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Research Article

Mineral and Heavy Metal Contents of Some Animal Livers

Erman Duman[1]*, Mustafa Mete Özcan[2], Mehmet Hamurcu[3], Mehmet Musa Özcan[4]

[1] Afyon Kocatepe Üniversitesi, Mühendislik Fakültesi, Gıda Mühendisliği Bölümü, Afyonkarahisar, Türkiye(ORCID: 0000-0003-3405-9572)
[2]Selçuk Üniversitesi, Karapınar Aydoğanlar Yüksekokulu, Veterinerlik Bölümü,Karapınar, Konya, Türkiye(ORCID: 0000-0003-0608-771X)
[3]Selçuk Üniversitesi, Ziraat Fakültesi, Toprak Bilimi ve Bitki Besleme Bölümü, Konya, Türkiye(ORCID: 0000-0001-7378-4406)
[43]Selçuk Üniversitesi, Ziraat Fakültesi, Gıda Mühendisliği Bölümü, Konya, Türkiye(ORCID: 0000-0002-5024-9512)

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Abstract

The mineral and heavy metal contents of beef, chicken, goat, quail, sheep and five different ducks livers were determined by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES). The P contents of livers ranged from 8172.87 mg/kg (Civil) to 10051.46 mg/kg (goat). In addition, K contents of liver samples were found between 7848.39 mg/kg (Kaşıkcı) and 10404.48 mg/kg (chicken). While Ca contents of livers change between 117.46 mg/kg (goat) and 316.78 mg/kg (quail), Mg content varied between 475.69 mg/kg (beef) and 769.32 mg/kg (chicken). This study showed that quail liver contained the highest concentrations of iron (413.41 mg/kg), followed by chicken (363.88 mg/kg), goat (138.47 mg/kg), sheep (114.40 mg/kg) and beef (102.20 mg/kg). In addition,Zn contents of samples varied between 49.69 mg/kg (quail) and 104.20 mg/kg (Civil). While Fe contents of livers range from 669.12 mg/kg (Civil) to 3808.90 mg/kg (Kıl), Na contents were found between 3142.2 mg/kg (Yeşil) to 4756.8 mg/kg (Kıl). Cu contents of livers were established between 16.48 mg/kg (Kıl) and 72.73 mg/kg (Civil). There were significant differences in mineral contents of liver types ($p<0.05$). In this study, investigated animal livers can be used as supplement for good personal health.

Key words: Beef, Goat, Chicken, Quail, Wild duck, Livers, Minerals, Heavy metals, ICP-AES.

Bazı Hayvan Karaciğerlerinin Mineral ve Ağır Metal İçerikleri

Öz

Sığır, tavuk, keçi, bıldırcın, koyun ve beş farklı ördek karaciğerlerinin mineral ve ağır metal içerikleri, İndüktif Olarak Eşleşmiş Plazma-Atomik Emisyon Spektroskopisi (ICP-AES) ile belirlenmiştir. Karaciğerlerin P içeriği 8172.87 mg/kg (Civil) ila 10051.46 mg/kg (keçi) arasında değişmiştir. Ek olarak, karaciğer numunelerinin K içeriği 7848.39 mg/kg (Kaşıkcı) ile 10404.48 mg/kg (tavuk) arasında bulunmuştur. Karaciğerlerin Ca içerikleri 117.46 mg/kg (keçi) ile 316.78 mg/kg (bıldırcın) arasında değişirken, Mg içeriği 475.69 mg/kg (sığır eti) ve 769.32 mg/kg (tavuk) arasında değişmektedir. Bu çalışmada, bıldırcın karaciğerinin en yüksek demir konsantrasyonlarını (413.41 mg/kg) içerdiğini, ardından sırasıyla tavuk (363.88 mg/kg), keçi (138.47 mg/kg), koyun (114.40 mg/kg) ve sığır eti (102.20 mg/kg) belirlenmiştir. Ayrıca, numunelerin Zn içerikleri 49.69 mg/kg (bıldırcın) ve 104.20 mg/kg (Civil) arasında değişmiştir. Karaciğerlerin Fe içeriği 669.12 mg/kg (Civil) ila 3808.90 mg/kg (Kıl) arasında değişirken, Na içeriği 3142.2 mg/kg (Yeşil) ile 4756.8 mg/kg (Kıl) arasında bulunmuştur. Karaciğerlerin Cu içerikleri 16.48 mg/kg (Kıl) ile 72.73 mg/kg (Civil) arasında belirlenmiştir. Karaciğer tiplerinin mineral içeriğinde anlamlı farklılıklar tespit edilmiştir ($p <0.05$). Bu çalışmada araştırılan hayvanların karaciğerleri sağlık için iyi bir takviye gıda olarak kullanılabilir.

Anahtar Kelimeler: Sığır, Keçi, Tavuk, Bıldırcın, Yaban ördeği, Karaciğer, Mineral, Ağır metal, ICP-AES.

1. Introduction

The liver is the most important organ involved in metabolic processes and is considered to be one of the most eloquent witnesses of any disturbance in the body (Doneley, 2004). Mineral elements are essential for animal health, survival and production due to their participation in physiological, structural, catalytic and regulatory functions of animal organism (Underwood and Suttle, 2001; Reis et al., 2010). Heavy metals are included in the group of trace elements that have negative influence on human health (Lopez-Alonso et al. 2007; Pappas et al. 2010). Heavy metals often have direct physiologically toxic effects and are stored or incorporated in living tissues (Baykov et al. 1996). Birds may accumulate and concentrate heavy metals in their tissues and thus serve as more sensitive indicators of the level of environmental contamination (Guitant et al. 1994).John and Jeanne (1994) showed that levels of arsenic, cadmium, mercury and lead were detected in several tissues of goats. With increasing industrialization, more and more metals are entering into the environment. They enter into the food material and from there they ultimately make their passage into the tissue (Baykov et al. 1996; Walsh 2000; Olarifa et al. 2004). Zinc concentrations were found to be highest in meat liver, fish and eggs (Janet and Carl 1994).There has has been increasing concern about the entry of potentially harm ful substances into the food chain destined for human consumption (Mailman, 1980; Lacher Goldstein, 1997). Because, heavy metals can be responsible fer a variety of acute and chonic toxic effects in vertebrates (Parmegianni 1983). Heavy metals often have direct physiologically toxic effects and are stored or incorporated in living tissues (Baykov et al., 1996). Due to the grazing of cattle on contaminated soil higher levels of metals have been found in beef and muttan (Sabir et al., 2003). The aim of current study is to determine mineral and heavy metal contents of several animal livers.

2. Material and Method

2.1. Material

Liver samples (sheep, beef, chicken, goat and quail) and duck liver samples (*Kaşıkçı, Yeşil, Civil, Kıl and Tıjır*) were provided from local market of Konya, Turkey. The samples were transported to the laboratory in polyethylene bags for analysis. The obtained samples were washed with distilled water to remove any contaminant particies. The samples were cut to small pieces using clean scalpel. Livers were dried in an oven at 100 ± 5ºC/24 h. After drying the livers were ground into a fine powder using a ceramic pestle, and kept in $+4C^0$ till used for acid digestion.

2.1.1. Determination of Mineral and Heavy Metal Contents

About 0.5 g dried and ground each liver sample was digested by using 5ml of 65% HNO_3 and 2 ml of 35% H_2O_2 in a closed microwave system (Cem-MARS Xpress, Matthews NC, USA). The volumes of the digested samples were completed to 20 ml with ultra-deionized water, and mineral contents were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (Varian-Vista, Australia). Measurements of mineral concentrations were checked using the certified values of related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA) (Skujins, 1998).

Working conditions of ICP-AES:

In this study, ICP-AES (Varian-Vista) was used. Its RF Power changes between 0.7 and 1.5 kw (1.2-1.3 kw for Axial). In addition, plasma gas flow rate (Ar) ranged from 10.5 to 15 L/min. (radial) 15 " (Axial). Auxilary gas flow rate (Ar) is 1.5 ". Viewing height is between 5 and 12 mm. Copy and reading time change between 1 and 5 s (max.60 s).

2.1.2. Statistical analyses

Results of the research were analysed for statistical significance by analysis of variance (Püskülcü and İkiz 1989). The means were compared by the use of one way variance analyses (ANOVA) and the differences between the values were analyzed by Duncan multiple comparison test. Importance of the differences between the means were given according to $P<0.05$ importance levels.

3. Results and Discussion

3.1. Results

As shown Table 1. P contents of livers ranged from 8172.87 mg/Kg (Civil) to 10051.46 mg/kg (goat). In addition, K contents of liver samples were found between 7848.39 mg/Kg (Kaşıkcı) and 10404.48 mg/kg (chicken). While Ca contents of livers change between 117.46 mg/Kg (goat) and316.78 mg/Kg (quail), Mg content varied between 475.69 mg/kg (beef) and 769.32 mg/kg (chicken). Generally, the liver of goat rich in P and K.Their Ca and Mg contents were found low compared with results of other samples. The highest K was found in chicken (10404.48 mg/Kg) liver, followed by goat, sheep, quail and cow. P and K contents of goat liver were found partly similar. There were significant differences in mineral contents of liver samples ($P<0.05$).

Table 1.*Mineral contents, metal and non-metal contents of several animal livers (mg/kg)*

Duck livers	Macro nutrients			
	P	**K**	**Ca**	**Mg**
Kaşıkçı	8425.08±329.67*bc	7848.39±278.21d	202.22±18.42c	501.28±20.67b
Yeşil	8472.59±2.17bc	8057.22±74.32c	179.76±19.91d	544.56±17.96b
Civil	8172.87±2105.49d	8715.79±2293.46b	297.00±11.87b	656.29±199.36a
Kıl	9699.64±736.91a	8900.19±410.23a	313.00±66.35a	611.08±47.07ab
Tıkır	8697.34±179.44b	7995.08±331.78d	261.10±49.15ab	551.71±12.06b
Sheep	9495.21±191.68*b	9525.85±437.19b**	175.46±20.06b	538.94±18.67b
Beef	8508.88±324.06c	9211.48±261.47bc	148.09±109.58bc	475.69±21.14c
Chicken	9599.24±103.48ab	10404.46±60.96a	159.77±25.81bc	769.32±114.27a
Goat	10051.46±316.36a	10023.37±374.52a	117.46±57.35c	511.57±28.58b
Quail	9620.87±126.12ab	9397.19±85.17bc	316.78±82.60a	736.54±91.50a

*mean±standard deviation

**within column mean with different letters are statistically significant p<0.05

The concentration of Fe, Zn, Mn, B, Cu, Mo and Na in the studied five different animal livers (sheep, beef, chicken, goat, quail and ducks) are shown in Table 1 (continued). This study showed that quail liver contained the highest concentrations of iron (413.41 mg/Kg), followed by chicken (363.88 mg/Kg), goat (138.47 mg/Kg), sheep (114.40 mg/Kg) and beef (102.20 mg/Kg). While Fe contents of livers range from 102.20 mg/Kg (beef) to 3808.90 mg/Kg (Kıl), Na contents were found between 2088.70 mg/Kg (goat) to 4756.8 mg/Kg (Kıl). Also this study indicated that civil liver (104.20 mg/Kg) contained the highest concentrations of zinc followed by chicken (100.87 mg/Kg), beef (87.20 mg/Kg), sheep (81.84 mg/Kg) and goat (73.50 mg/Kg).

Table 1. (continued) *Mineral contents, metal and non-metal contents of several animal livers (mg/kg)*

Duck livers	Micro nutrients (mg/kg)						
	Fe	**Zn**	**Mn**	**B**	**Cu**	**Mo**	**Na**
Kaşıkçı	2969.91±150.08*b	52.40±0.50c**	8.91±0.30a	8.55±0.13a	26.69±1.00c	2.85±0.17b	4191.1±201.5b
Yeşil	1885.61±77.36c	67.18±0.20b	8.90±0.01a	6.83±0.88b	48.70±1.87b	3.75±0.34a	3142.2±61.4c
Civil	669.12±165.46d	104.20±25.99a	8.57±1.97a	6.42±1.53c	72.73±19.14a	2.57±0.57b	3321.5±1077.9c
Kıl	3808.90±1798.18a	63.45±1.97b	7.15±0.17b	4.38±1.33d	16.48±1.68d	3.49±0.36a	4756.8±986.8a
Tıkır	2298.42±460.84b	53.85±6.99c	8.59±1.55a	2.20±0.98e	18.01±2.99cd	2.48±0.76b	3307.6±429.3c
Sheep	114.40±2.99*cd	81.84±3.55b**	9.12±0.25b	33.56±3.08a	58.62±24.59a	3.30±0.01b	2217.52±93.99b
Beef	102.20±8.76cd	87.20±2.10b	5.96±0.20d	25.71±3.28b	97.05±3.14b	30.82±0.26a	2333.83±266.29b
Chicken	363.88±45.60b	100.87±2.62a	9.45±0.68b	19.66±2.88c	10.82±3.46c	2.09±0.10b	3160.41±99.50a
Goat	138.47±11.02c	73.50±3.88c	7.17±0.34c	11.78±2.13d	4.18±0.62c	1.41±0.05b	2088.70±213.81
Quail	413.41±77.16a	49.69±0.94d	11.69±1.05a	2.13±0.86e	7.32±0.57c	1.86±0.30b	2910.04±70.44ab

*mean±standard deviation

**within column mean with different letters are statistically significant p<0.05

In addition, Cu contents of livers were established between 4.18 mg/Kg (goat) and 58.62 mg/Kg (sheep). Also, Mn contents of liver samples were found between 5.96 mg/Kg (beef) and 11.69 mg/Kg (quail). Generally, Mn, B and Mo contents of livers were found at the lowest levels. There were significant differences in mineral contents of liver types (p<0.05). In addition, B contents of livers were found between 2.13 mg/kg (quail) and 33.56 mg/kg (sheep). In addition, while Mo contents of liver change from 1.41 mg/Kg (goat) to 30.82 mg/Kg (cow),Na content varied from 2088.70 mg/Kg (goat) to 4756.8 mg/Kg (kıl). Mn, Cu (except sheep) and Mo content of liver samples were found at the lowest levels.

3.2. Discussion

Oforka et al., (2012) reported that chicken liver 0.0457 mg/ Kg Cd, 0.3042 mg/ Kg Pb, 0.4150 mg/ Kg Mn, 2.3245 mg/ Kg Zn and 0.1079 mg/ Kg Ni. The concentrations in Mn chicken liver is slightly above the WHO reference standard of 0.5 mg/ Kg (WHO 1996), The role of manganese in neurosychiatric disorders is also documented (Jackson and Marris, 1989). Copper contents of samples ranged between 2.20 mg/g and 12.37 mg/g for meat and camel meat, respectively (Badiel et al. 2014). Determination of the Cu content in foods is also an important subject with respect to human consumption (Lee and Stuebing 1990; FAO 1995). The levels

of Zn in the chicken livers ranged from 4.116 mg/g to 3.266 mg/g (Hussain et al, 2012). Mariam et al. (2004) reported mean levels of Zn (28.53 mg/kg) in lean meat of poultry in Lahore. Also, Iwegbue et al. (2008) reported that the concentrations of Zn for Turkey meat, chicken meat and chicken gizzand in Delta State Southern Nigeria determined as 4.95-48.23 mg/kg, 6.12-33.21 mg/kg and 10.19-37.03 mg/kg, respectively. It was noticed that Fe contents in the livers were significantly ($p<0.05$) higher when compared to those in the other meats. Our result shown partly differences when compared with literature values. The high metal content found in the liver samples may be caused by pollution and the environment itself, more probably by secondary contamination caused by agricultural practices and live stock feed, as weel. Contamination is transferred to animals through direct seawage water and industrial effluent, vehicle emission and dirty slaughter places.

The levels of metals in the chicken livers were ranged between (0.004) mg/g and 10.124 mg/g for Cd, 0.171 mg/g and 3.269 mg/g for Pb and 4.116 mg/g and 3.266 mg/g for Zn (Hussain et al. 2012). Akan et al., (2010) established 0.43-1.26 mg/g Cr, 0.22-1.34 mg/g Pb, 0.54-1.44 mg/g Cu, 2.13-4.65 mg/g Fe, 0.09-1.09 mg/kg Ni, 0.22-1.09 mg/g Co, 1.34-4.11 mg/g Mn, 0.22-0.76 mg/g Cd, and 2.34-6.23 mg/g Zn in beef, mutton, caprine and chicken livers. Rehman et al. (2012) reported that liver of chicken 156-340 mg/kg Mn and 2320-3942 mg/kg Fe. Khan et al. (2005) assessed the risk of polluted and excessive amount of various ingredients used in animal feed. The average mineral values of chicken liver were 83.65, 50.75, 5.29, 1.15, 0.154, 0.683, 0.317 and 0.066 Mg/g of Fe, Zn, Cu, Mn, Cd, Pb, Ni, and Cr, respectively (Abu-Salem et al., 2010). In addition, the same researchers established that duck liver contained 79.60 Fe, 51.10 Zn, 3.30 Cu, 2.40 Man and 0.80 Pb (Abu-Salem et al., 2010). Oforka et al., (2012) reported that chicken liver 0.0457 mg/kg Cd, 0.3042 mg/kg Pb, 0.4150 mg/kg Mn, 2.3245 mg/kg Zn and 0.1079 mg/kg Ni. The concentrations in Mn chicken liver is slightly above the WHO reference standard of 0.5 mg/kg (WHO 1996).

This study was carried out to determine the levels of mineral and heavy metal contents in livers of different animals. It was noticed that Fe contents in the livers were significantly ($p<0.05$) higher when compared to those in the other meats. Determination of the Cu content in food is also an important subject with respect to human consumption (FAO, 1995, Lee and Stuebing, 1990). The high metal content found in the liver samples may be caused by pollution and the environment it self, more probably by secondary contamination caused by agricultural practices and live stock feed, as weel. Contamination is transferred to animals through direct sewage water and industrial effluent. In addition, contamination of liver can also be caused by vehicle emission and from dirty slaughter places. The accumulation of heavy metals varies significantly from one tissue to another within an animal and varies also between one animal and another (John and Jeanne, 1994).

4. Conclusions and Recommendations

This study is carried out to determine the levels of heavy metals in livers of different ducks. In comparison with literature, it may be different values for almost all element parameters. Differences among the values of liver element contents can be probably due to feeding, environmental conditions, ingredients used in animal feed and analytical conditions.The Ca, K, Mg, and P contents of livers were found in the highest levels in all liver samples. Liver can be used as supplement for good personal health.

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