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Determination of Some Elements in Canned and Frozen Vegetables Sold in Balıkesir (Türkiye) Markets and Nutritional Assessment

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Abstract

In this work, determination of some elements including Pb, Ni, Ba, Fe, Zn, Mg, Mn, Al, Cu, Mo, Ca, B, Cr, Cd, V and Co was carried out in some canned and frozen vegetable samples sold in Balıkesir, Türkiye. The study covered randomly chosen 13 canned and frozen samples such as green peas, okra, shell bean, sweet corn, green beans, garniture and tomato paste. Mineralization of the samples was achieved using microwave assisted wet digestion in closed vessels. The element contents were determined using ICP OES. The element contents were between 0.16-1.86 mg kg^{-1} for Ni; 0.33-5.02 mg kg^{-1} for Ba; 4.20-32.22 mg kg^{-1} for Fe; 1.65-14.64 mg kg^{-1} for Zn; 124.83-1016.79 mg kg^{-1} for Mg; 0.87-4.99 mg kg^{-1} for Mn; 0.32-1.74 mg kg^{-1} for Al; 0.78-14.97 mg kg^{-1} for Cu; 0.38-4.24 mg kg^{-1} for Mo; 42.60-1607.40 mg kg^{-1} for Ca and 0.96-7.56 mg kg^{-1} for B. Additionally, Pb was determined in only frozen green peas as 1.3±0.1 mg kg^{-1}. In general, the highest element contents were found in frozen samples. In terms of nutritional assessment, estimated daily intakes of the elements were compared with recommended dietary allowances (RDA), nutrition reference values (TFC) and daily tolerable upper intake levels (UL) which were established by World Health Organization, Turkish Food Codex and Institute of Medicine, respectively. The results showed that the element contents of the analysed samples did not exceeded the permissible limits set by various health organizations. It is

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concluded that the contamination of these products may be an important threatening for public health. Therefore, monitoring of these samples should be a vital strategy for food industry.

Keywords: Canned food; Frozen food; ICP OES; Metal determination; Nutritional assessment.

Balıkesir (Türkiye) Marketlerinde Satılan Konserve ve Dondurulmuş Sebzelerde Bazı Elementlerin Tayini ve Beslenme Açısından Değerlendirilmesi

Öz

Bu çalışmada, Balıkesir Türkiye'de marketlerde satılan bazı konserve ve dondurulmuş sebze örneklerinde Pb, Ni, Ba, Fe, Zn, Mg, Mn, Al, Cu, Mo, Ca, B, Cr, Cd, V ve Co gibi elementlerin tayini yapılmıştır. Çalışma, bezelye, bamya, barbunya, tatlı mısır, yeşil fasulye, garnitür ve salça gibi rastgele seçilmiş 13 konserve ve dondurulmuş örneği kapsamaktadır. Numunelerin çözünürleştirilmesi, kapalı kaplarda mikrodalga destekli yaş yakma kullanılarak gerçekleştirilmiştir. Numunelerin element içerikleri ICP OES kullanılarak belirlenmiştir. Buna göre numunelerdeki element içeriklerinin Ni için 0,16-1,86 mg kg^{-1}; Ba için 0,33-5,02 mg kg^{-1}; Fe için 4,20-32,22 mg kg^{-1}; Zn için 1,65-14,64 mg kg^{-1}; Mg için 124,83-1016,79 mg kg^{-1}; Mn için 0,87-4,99 mg kg^{-1}; Al için 0,32-1,74 mg kg^{-1}; Cu için 0,78-14,97 mg kg^{-1}; Mo için 0,38-4,24 mg kg^{-1}; Ca için 42,60-1607,40 mg kg^{-1} ve B için 0,96-7,56 mg kg^{-1} aralığında olduğu tespit edilmiştir. Ayrıca, Pb elementi sadece donmuş bezelye numunesinde 1,3±0,1 mg kg^{-1} olarak belirlenmiştir. Genel olarak, donmuş örneklerde element içeriklerinin en yüksek olduğu gözlenmiştir. Beslenme açısından değerlendirildiğinde, elementlerin tahmini günlük alımları, Dünya Sağlık Örgütü, Türk Gıda Kodeksi ve İlaç Enstitüsü tarafından belirlenen, sırasıyla, tüketilmesi tavsiye edilen günlük miktar (RDA), beslenme referans değerleri (TFC) ve günlük tolere edilebilir üst alım seviyeleri (UL) ile karşılaştırılmıştır. Sonuçlar, analiz edilen numunelerin element içeriklerinin, çeşitli sağlık kuruluşları tarafından belirlenen sınırları aşmadığını göstermiştir. Bu ürünlerin potansiyel kirliliği halk sağlığı için önemli bir tehdit olabileceği sonucuna varılmıştır. Bu nedenle, bu örneklere ait kimyasal analiz sonuçlarının izlenmesi gıda endüstrisi için hayati bir stratejidir.

Anahtar Kelimeler: Konserve gıda; Dondurulmuş gıda; ICP OES; Metal tayini; Beslenme değerlendirilmesi.

1. Introduction

Considering the changing living conditions and busy working schedules of the human, nowadays, processed foods including canned, packaged or frozen, have growing interest. These food types such as vegetables, fruits, meat and drink are highly consumed in daily life [1-5]. So, they are important sources of carbohydrates, proteins, fibres, vitamins, minerals and trace elements. Assuming the high consumption amounts of these foods, production conditions and packaging materials, exposure possibility of human to contaminants especially to heavy metals may occur more likely. Soil may be considered as the primary responsible for the metal content of the vegetables [6]. However, other sources including industrial emissions, release of wastes, using of herbicides, fertilizers and insecticides affect the trace element levels. Due to growing industry, pollution level of the foods is constantly increasing. Additionally, due to globalization and trade, the rate of spread of this pollution is also increasing especially by foodstuff. Additionally, migration of the elements from packaging material through the food is another problem on contamination [7-9].

In this perspective, monitoring the quality and safety of food are the most important problems for the producers. Moreover, as it is important for human health, determination of the contaminants including inorganic, organic and organometallic species in the food is a challenge for the analysts [10]. Although some of the trace elements taken with diet are essential, their high concentration may be toxic at high levels and may led to chronic health disorders. Consideringly, determination of the elements in the food samples is quite important to elicit the element profiles and amount that consumers are exposed to. Various techniques have been used for determination of the elements including flame atomic absorption spectrometry (FAAS) [11], graphite furnace atomic absorption spectrometry (GFAAS) [12], inductively coupled plasma optic emission spectrometry (ICP OES) [13] and mass spectrometry (ICP MS) [3, 4] and polarography and voltammetry [14]. Among these techniques, ICP OES offers wide dynamic linear range.

Various sample preparation protocols have been utilized prior to element detection for food samples. Liquid-liquid extraction, dry ashing, open vessel wet digestion and closed vessel wet digestion are some of the most commonly used sample preparation procedures for various samples including edible oils, milk, food additives, dairy products, frozen and canned foods [15-19]. Closed vessel wet digestion is one of the most effective matrix-destructive way among abovementioned sample preparation procedures. Digestion of the sample is carried out in a closed vessel under high pressure and temperature and closed system preserve the sample from contamination and/or loss of analytes.

The main objectives of the proposed study were (*i*) determination of Pb, Ni, Ba, Fe, Zn, Mg, Mn, Al, Cu, Mo, Ca, B, Cr, Cd, V and Co in canned and frozen food samples (green peas, okra, shell bean, sweet corn, green beans, garniture and tomato paste) from Balıkesir, Türkiye, (*ii*) to compare the obtained results via estimated daily intake (EDI) with recommended daily allowances (RDA), nutrition reference values of Turkish Food Codex and daily tolerable upper intake levels, (*iii*) to compare the results with those reported in literature.

2. Materials and Methods

2.1. Chemicals

All reagents were of analytical grade and used without any purification. All glass and plastic laboratory equipments were cleaned by soaking in 10% (v/v) HNO_3, rinsed with deionized water and dried in a dust free environment. The deionized water that used throughout the experiments was obtained from reversed osmosis water purification system. The concentrated HNO_3 and HCl were purchased from Merck (Darmstadt, Germany). ICP multi element stock standard solution for Pb, Ni, Ba, Fe, Zn, Mg, Mn, Al, Cu, Mo, Ca, B, Cr, Cd, V and Co (1000 mg L^{-1}) was obtained from Merck, Darmstadt, Germany. The external standard calibration method was used for construction of calibration curves in a working range 0.01-5.00 mg L^{-1} with 3% HNO_3 ($r^2 \geq 0.995$). The digestion procedure was validated using a certificated reference material NIST-1549a whole milk powder (CRM) purchased from National Institute for Standards and Technology (NIST), Gaithersburg, MD, USA.

2.2. Instrumentation

An axially viewed Perkin Elmer Optima 3100 XL inductively coupled plasma optic emission spectrometer was utilized for determination of the target analytes in food samples. The working conditions of the ICP OES were tabulated in Table 1. CEM Mars 5 (Matthews, NC, USA) microwave oven system equipped with pressure and temperature controlled closed vessels was used for wet digestion of the food samples. The mass of the samples were weighed with Precisa XB 220A analytical laboratory balance.

Table 1: Working conditions for ICP OES

Polychromator	Echelle based polychromator, UV region (167-403 nm)
Recalibration system	Hg lamp
Detector	Segmented array charge coupled device detector
RF jenerator	40 MHz, free running, 750-1000 Watts
Nebulizer	Cross flow
Plasma gas flow	15 L min^{-1}
Auxiliary gas flow	0.5 L min^{-1}
Nebulization gas flow	0.5 L min^{-1}
Sample flow rate	1.5 mL min^{-1}
Wavelengths (nm)	220.349 for Pb; 231.604 for Ni; 233.527 for Ba; 238.204 for Fe; 206.200 for Zn; 285.213 for Mg; 257.610 for Mn; 308.215 for Al; 327.393 for Cu; 202.031 for Mo; 317.933 for Ca; 249.667 for B; 267.716 for Cr; 228.802 for Cd; 290.880 for V; 228.616 for Co

2.3. Sample collection

Various retail samples of canned or frozen food including green peas, okra, shell bean, sweet corn, green beans, garniture and tomato paste of randomly chosen different brands were obtained from local supermarkets of Balıkesir, Türkiye. The purchased products were within the expiry date declared on the respective packages. All the samples were transported to research laboratory and kept in their original packages to avoid contamination. Frozen and canned food samples were kept at -18°C and +4°C, respectively, up to analysis.

2.4. Preparation of the samples

All the samples were prepared in the same way for chemical analysis. Initially, each sample was removed from storage conditions and reached to room temperature. The samples were homogenized using a food blender with stainless steel cutters. In the next step, the homogenized samples were accurately weighted (about 1.0 g) in Teflon liners of microwave oven system. Then, 5 mL of concentrated HNO_3 was added on the samples and covered with watch glass to allow pre-digestion in a fume hood by standing overnight. After that, the vessels were closed and subjected to temperature controlled program (ramp up to 180 °C and 185 psi in 25 min with 600 W and hold for 10 min). Finally, the digested samples were cooled to room temperature, transferred to a volumetric flask and diluted up to 25 mL. For each sample three independent experiments were performed in addition to blank samples. The digested samples were analysed by ICP OES.

2.5. Analysis of standard reference material

The analysis of CRM (NIST-1549a whole milk powder) was used in order to verify the digestion procedure and to assess the degree of the contamination at any stage of sample treatment. The digestion of the CRM was performed in triplicate according to the same procedure that was described above.

3. Results and Discussion

Determination of the analytes including Pb, Ni, Ba, Fe, Zn, Mg, Mn, Al, Cu, Mo, Ca, B, Cr, Cd, V and Co in green peas, okra, shell bean, sweet corn, green beans, garniture and tomato paste samples was achieved using ICP OES. Cr, Cd, V and Co contents of all samples were found below detection limits (LOD). The LOD values ($3s_b/m$) were 109.65 µg kg^{-1} for Pb; 117.49 µg kg^{-1} for Ni; 80.69 µg kg^{-1} for Ba; 280.19 µg kg^{-1} for Fe; 147.58 µg kg^{-1} for Zn; 263.90 µg kg^{-1} for Mg; 182.96 µg kg^{-1} for Mn; 231.69 µg kg^{-1} for Al; 536.02 µg kg^{-1} for Cu; 109.02 µg kg^{-1} for Mo;

723.88 μg kg^{-1} for Ca; 218.55 μg kg^{-1} for B; 79.98 μg kg^{-1} for Cr; 52.41 μg kg^{-1} for Cd; 64.07 μg kg^{-1} for V and 135.47 μg kg^{-1} for Co for the applied method.

The CRM NIST-1549a whole milk powder was analysed to show the efficiency of the digestion procedure and accuracy of the analysis. The analysis results of CRM were tabulated in Table 2 for the analytes Ba, Ca, Fe, Cu, Mg and Zn. The recovery values which were obtained between 93.6%-107.8%, proved that there is no contamination or loss of analyte during the digestion procedure. Additionally, according to Student's t test, the differences between the experimental results ($\bar{x}$) and certified values (μ) were statistically insignificant at the 95% significance level.

Table 2: Analysis results and statistical evaluation for certified reference material (N=3)

Element	Certified Value (mg kg^{-1})	Experimental Value (mg kg^{-1})	Recovery (%)	$\lvert x-\mu \rvert$	$\frac{ts}{\sqrt{N}}$
Ba	0.566±0.039	0.56±0.01	99.2	0.005	0.030
Ca	8810±240	8514.06±491.95	96.6	295.94	1221.31
Fe	1.85±0.73	1.99±0.36	107.8	0.14	0.88
Cu	0.638±0.049	0.60±0.03	93.6	0.04	0.09
Mg	892±62	881.94±21.65	98.9	10.06	53.74
Zn	33.8±2.3	36.06±2.07	106.7	2.26	5.14

3.1. Concentration of target analytes in samples

The results of the analyte contents for the samples, green peas, okra, shell bean, sweet corn, green beans, garniture and tomato paste were tabulated in Table 3. The amounts of the analytes were reported as mg kg^{-1} for each sample in wet weight basis.

The concentrations of the examined analytes were between 0.16-1.86 mg kg^{-1} for Ni; 0.33-5.02 mg kg^{-1} for Ba; 4.20-32.22 mg kg^{-1} for Fe; 1.65-14.64 mg kg^{-1} for Zn; 124.83-1016.79 mg kg^{-1} for Mg; 0.87-4.99 mg kg^{-1} for Mn; 0.32-1.74 mg kg^{-1} for Al; 0.78-14.97 mg kg^{-1} for Cu; 0.38-4.24 mg kg^{-1} for Mo; 42.60-1607.40 mg kg^{-1} for Ca and 0.96-7.56 mg kg^{-1} for B for investigated samples. In terms of Pb, the concentrations were below detection limits for all samples excluding frozen green peas. The concentration of Pb was 1.34±0.10 mg kg^{-1} in frozen green peas. Ca and Mg levels were the highest for all samples among investigated analytes. In terms of concentrations, these analytes were followed by Fe for all samples except frozen sweet corn and jarred tomato paste. Additionally, excluding the samples frozen green peas, frozen shell bean and canned green beans, Ni concentrations were found to be the lowest in the samples. The variation in analyte concentration of the investigated samples may be attributed to numerous factors including the region where the vegetable grown, source of food, type of food processing, type of packaging and possible corrosion of can.

The highest and the lowest concentrations of Ni were found in frozen green peas (1.86±0.06 mg kg^{-1}) and canned sweet corn (0.150±0.003 mg kg^{-1}). On the other hand, Ni content of sample 13 (canned green peas) was found to be below detection limit. The obtained data showed that our findings for Ni were lower than the results reported in literature [10, 19]. Additionally, the results were found comparable with the report from Türkiye and India [1, 8].

In terms of Fe, the concentrations were between 4.53-18.84 mg kg^{-1} in canned foods and 4.20-32.22 mg kg^{-1} in frozen food samples. The lowest Fe content was detected for frozen sweet corn (4.20±0.36) sample and the highest level was detected for frozen shell bean (32.22±1.10). Generally, it may be concluded here that Fe levels of canned food samples were lower than the frozen food samples for investigated samples. Comparing the data, the results were found almost similar to that found in Lebanon [7], India [8], Iran [11] and Ghana [21] for various canned or frozen food samples, but lower than the data obtained by Tuzen and Soylak [1].

Considering Zn which is a nutritionally essential element and deficiency may lead some disorders, the concentrations were between 1.65-14.64 mg kg^{-1}. The lowest and highest concentrations of Zn were found in canned green beans (1.65±0.14) and frozen shell bean (14.64±1.08), respectively. Additionally, similar to judgment for Fe above, levels of Zn in canned food samples were lower than the frozen food samples for investigated samples. These values were found similar and/or comparable to those reported by [6, 7, 19, 20], but were extremely lower obtained by Ahmadi and Ziarati [11] and Tuzen and Soylak [1].

The concentrations of Mn were ranged from 0.87±0.09 mg kg^{-1} (tomato paste) to 4.99±0.28 mg kg^{-1} (frozen shell bean). Considering the analyzed sample types as frozen and canned, the levels of Mn did not show a clear trend to differentiate. The results were in good agreement with [8] and [21]. On the other hand, previous finding from Türkiye [1] is about five times that observed for the counterpart assortments in this study.

Mean concentrations of Al of the investigated samples were varied between 0.32(±0.02)-1.74(±0.74) mg kg^{-1}. Besides that Al contents were below detection limit for sweet corn samples both for canned and frozen. The decreasing order of Al contents of the samples were frozen green peas>frozen green beans>canned shell bean>canned green peas>canned okra>frozen shell bean>tomato paste(jarred)>tomato paste(tin can)>frozen okra=frozen garniture>canned green beans. Reports showed the levels of Al for tomato 9.8±4.2 mg kg^{-1} [8], for vegetables and legumes 0.74±0.49-1.63±0.80 mg kg^{-1} [7], for corn, pea, tomato and bean 1.27±0.10-1.73±0.12 mg kg^{-1} [1]. The obtained results were found comparable with the literature excepting assortments consumed in India [7].

Cu concentrations of the samples present in this study were varied from 0.78±0.04 mg kg^{-1} to 14.97±0.14 mg kg^{-1}. The concentrations of the analyte showed similar trend for green peas, okra, shell bean, sweet corn and green beans samples in each varieties. Conversely, Cu concentrations of tomato samples were different about fifteen times. Values of Cu were 0.91±0.07-2.62±0.27 mg kg^{-1} [22], 0.89±0.02-0.91±0.02 mg kg^{-1} [20], 0.8±0.4-1.3±0.3 mg kg^{-1} [8], 1.28±0.81-2.14±1.35 mg kg^{-1} [7], 6.22±1.23-8.03±2.76 mg kg^{-1} [11], 2.94±0.24-7.77±0.57 mg kg^{-1} [1]. The reported values found comparable with the results present in this study except the jarred tomato paste sample (14.97±0.14 mg kg^{-1}).

To the best of our knowledge, determination of the analytes Ba, Mo and B were firstly presented in this study for the mentioned sample types. The obtained results were between 0.33±0.01-5.02±0.16 mg kg^{-1}; 0.384±0.005-4.24±0.31 mg kg^{-1} and 0.96±0.08-7.56±1.45 mg kg^{-1} for Ba, Mo and B, respectively. In regard of analyzed sweet corn samples all these elements were below detection limits. Additionally, Mo contents of canned and frozen okra, frozen green beans and tomato paste samples were below detection limits. The similar results were also found for canned shell bean and canned green beans in the case of B.

Considering Mg levels of the samples, the concentrations were varied from 124.83±4.31 mg kg^{-1} (tomato paste, tin can) to 1016.79±21.20 mg kg^{-1} (frozen okra). The obtained results showed that Mg levels of frozen samples were relatively higher than the canned samples. In the case of Ca, the mean concentrations were between 42.60±1.43-1607.40±84.62 mg kg^{-1}.The highest and lowest levels of Ca were quantified for frozen okra and canned sweet corn, respectively. The existing tendency of the analyte was showed similarity with Mg which were relatively high in frozen samples. However, it should be noted that these findings were found to be lower than the values obtained in Iran [11] both for Mg and Ca.

Table 3: Analysis results of canned and frozen vegetables (N=3)

Sample No	Sample	Element (mg kg^{-1})											
		Pb	Ni	Ba	Fe	Zn	Mg	Mn	Al	Cu	Mo	Ca	B
1	Frozen Green Peas	1.3±0.1	1.86±0.06	0.90±0.02	21.00±1.87	8.28±0.24	444.55±15.21	4.29±0.18	1.74±0.74	5.31±0.30	0.97±0.03	425.70±10.73	7.56±1.45
2	Canned Okra (Tin Can)	nd	0.19±0.01	5.02±0.16	12.93±0.46	3.41±0.05	298.63±12.64	1.22±0.05	0.97±0.08	1.92±0.12	nd	931.02±60.34	3.90±0.20
3	Frozen Shell Bean	nd	0.54±0.04	0.41±0.02	32.22±1.10	14.64±1.08	791.19±71.29	4.99±0.28	0.72±0.07	6.44±0.40	4.24±0.31	435.17±45.84	6.78±0.26
4	Canned Sweet Corn (Tin Can)	nd	0.150±0.003	nd	4.53±0.61	4.51±0.13	175.62±1.09	1.10±12.22	nd	0.84±0.08	nd	42.60±1.43	nd
5	Frozen Sweet Corn	nd	0.252±0.001	nd	4.20±0.36	4.58±0.29	275.58±25.90	1.24±0.21	nd	1.00±0.05	nd	85.15±3.02	nd
6	Canned Shell Bean (Tin Can)	nd	0.21±0.01	0.34±0.01	18.84±1.17	7.00±0.44	228.26±2.26	2.43±0.15	1.18±0.10	4.16±0.02	2.70±0.25	474.74±24.56	nd
7	Frozen Green Beans	nd	0.204±0.004	0.48±0.03	10.38±1.45	2.29±0.07	209.02±9.32	1.79±0.09	1.34±0.03	0.98±0.10	nd	540.62±20.40	1.20±0.02
8	Canned Green Peas (Tin Can)	nd	0.33±0.01	2.25±0.04	12.49±0.22	7.07±0.36	281.58±6.31	3.02±0.08	1.03±0.08	2.89±0.14	1.18±0.08	449.34±13.56	2.78±0.63
9	Frozen Okra	nd	0.33±0.02	2.02±0.11	5.89±0.04	8.40±0.32	1016.79±21.20	2.92±0.14	0.63±0.06	2.08±0.13	nd	1607.40±84.62	4.39±0.42
10	Frozen Garniture	nd	0.32±0.03	0.77±0.04	8.40±0.06	7.12±0.37	287.91±4.81	2.22±0.19	0.63±0.06	2.30±0.09	0.81±0.04	301.24±8.37	1.64±0.10
11	Tomato Paste (Tin Can)	nd	0.16±0.01	0.33±0.01	10.22±0.99	1.75±0.14	124.83±4.31	0.87±0.09	0.67±0.05	0.92±0.04	nd	174.74±0.55	0.96±0.08
12	Tomato Paste (Jarred)	nd	0.198±0.001	0.34±0.01	5.78±0.44	2.01±0.09	193.74±2.53	1.44±0.04	0.69±0.07	14.97±0.14	nd	172.69±9.48	1.17±0.03
13	Canned Green Beans (Tin Can)	nd	nd	0.38±0.01	15.32±0.93	1.65±0.14	153.53±5.05	0.99±0.02	0.32±0.02	0.78±0.04	0.384±0.005	350.45±16.98	nd

3.2. Nutrition reference values

Daily contribution of Fe, Zn, Mg, Mn, Cu, Mo and Ca to dietary intake were calculated from the total amounts of the analytes using consumed portions to find out the nutritional value of the investigated samples (Table 4). According to Turkish Food Codex, the consumed portion of the vegetables was assumed as 150 g. The calculated estimated daily intake (EDI) values of certain analytes were appraised by benchmarking of recommended dietary allowances (RDA) established by World Health Organization, nutrition reference values (TFC) established by Turkish Food Codex and daily tolerable upper intake levels (UL) established by Institute of Medicine. Considering the highest amounts of the analytes in the examined samples, the EDI values were in decreasing order as follow: Ca>Mg>Fe>Cu=Zn>Mn>Mo. On the other hand, considering to EDIs to RDA and/or TFC, generally, the highest contribution range was provided by Mo element for all samples. Typically, contribution to RDA values showed increasing order as follow: Mn<Zn<Ca<Fe<Mg<Cu<Mo. Similar to RDA, the contribution of analytes were lined up in increasing order as follow for TFC: Zn<Ca<Fe<Mn<Mg<Cu<Mo. In terms of upper intake levels, the calculated estimated daily intakes of Zn, Mg, Cu, Mo and Ca were below daily tolerable upper intake levels (UL) defined by Institute of Medicine for adults. Additionally, due to the absence of a UL for Fe, Mn and Ni, it was not able to evaluate the EDIs for tenability. Finally, under normal conditions, it can be seen that daily consumption of the analyzed samples will not cause any harmful impact on health.

Table 4: Nutritional assessment for the analysed samples

Analyte	Detected Analyte Concentration Range[1] (mg kg^{-1})	EDI[2] (mg day^{-1})	Contribution to RDA[3, 5] (%)	Contribution to TFC[4, 5] (%)	Daily Tolerable Upper Intake Levels (UL)
Fe	4.20-32.22	0.6-4.8	4-32 (F) 6-48 (M)	4-34	Not established
Zn	1.65-14.64	0.2-2.2	2-18 (F), 1-15 (M)	2-22	25 mg
Mg	124.83-1016.79	18.9-152.5	7-54 (F), 5-44 (M)	5-41	2500 mg
Mn	0.87-4.99	0.1-0.7	2-14 (F/M)	5-35	Not established
Cu	0.78-14.97	0.1-2.2	3-73 (F/M)	10-220	5 mg
Mo	0.38-4.24	0.06-0.64	24-256 (F/M)	120-1280	0.6 mg
Ca	42.60-1607.40	6.4-241.1	0.5-20.1 (F/M)	0.8-30.1	2500 mg
Ni	0.16-1.86	0.02-0.28	-	-	Not established

[1] Analyte concentration ranges were extracted from Table 3 which indicates detected minimum and maximum levels, respectively.

[2] Estimated daily intake (EDI) was calculated by the equation; $EDI = \frac{Total\ element\ content\ of\ sample \times Consumed\ Food\ Amount}{Day}$

Consumed Food portion was assumed as 150 g per adult according to Turkish Food Codex

[3] Recommended Daily Allowance (RDA); for female (F), for male (M): Fe 15 mg (F), 10 mg (M); Zn 12 mg (F), 15 mg (M); Mg 280 mg (F), 350 mg (M); Ca 1200 mg (F/M); Mn 5 mg(F/M); Cu 3 mg (F/M); Mo 250 µg (F/M)

[4] Turkish Food Codex (TFC) Nutrition Reference Values for adult: Fe 14 mg; Zn 10 mg; Mg 375 mg; Ca 800 mg; Mn 2 mg; Cu 1 mg; Mo 50 µg

[5] Contribution percentages were calculated according to lowest and highest EDI values, respectively.

4. Conclusion

In this study, determination of some elements including Pb, Ni, Ba, Fe, Zn, Mg, Mn, Al, Cu, Mo, Ca, B, Cr, Cd, V and Co was carried out in canned or frozen food samples such as green peas, okra, shell bean, sweet corn, green beans, garniture and tomato paste sold in local markets of Balıkesir. Additionally, the results of Ba, Mo and B were firstly reported for those sample types. Quantification of the analytes was achieved using ICP OES after decomposition of the samples by microwave digestion. The obtained results showed that the analytes Cr, Cd, V and Co were below detection limits for all samples. Generally, comparing to frozen samples, the analyte levels of canned food samples were recorded lower. It can be concluded that all samples that were analyzed in this study were within international maximum permissible limits. Therefore, it can be concluded that the consumers have no potential risk through consuming those products. Nevertheless, the number of the analyzed samples may be found limited for a general judgment. However, this study may be assessed as a precursor work and in future, sample types and numbers may be expanded. As a conclusion, comprehensively and periodically monitoring of elements in such samples is imperative to safeguard the health of the public.

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