflammation, thirst, dysentery, diarrhoea, cholera, and kidney disease (Kumar et al. 2005). Peppermint (*Mentha piperita L.*) is among the most popular single ingredients of mint tea used in alternative medical therapy, including for biliary disorders, dyspepsia, enteritis, flatulence, gastritis, intestinal colic, and spasms of the bile duct, gallbladder, and gastrointestinal (GI) tract (McKay and Blumberg 2006). Sage is a popular plant because it has antioxidant activity and has a soothing therapeutic effect and an antiseptic effect on mucus (Cam and Engin 2010; Zimmermann et al. 2011).

Apple, lemon, and rosehip from the fruit teas are also consumed all over the world. Apple tea (apple peel extract) is an effective angiotensin-converting enzyme (ACE) inhibitor. Apple peels contain three- to sixfold more flavonoids, leading to higher antioxidant activities than flesh extracts (Balasuriya and Rupasinghe 2012; Thilakarathna et al. 2013). Lemon tea (lemon seed extract) could be a good source of antioxidants and induce apoptosis in breast cancer cells due to its bioactive components (Kim et al. 2012). Rosehip tea and fruit have traditionally been used as supplements for health food products in many European countries because they contain vitamin C and the minerals of potassium (K) and phosphorus (P). Rosehip extracts have exhibited a high antioxidative capacity in all tested assays as well as antimutagenic effects (Erenturk et al. 2005; Basgel and Erdemoglu 2006) that can be used for the treatment of colds, influenza, infections, and diarrhoea (Barros et al. 2010).

According to the literature, herbal and fruit teas have a rich content of essential elements that are given in Table 1, especially calcium (Ca), cobalt (Co), copper (Cu), iron (Fe), K, magnesium (Mg), sodium (Na), P, selenium (Se), and zinc (Zn) (Fernandez et al. 2002; Salvador et al. 2002; Lozak et al. 2002; Ozcan and Akbulut 2007; Othman et al. 2012; Pytlakowska et al. 2012; Cindric et al. 2013; Malik et al. 2013).

The health benefits of these elements on the human body are quite diverse. Ca is an essential micronutrient required for biological functions in the body such as nerve conduction, muscle contraction, mitosis, blood coagulation, and structural support of the skeleton (Cilla et al. 2011). Apart from the prevention of osteoporosis, adequate Ca intake has been associated with reduced risks of hypertension, colon cancer, kidney stones, and lead absorption (Singh et al. 2007). Co is an essential element for humans as a component of cyanocobalamin (vitamin B12) (Finley et al. 2012), and several manufacturers have recommended daily doses up to 1 mg $Co.day^{-1}$ to help in fat and carbohydrate metabolism, protein synthesis, and red blood cell production (Tvermoes et al. 2013). Low Cu levels have been associated with bone malformation during development, a risk of developing osteoporosis in later life, impaired melanin synthesis, poor immune response, increased frequency of infections, poor cardiovascular health, and alterations in cholesterol metabolism (Adams and Keen 2005; Romana et al. 2011).

Fe deficiency and excess result in deviations from optimal health, as increased Fe levels have been reported in many common neurological diseases, including Alzheimer's disease and Parkinson's disease (Lieu et al. 2001; Rajpathak et al. 2009). Some common problems associated with low K levels include hypertension, congestive heart failure, cardiac arrhythmia, fatigue, depression, and other mood changes (Akhter et al. 2003). Low intakes of Mg are etiological factors leading to cardiovascular and nervous diseases, bone deterioration, and stress (Oury et al. 2006; Zeiner et al. 2013).

Na is important for controlling the heartbeat and regulating the blood pressure. Na generates electrical signals required for communication processes in the brain, nervous

**Table 1** Previously published data on essential element concentrations of fennel, mint, sage, apple, lemon, and rosehip teas

| Element | Apple (ppm) | | Lemon (ppm) | | Rosehip (ppm) | | Fennel (ppm) | Mint (ppm) | | Sage (ppm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ca | 2.6–1.8 | | | 2.6–1.8 | 12.77 ± 1.68 | 0.7889 | 1.842 | 2871 ± 107 | | 10.4 ± 0.1 | 0.013 | 1.5855 |
| Co | | 0.05–0.16 | b.d.l. | | | 0.0002 | 0.0003 | 0.056 ± 0.001 | 0.23–0.57 | | | 0.0002 |
| Cu | 0.013–0.010 | 0.22–0.25 | 5.2 | 0.013–0.010 | 0.041 ± 0.004 | 0.0005 | 0.0001 | 2.96 ± 0.27 | 1.41–2.42 | 0.719 ± 0.101 | 0.00163 | 0.0017 |
| Fe | 0.063–0.050 | 12.59–32.86 | 336 | 0.063–0.050 | 0.087 ± 0.006 | 0.107 | 0.0671 | 20.2 ± 2.2 | 42.79–58.63 | 3.39 ± 0.15 | 0.00017 | 0.0668 |
| K | 230–204 | | | 230–204 | 165.7 ± 13.9 | 9.9819 | 12.0697 | | | 1379 ± 14 | 5.87 | 12.7611 |
| Mg | 5.0–3.0 | b.d.l. | | 5.0–3.0 | 10.799 ± 1.052 | 0.8286 | 1.2459 | 2219 ± 99 | | 271 ± 2 | 1.11 | 0.7825 |
| Na | 1.6–1.2 | | | 1.6–1.2 | | 0.0496 | 0.0031 | | | 50.0 ± 1.9 | 0.053 | 0.3008 |
| P | | | | | 9.18 ± 0.33 | 0.1522 | 0.4672 | | | 937 ± 9 | | 0.3468 |
| Se | | | | | | <0.0001 | 0.00022 | 0.087 ± 0.033 | | | | |
| Zn | 0.060–0.044 | 0.01–0.35 | 6.6 | 0.060–0.044 | 0.276 ± 0.027 | 0.0023 | 0.0046 | 6.34 ± 0.41 | 0.44-3.71 | 6.22 ± 0.12 | 0.0117 | 0.0053 |
| Ref. | Fernandez et al. (2002) | Salvador et al. (2002) | Othman et al. (2012) | Fernandez et al. (2002) | Malik et al. (2013) | Ozcan and Akbulut (2007) | Ozcan and Akbulut (2007) | Lozak et al. (2002) | Salvador et al. (2002) | Pytlakowska et al. (2012) | Cindric et al. (2013) | Ozcan and Akbulut (2007) |

*b.d.l* Below the detection limit

system, and muscles (Waheed et al. 2012). P is a primary constituent of deoxyribonucleic acid (DNA) and adenosine triphosphate (ATP) (Suh and Yee 2011). Se, present in 25 selenoproteins in humans, has several important functions as an antioxidant, in thyroid hormone metabolism, in redox reactions, and in other undefined functions (Rayman 2000). Zn supports normal growth and development in pregnancy, childhood, and adolescence. Zn deficiency leads to growth retardation, diarrhoea, interference with cerebral functions, malfunction in wound healing, and skin diseases. Excessive Zn intake leads to diarrhoea, vomiting, abdominal cramps, and headache (Fraga 2005; Scherz and Kirchhoff 2006).

In addition to the health benefits of herbal and fruit teas, the determination of the essential element contents is very important. Thus, the novelty in this study is its determination of the essential element concentrations (Ca, Co, Cu, Fe, K, Mg, Na, P, Se, and Zn) of herbal teas (fennel, mint and sage) and fruit teas (apple, lemon and rosehip). Another novelty of this study is the investigation of how lemon affects the abovementioned elemental contents, as determined by inductively coupled plasma optical emission spectrometry (ICP-OES) for the purpose of evaluating the health effects, and the results are compared with the essential element concentrations of pure infusions. The daily intake percentages of two cups of selected herbal and fruit teas are provided and discussed for conscious consumption between the ages of 31–50.

## Materials and methods

The herbal teas used in this study are fennel, mint, and sage teas; the fruit teas are apple, lemon, and rosehip teas. All of these products, together with the lemons, were purchased from a local market in Istanbul, Turkey. Pure water (0.07 μs $cm^{-1}$) was obtained from a Human Power $I^{+}$ brand water purification system (HUMAN Corporation, Seoul, Korea).

The elementary analysis was performed with a PerkinElmer Optima 2100 DV ICP-OES (PerkinElmer Inc., MA, USA) equipped with an AS-93 autosampler. The measurement conditions were set to a power of 1.45 kW, a plasma flow of 15.0 L $min^{-1}$, an auxiliary flow of 0.8 L $min^{-1}$, and a nebulizer flow of 1 L $min^{-1}$.

The Ca, Co, Cu, Fe, K, Mg, Na, P, Se, and Zn concentrations were analysed with ICP-OES in selected teas after the infusion method was carried out. The infusion method was conducted according to the ISO-3103 standard (1980): 100 mL of hot pure water (90–100 °C) was added to 2 g sample in a glass beaker and then allowed to sit for 5 min. After the infusion, the extracted tea samples were filtered and filled up to 100 mL with pure water in a volumetric flask.

The same experimental procedure was repeated for the lemon addition, where the pH of the lemon was measured as 3.01 using an HI 2211 pH/ORP/Temperature Benchtop Meter (Hanna Instruments, MI, USA). Lemons were added after the infusion step in a 1:6 (volume lemon/volume infusion) ratio 15 min before the ICP-OES measurements for the determination of the lemon's effect on the elemental concentrations of these teas.

## Results and discussion

The detection limits of the elements that were analysed are shown in Table 2. LOD represents the limit of detection, and LOQ represents the limit of quantitation. The essential element (Ca, Co, Cu, Fe, K, Mg, Na, P, Se, and Zn) contents before and after the lemon addition of the three types of herbal tea (fennel, mint, and sage) and the three types of fruit tea (apple, lemon, and rosehip) are shown in Table 3 and Table 4. The essential element concentrations of two cups of each of the fruit and herbal teas are calculated using Eq. 1.

$$m(\mathrm{mg}) = C\left(\frac{\mathrm{mg}}{\mathrm{L}}\right) \times \frac{\mathrm{L}}{1000\,\mathrm{mL}} \times 100\,\mathrm{mL} \times 2, \qquad (1)$$

where "$m$" is the element content of two cups of tea and "$C$" is the element concentration. The daily essential element requirements for humans have been provided in the literature by many researchers (EGVM 2003; Gallaher et al. 2006; IMFNB 2000; IMFNB 2001; IMNA 1997; IMNA 2005; Taylor et al. 2010; USDA 2010). Using Eq. 2., the daily essential element intakes (DEI) were also calculated, and these values are given in Tables 5 and 6.

$$\mathrm{DEI} = m \times \frac{100}{A} \qquad (2)$$

"$A$" can be the recommended daily allowance (RDA), the upper limit for the RDA ($RDA^{ul}$), the adequate (mean) intake (Al), or the upper limit for Al ($Al^{up}$). Between the ages of 31–50, the Mg RDA values are 420 mg $day^{-1}$ for males and 320 mg $day^{-1}$ for females. The $RDA^{ul}$ values are 1.0–2.5 g $day^{-1}$ for both males and females for Ca, 0.90–10 mg $day^{-1}$ for both males and females for Cu, 8–45 mg $day^{-1}$ for males and 18–45 mg $day^{-1}$ for females for Fe, 0.7–4 g $day^{-1}$ for both males and females for P, 400 μg $day^{-1}$ for both males and females for Se, and 11–40 mg $day^{-1}$ for males and 8–40 mg $day^{-1}$ for females for Zn. The Al value is 4.7 g $day^{-1}$ for both males and females for K. The $Al^{ul}$ value is 1.5–2.3 g $day^{-1}$ for both of males and females for Na (EGVM 2003; Gallaher et al. 2006; IMFNB 2000; IMFNB 2001; IMNA 1997; IMNA 2005; Taylor et al. 2010; USDA 2010). The RDA value of Co is 1 mg $day^{-1}$ for both males and females (Tvermoes et al. 2013).

**Table 2** Detection limits of the elements analysed in the experiments

| | Ca (ppm) | Co (ppm) | Cu (ppm) | Fe (ppm) | K (ppm) | Mg (ppm) | Na (ppm) | P (ppm) | Se (ppm) | Zn (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| LOD | 0.0063 | 0.0005 | 0.0004 | 0.0017 | 0.0015 | 0.0010 | 0.0029 | 0.0038 | 0.0019 | 0.0002 |
| LOQ | 0.0209 | 0.0015 | 0.0013 | 0.0055 | 0.0049 | 0.0035 | 0.0096 | 0.0125 | 0.0065 | 0.0006 |

**Table 3** Essential element concentrations in fennel, mint, and sage teas both before and after lemon addition

| Tea | Fennel | | Mint | | Sage | |
|---|---|---|---|---|---|---|
| Element (ppm) | Brewing | Lemon addition | Brewing | Lemon addition | Brewing | Lemon addition |
| Ca | 24.34 ± 0.354 | 46.70 ± 0.474 | 61.86 ± 3.132 | 81.88 ± 0.219 | 33.98 ± 0.311 | 57.25 ± 1.817 |
| Co | 0.052 ± 0.004 | 0.089 ± 0.008 | b.d.l. | b.d.l. | 0.040 ± 0.003 | 0.068 ± 0.006 |
| Cu | 2.315 ± 0.194 | 3.444 ± 0.208 | $0.005 \pm 0.1 \times 10^{-3}$ | $0.009 \pm 0.1 \times 10^{-3}$ | 0.651 ± 0.045 | 1.489 ± 0.001 |
| Fe | b.d.l. | 1.418 ± 0.015 | 0.029 ± 0.001 | 0.036 ± 0.001 | b.d.l. | 1.234 ± 0.106 |
| K | 178.7 ± 11.17 | 845.0 ± 25.88 | 168.5 ± 6.930 | 823.3 ± 37.05 | 141.3 ± 9.829 | 740.7 ± 1.909 |
| Mg | 24.65 ± 0.134 | 38.27 ± 0.976 | 52.84 ± 0.212 | 53.83 ± 1.047 | 16.57 ± 0.559 | 30.19 ± 0.544 |
| Na | b.d.l. | 215.1 ± 21.10 | 17.33 ± 0.1697 | 18.38 ± 0.2969 | 55.44 ± 4.533 | 34.23 ± 2.350 |
| P | 11.93 ± 0.438 | 26.08 ± 0.184 | 17.05 ± 0.269 | 27.47 ± 0.537 | 8.660 ± 0.130 | 22.14 ± 0.382 |
| Se | 0.398 ± 0.034 | 0.996 ± 0.014 | 0.010 ± 0.001 | 0.044 ± 0.001 | 0.0044 ± 0.0001 | 1.096 ± 0.035 |
| Zn | b.d.l. | 9.330 ± 0.370 | 0.047 ± 0.003 | 0.146 ± 0.012 | 0.031 ± 0.0014 | 7.546 ± 0.745 |

*b.d.l* Below the detection limit

**Table 4** Essential element concentrations in apple, lemon, and rosehip teas both before and after lemon addition

| Tea | Apple | | Lemon | | Rosehip | |
|---|---|---|---|---|---|---|
| Element (ppm) | Brewing | Lemon addition | Brewing | Lemon addition | Brewing | Lemon addition |
| Ca | 34.62 ± 0.912 | 54.73 ± 0.085 | 67.62 ± 3.210 | 67.91 ± 3.054 | 53.41 ± 1.181 | 74.18 ± 2.729 |
| Co | 0.053 ± 0.004 | 0.074 ± 0.007 | $1.13 \times 10^{-3} \pm 1.10 \times 10^{-4}$ | 0.074 ± 0.007 | 0.073 ± 0.007 | 0.084 ± 0.007 |
| Cu | 0.578 ± 0.045 | 1.374 ± 0.003 | 0.797 ± 0.064 | 2.695 ± 0.148 | 0.610 ± 0.012 | 1.210 ± 0.038 |
| Fe | 4.968 ± 0.490 | 5.102 ± 0.013 | 2.424 ± 0.240 | 8.200 ± 0.520 | 4.585 ± 0.062 | 4.988 ± 0.087 |
| K | 118.2 ± 0.778 | 1178 ± 63.64 | 93.72 ± 0.339 | 1104 ± 0.707 | 177.8 ± 4.667 | 798.3 ± 10.32 |
| Mg | 14.27 ± 0.127 | 28.32 ± 0.495 | 19.71 ± 0.368 | 33.99 ± 1.315 | 29.14 ± 0.106 | 35.34 ± 0.976 |
| Na | b.d.l. | 36.95 ± 1.600 | b.d.l. | 175.8 ± 16.50 | b.d.l. | 32.21 ± 1.050 |
| P | 7.444 ± 0.138 | 22.16 ± 0.389 | 8.192 ± 0.077 | 22.31 ± 0.389 | 10.52 ± 0.389 | 24.94 ± 0.516 |
| Se | 0.547 ± 0.053 | 1.539 ± 0.018 | 0.180 ± 0.016 | 1.851 ± 0.095 | 0.421 ± 0.025 | 1.042 ± 0.062 |
| Zn | 0.383 ± 0.001 | 11.53 ± 0.750 | b.d.l. | 21.40 ± 2.030 | 0.743 ± 0.064 | 12.21 ± 0.430 |

*b.d.l* Below the detection limit

From the results obtained (Tables 3, 4), it could be seen that after the lemon addition, the Ca, Cu, Fe, K, Mg, P, Se, and Zn contents of the selected teas increased. The Co content also increased, except in mint tea, where the concentration was the below detection limit. The Na contents increased in fennel, mint, apple, lemon, and rosehip teas and decreased in sage tea.

The elemental analyses showed that the major element in the analysed teas is K (max: 1178 ppm), generally followed by Na (max: 215.1 ppm), Ca (max: 81.88 ppm), Mg (max: 53.83 ppm), P (max: 27.47 ppm), Zn (max: 21.40 ppm), Fe (max: 8.200 ppm), Cu (max: 3.444 ppm), Se (max: 1.851 ppm), and Co (max: 0.089 ppm). Some values were out of the detection limit of ICP-OES, as shown in Tables 3 and 4. The major four elements found in the analysed teas are in the order of K > Na > Ca > Mg.

Whenever the essential element concentrations are examined in analysed teas, differences are generally found

**Table 5** Essential element intake percentages for humans between the ages of 31–50 in 2 cups of fennel, mint, and sage teas both before and after lemon addition

| Tea | Fennel | | Mint | | Sage | |
|---|---|---|---|---|---|---|
| Element | Brewing | Lemon addition | Brewing | Lemon addition | Brewing | Lemon addition |
| Ca | 0.195–0.487 | 0.374–0.934 | 0.495–1.237 | 0.655–1.638 | 0.272–0.680 | 0.458–1.145 |
| Co | 1.040 | 1.780 | | | 0.800 | 1.360 |
| Cu | 4.630–51.44 | 6.888–76.53 | 0.011–0.120 | 0.019–0.207 | 1.302–14.47 | 2.978–33.09 |
| Fe | | 0.630–3.545 (1.576*) | 0.013–0.073 (0.032*) | 0.016–0.090 (0.040*) | | 0.548–3.085 (1.371*) |
| K | 0.760 | 3.596 | 0.717 | 3.503 | 0.601 | 3.152 |
| Mg | 1.174 (1.541*) | 1.822 (2.392*) | 2.516 (3.303*) | 2.563 (3.364*) | 0.789 (1.036*) | 1.438 (1.887*) |
| Na | | 1.870–2.867 | 0.151–0.230 | 0.160–0.245 | 0.482–0.739 | 0.298–0.456 |
| P | 0.060–0.341 | 0.130–0.745 | 0.085–0.487 | 0.137–0.785 | 0.043–0.247 | 0.111–0.633 |
| Se | 19.90 | 49.80 | 0.500 | 2.200 | 0.220 | 54.80 |
| Zn | | 4.665–16.96 (23.33*) | 0.023–0.085(0.118*) | 0.073–0.265 (0.365*) | 0.016–0.056 (0.078*) | 3.773–13.72 (18.87*) |

* Female intake percentages

**Table 6** Essential element intake percentages for humans between the ages of 31–50 in 2 cups of apple, lemon, and rosehip teas both before and after lemon addition

| Tea | Apple | | Lemon | | Rosehip | |
|---|---|---|---|---|---|---|
| Element | Brewing | Lemon addition | Brewing | Lemon addition | Brewing | Lemon addition |
| Ca | 0.277–0.692 | 0.438–1.095 | 0.541–1.352 | 0.543–1.358 | 0.427–1.068 | 0.593–1.484 |
| Co | 1.060 | 1.480 | 0.023 | 1.480 | 1.460 | 1.680 |
| Cu | 1.156–12.84 | 2.748–30.53 | 1.594–17.71 | 5.390–59.89 | 1.220–13.56 | 2.420–6.89 |
| Fe | 2.208–12.42 (5.520*) | 2.268–12.75 (5.669*) | 1.077–6.060 (2.693*) | 3.644–20.50 (9.111*) | 2.038–11.46 (5.094*) | 2.217–12.47 (5.542*) |
| K | 0.503 | 5.013 | 0.399 | 4.700 | 0.757 | 3.397 |
| Mg | 0.680 (0.892*) | 1.349 (1.770*) | 0.939 (1.232*) | 1.619 (2.124*) | 1.388 (1.821*) | 1.683 (2.209*) |
| Na | | 0.321–0.493 | | 1.528–2.343 | | 0.280–0.429 |
| P | 0.037–0.213 | 0.111–0.633 | 0.041–0.234 | 0.112–0.637 | 0.053–0.301 | 0.125–0.713 |
| Se | 27.35 | 76.95 | 9.000 | 92.55 | 21.05 | 52.10 |
| Zn | 0.192–0.696 (0.958*) | 5.765–20.96 (28.83*) | | 10.70–38.91 (53.50*) | 0.372–1.351 (1.858*) | 6.105–22.20 (30.53*) |

* Female intake percentages

from the published data. These differences are based on the region, soil, and climatic conditions of where the tea is grown. Some of the essential element concentrations in the analysed teas are in line with the results of previous studies, as shown in Table 1. In sage tea, the values of Cu (0.651 ppm), Na (55.44 ppm), and Zn (0.0310 ppm) are close to the study results of Pytlakowska et al. (2012), and the Fe results (below detection limit) support those of Cindric et al. (2013). The K (141.3 ppm), Mg (16.57 ppm), and P (8.660 ppm) concentrations in sage tea are between the study results of Pytlakowska et al. (2012) and Ozcan and Akbulut (2007).

In the apple tea, the values of Co (0.053 ppm) and Zn (0.383 ppm) are compatible with those of Salvador et al. (2002). The value of Fe (4.968 ppm) is between the values of Fernandez et al. (2002) and Salvador et al. (2002). The K concentration (118.2 ppm) is also comparable with Fernandez et al. (2002). In lemon tea, the value of Co ($1.13 \times 10^{-3}$ ppm) is comparable with that of Othman et al. (2012). The values of Cu (0.797 ppm) and Fe (2.424 ppm) are between the study results of Othman et al. (2012) and Fernandez et al. (2002). In rosehip tea, the concentrations of K (177.8 ppm) and P (10.52 ppm) are close to the results of Malik et al. (2013).

The most essential element for the human body is K (max: 5.1 g), followed by P (max: 4.0 g), Ca (max: 2.5 g), Na (max: 2.3 g), Mg (max: 420 mg), Fe (max: 45 mg), Zn (max: 40 mg), Cu (max: 10 mg), and Se (max: 400 µg) (EGVM 2003; Gallaher et al. 2006; IMFNB 2000; IMFNB 2001; IMNA 1997; IMNA 2005; Taylor et al. 2010; USDA 2010). The maximum amount for Co is 1 mg $day^{-1}$ (Tvermoes et al. 2013). In the daily requirements for humans, the five major elements are in the order K > P > Ca > Na > Mg. Because the analysed tea content major elements are the same as the daily requirements, it can be said that fruit and herbal teas are good sources of essential element intakes.

In Tables 5 and 6, the essential element intake percentages for humans between the ages of 31–50 in 2 cups (1 cup is equal to 100 mL) of fruit and herbal teas are given. According to the results obtained, the three major contents of essential element intakes for humans in the teas are found to be Se (92.55 % for both males and females) in lemon tea after lemon addition and the Cu and Zn contents, which are found to be 6.888–76.53 % for both males and females in fennel tea after lemon addition and 10.70–38.91 % for males and 10.70–53.50 % for females in lemon tea with lemon addition.

Another essential element, Fe, is found to reach 3.644–20.50 % of the requirement for males and 3.644–9.111 % for females in lemon tea after the lemon addition. The minor elements in the analysed teas are K, Na, and Mg. For K, the intake is found to be 5.013 % for both males and females in apple tea with lemon. For Na, the intake is 1.870–2.867 % for both males and females in fennel tea with lemon. For Mg, the intake is 2.563 % for males and 3.364 % for females in mint tea after lemon addition.

The lowest three elements of Co, Ca, and P were found to be less than 5 %, where Co is found in the greatest portion of the daily requirements in fennel tea after lemon addition (1.780 % for both males and females), and Ca (0.655–1.638 % for both males and females) and P are found to reach their maxima (0.137–0.785 % for both males and females) in mint tea with lemon addition.

In conclusion, the largest intake percentages of essential elements for the human body in fruit and herbal teas are Se and Cu and Zn, respectively. Based on the RDA results, it can be concluded that the addition of lemon increases the element contents of Se, Cu, and Zn in herbal and fruit teas, where Se and Zn were found to be at the maximum intake level in lemon tea after lemon addition, with values of 92.55 and 53.50 %, respectively, while the Cu content was determined to be the at the maximum level in fennel tea with lemon addition, at 76.53 %. It must be mentioned that lemon had a small increasing effect on all of the elements in all types of teas except for sage tea.

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