

METALS PROFILE IN BLOOD PLASMA, MUSCLE AND LIVER OF EGYPTIAN BALADI BULLS AND FRIESIAN x BALADI BULLS

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SUMMARY

The present study was aimed to quantify the (selenium, zinc, lead and cadmium) metals in blood plasma, muscle and liver in Egyptian Baladi bulls and Friesian x Baladi bulls. The metals were determined by using atomic absorption (AA) flame spectrometry techniques. The overall mean content of selenium in blood plasma, muscle and liver of Egyptian Baladi bulls and Friesian x Baladi bulls was 0.044 ± 0.019 mg/l, 0.170 ± 0.027 , and 0.39 ± 0.17 , mg/kg, respectively, while content of zinc was 0.81 ± 0.14 mg/l, 33.5 ± 5.5 and 48.2 ± 12.4 mg/kg, respectively. The toxic elements lead and cadmium in blood plasma, muscle and liver of Egyptian Baladi bulls and Friesian x Baladi bulls was 0.01 ± 0.01 , 0.0008 ± 0.0001 mg/l, 0.06 ± 0.01 , 0.0049 ± 0.0023 and 0.351 ± 0.14 , 0.277 ± 0.1 mg/kg, respectively. The correlation between selenium and cadmium concentration in blood plasma of Egyptian Baladi bulls was negative ($P < 0.05$) ($r = -0.82$) and crossbred bull was ($r = -0.24$), respectively. Positive correlation ($P < 0.05$) between zinc and cadmium concentration was observed in Egyptian Baladi bulls and Friesian x Baladi bulls ($r = 0.66$) and ($r = 0.95$), respectively. The present investigation demonstrates that the level of cadmium was decreased as plasma selenium concentration was increased and the correlation between selenium and cadmium concentration in blood plasma of Egyptian Baladi bulls was higher ($P < 0.05$) and negative ($r = -0.82$) than crossbred bull ($r = -0.24$). The positive correlation between zinc and cadmium concentration in blood plasma Egyptian Baladi bulls and Friesian x Baladi bulls ($r = 0.66$) and ($r = 0.95$), respectively.

Keywords: Metals, blood plasma, muscle, liver, Egyptian Baladi bull and Friesian x Baladi bulls

INTRODUCTION

In recent years, there has been an increasing ecological and global public health concern associated with environmental contamination with heavy metals. The multiple industrial, agricultural, medical and technological applications have led to high distribution in the environment, increasing concerns over their potential effects on environment and the human health. Environmental pollution associated with (toxic) trace elements has global concern over many decades. These elements are natural components of the environment but high rate of industrialization has been responsible for their wider diffusion and dispersal in the environment (Rajaganapathy *et al.*, 2011).

Many researchers studied the content of selenium and zinc in blood plasma of cattle (Marciniak *et al.*, 2011 and Dermauw *et al.*, 2014), also the toxic metals (lead and cadmium) reported by (Hoff *et al.*, 1998 and Marciniak *et al.*, 2011) in cattle. Leheska *et al.* (2008) and Garcia-Vaquero *et al.* (2011) reported the content of zinc and selenium in bovine muscle, while lead and cadmium reported by (Abou-Donia, 2008 and Denise *et al.*, 2012). The bovine liver content of zinc and selenium recorded by (Lopez-Alonso *et al.*, 2004 and Nriagu *et al.*, 2009), toxic metals (lead and cadmium) in bovine liver reported by (Abou-Donia, 2008 and Denise *et al.*, 2012).

Lead is one of the toxic metals, the inhalation of lead can permanently lower intelligence quotient (IQ), damage emotional stability cause hyperactivity, poor school performance and hearing loss (Goyer,

1996). Cadmium is a heavy metal with a high toxicity; Sherief *et al.* (2015) show a significant positive association between pediatric cancer and environmental exposure to Cadmium particularly through contaminated food and water in Egypt.

Deficiencies of nutritional essential elements, of human such as selenium (Se) and zinc (Zn), may have an effect on health consequences (e.g. stunted growth, lowered antioxidant status (World Health Organization, 1996). Many researchers suggest that higher selenium intakes may be beneficial for protection against cancer (Clark *et al.*, 1996) and psychological function (Benton and Cook, 1990).

Meat and liver consumption form an important contribution to human nutrition, as these tissues have the capacity to store high amounts of trace elements (Berger, 2005). Liver is considered the main indicator organ for status evaluation of several essential trace elements, assuming that it forms the main storage depot and is the most responsive tissue to dietary trace element supply (Suttle, 2010). Dermauw *et al.* (2014) found that the levels of Se and Zn in liver of (*Bos indicus*) were higher than of (*Bos taurus*). The present study was aimed to estimate the nutritional and toxic metals in blood plasma, muscle and liver of Baladi bulls and Friesian x Baladi bulls.

MATERIALS AND METHODS

Management and feeding:

This study was carried out under the environmental conditions of Aswan governorate,

which is located in the south valley of Egypt, during the period from March to September, 2015. The experimental animals were kept in a traditional semi shading farm. The farm is near industrial activities. The animals were fed concentrate feed mixture (corn grain and wheat bran), wheat straw and *Alfa-Alfa* hay, the feeding system was *ad-libitum* for all the experimental animals.

Estimation of metals:

Samples of blood (n=60), muscle (n=40) and liver (n=40) were analyzed quantitatively for zinc (Zn),

selenium (Se), Lead (Pb) and Cadmium (Cd) using atomic absorption (AA) flame spectrometry techniques. Spectrometer: ICE 3000C113500040 v1.30, England, the wavelength was used 196.0 nm for (Se), 213.9 (Zn), 217.0 (Pb) and 228.8 (Cd). Measurement mode: Absorbance, Band pass: of Se, Pb and Cd was (0.5nm), but for Zn was (0.2). Fuel Flow: 1.1 L/min (Pb) and 1.2 L/min for Cd, Se and Zn. Analysis of nutritional and toxic minerals in animal's diet (mg/kg) and drinking water (mg/l) is in (Table 1).

Table 1. Analysis of selenium, zinc, lead and cadmium metals in the experimental animal's diet (mg/kg) and drinking water (mg/l)

Minerals	NRC requirement	Dietary concentration
Mineral in animals diet (mg/kg):		
Selenium	0.3	0.44
Zinc	32.0	73.7
Lead	0.2	1.3
Cadmium	0.5	0.16
Mineral in drinking water (mg /l):		
Selenium	0.05	0.07
Zinc	5.0	0.3
Lead	0.015	0.002
Cadmium	0.005	0.001

Source: NRC, 2001

Procedures of chemical analysis:

The samples were analyzed in Unit of the Environmental Studies and Development, Aswan University. Microwave system was used for acid digestion of all the samples. Samples were dried at 70°C in a forced stove until dry weight was obtained. An amount of 1.0 g of the sample was measured into a clean 250 ml dry Pyrex digestion flask. A total of 10 ml of 65% nitric acid was added, followed by the addition of 3.0 ml of 30% hydrogen peroxide. The digestion flask was heated gently until frothing subsided. The sample was then heated to dryness, dissolved in 30 ml deionized and filtered with, Whatman filter paper 102, 12.5cm. The solution was made up to volume in a 100 ml flask and stored in a special container ready for analysis (AOAC, 2000).

Statistical analysis:

The collected data were divided into two groups, the first group was collected from Baladi bulls and the second group was collected from crossbred bulls. Data were statistically analyzed to compare among groups using the general linear model procedure of SAS(2002). Significance among the means was checked using Duncan's Multiple Range Test (Duncan, 1955). The model included one fixed factor, the breed. The used model was:

$$Y_{ij} = \mu + B_i + e_{ij}$$

Where:

Y_{ij} = the measured trait

μ = overall mean

B_i = effect of breed (Baladi bulls =1, Friesian x Baladi bulls = 2) e_{ij} = experimental error assumed to be randomly distributed (0, σ^2)

RESULTS AND DISCUSSION

1- Concentrations of Se and Zn in blood plasma of Egyptian Baladi bulls and Friesian x Baladi bulls

The overall mean of selenium and zinc concentrations in plasma of Egyptian Baladi bulls and Friesian x Baladi bulls were 0.044 ± 0.019 and 0.81 ± 0.14 mg/L, respectively (Figures 1 and 2). The results indicate that concentration of selenium in blood plasma of Baladi bulls was higher 0.048 ± 0.023 than crossbred bulls 0.040 ± 0.014 , mg/L respectively (Table 2), but the difference was insignificant ($P < 0.05$), however, concentration of Zn in blood plasma of crossbred bulls was significantly higher 0.90 ± 0.11 than Baladi bulls 0.72 ± 0.12 mg/L ($P < 0.05$). The obtained results agree with that reported by Dermauw *et al.* (2014) who found that the content of Se in blood plasma was $45.0 \mu\text{g/L}$ (0.045, mg/L), but the content of Zn was lower (0.81 ± 0.14 , mg/L) than that reported by Dermauw *et al.* (2014) in blood plasma of Zebu cattle. Marciniak *et al.* (2011) reported higher content of Se $83.0 \mu\text{g/L}$ (0.083, mg/L) and lower content of Zn (0.629 mg/L) in the serum of cattle than the present results. On the other hand, Suttle (2010) found lower concentrations of Se and Zn in blood plasma of cattle ($20 \mu\text{g/L}$ and 0.6 mg/L), than the obtained results. According to recommendation of (FDA, 2005) the safety and effectiveness concentrations of selenium and zinc concern human are 0.069 and 0.034 ppm, respectively.

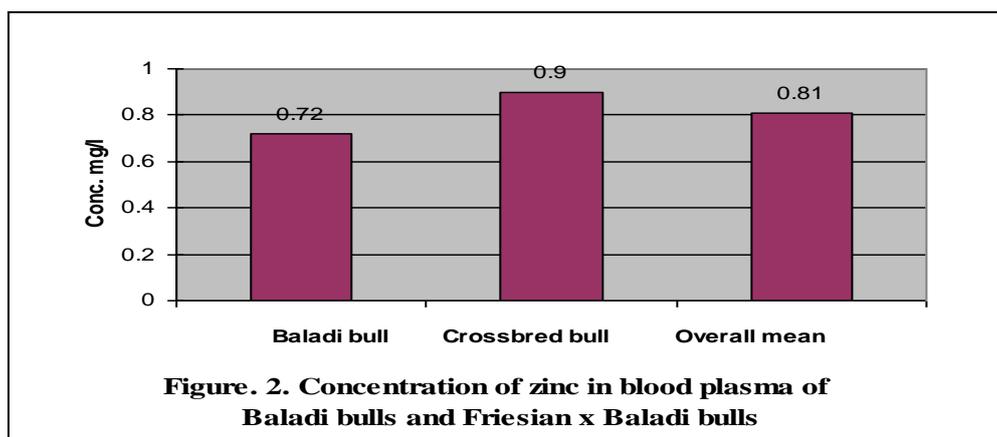
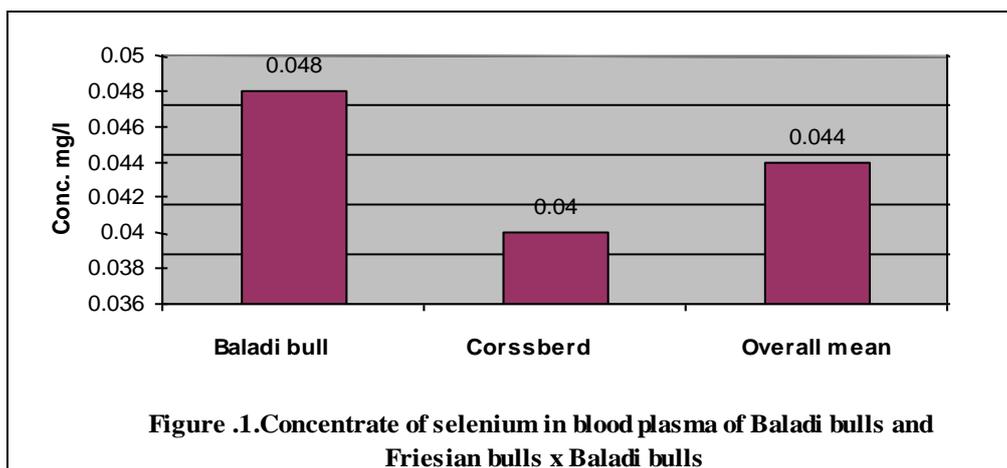


Table 2. Concentrations (X ± SE mg/l, ppm) of Se and Zn in blood plasma of Egyptian Baladi bulls and Friesian x Baladi bulls

Elements	Baladi bull	Friesian x Baladi bulls	Overall me
Se	0.048 ± 0.023	0.040 ± 0.014	0.044 ± 0.019
Zn	0.72 ± 0.12 ^a	0.90 ± 0.11 ^b	0.81 ± 0.14

^{a, b}: values within the same row having different superscripts are different at ($P < 0.05$).

2- The correlation between selenium and cadmium concentration in blood plasma of Egyptian Baladi bulls and Friesian x Baladi bulls

The liner correlation coefficients between blood plasma selenium concentration and cadmium was negative ($r = - 0.82$) for Egyptian Baladi bulls, and similar trend was observed in Friesian x Baladi bulls ($r = - 0.24$). These results agree with that reported by Marciniak *et al.* (2011) who found a negative ($r = - 0.62$) relationship between selenium and cadmium concentration in blood of cattle.

3- The correlation between selenium and lead concentration in blood plasma of Egyptian Baladi bull and Friesian x Baladi bulls

Negative liner correlation coefficients between selenium concentration and lead was ($r = - 0.43$) for Egyptian Baladi bulls, similar trend was found in Friesian x Baladi bulls ($r = - 0.47$). These results agree with that reported by Marciniak *et al.* (2011) who found a negative ($r = - 0.59$) relationship between selenium and lead concentration in blood of cattle.

4- The correlation between zinc and cadmium concentration in blood plasma of Egyptian Baladi bulls and Friesian x Baladi bulls

Positive liner correlation coefficient between zinc and cadmium concentration was observed for Egyptian Baladi bulls and for Friesian x Baladi bulls ($r = 0.66$) and ($r = 0.95$), respectively. This result agrees with that reported by (European Food Safety Authority, 2004) who reported a significant increase of Cd accumulation in tissues when high dietary supplements of trace minerals and Zn are used in the ration of animal feed. A recent study indicates that hepatic and renal Cd accumulation was significantly higher in pigs from intensive systems (Cu and Zn supplemented) compared with extensively grown animals (non- supplemented) (Alonso *et al.*, 2012). This is due to the fact that these metals have similar chemical properties and are able to induce and compete for the binding sites of metallothioneins.

5- Concentrations of toxic metals Pb and Cd in blood plasma of Egyptian Baladi bulls and Friesian x Baladi bulls

The overall mean of blood plasma lead and cadmium concentrations were 0.01 ± 0.01 and 0.0008 ± 0.0001 mg/L respectively (Figures 3 and 4). The results found that there was no significant difference of lead concentrations in blood plasma Baladi bulls and their crossbreds 0.012 ± 0.01 and 0.011 ± 0.01 , mg/L, respectively, but cadmium concentrations in blood plasma of crossbreds was higher 0.001 ppm than Baladi bulls 0.0005 ppm (Table 3). The present results are nearly equal with that of Marciniak *et al.* (2011) who found that lead and cadmium

concentrations were 0.018 ± 0.016 and 0.0009 ± 0.0008 mg/L, respectively in blood of cattle. The toxic range of lead (Pb) in cattle blood was 0.3-32 $\mu\text{g}/\text{gram}$ of tissue wet weight Hoff *et al.* (1998). According to recommendation of (FDA, 2005) the safe and effective concentrations of lead and cadmium concerning human were 0.01 and 0.002 ppm. Chronic toxicity in the human occurs at blood lead levels of about 40–60 $\mu\text{g}/\text{dL}$ (Flora *et al.*, 2012). WHO (1995) has established a Provisional Tolerable Weekly Intake (PTWI) for lead of 25 $\mu\text{g}/\text{kg}$ of body weight (equivalent to 3.5 $\mu\text{g}/\text{kg}$ of body weight per day), this level refers to lead from all sources and was set to protect all humans.

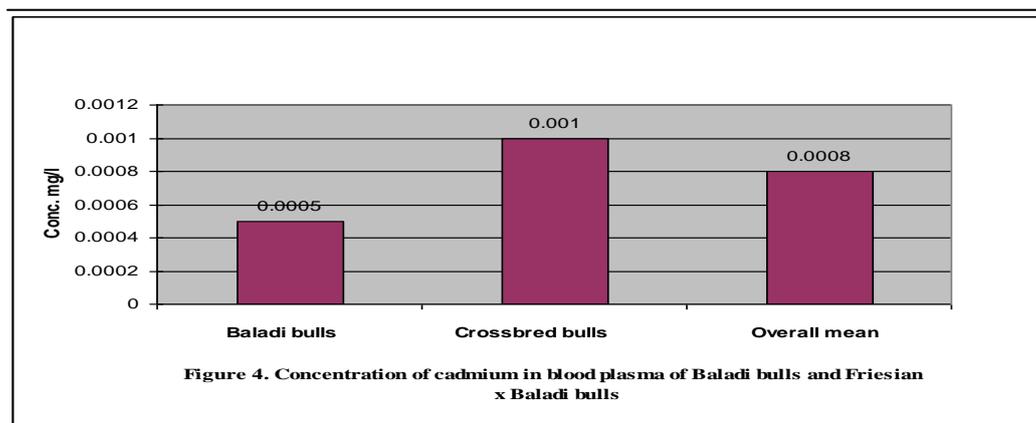
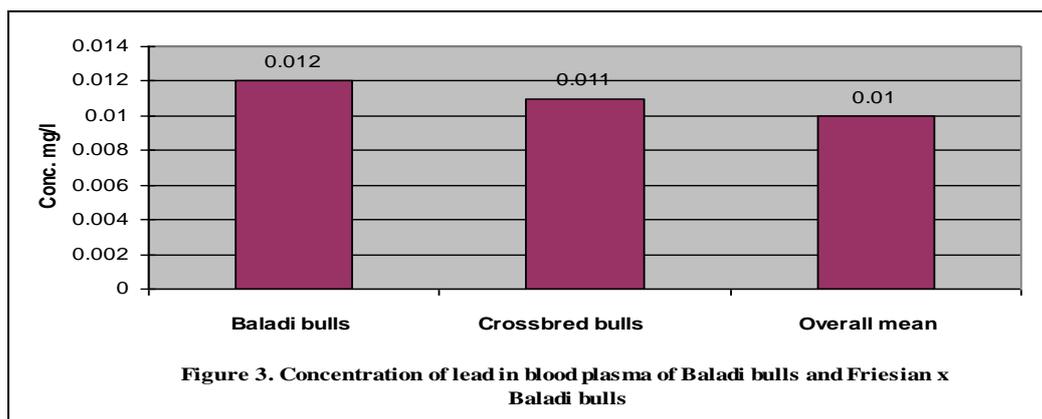


Table 3. Concentrations ($X \pm SE$ mg/l, ppm) of toxic metals Pb and Cd in blood plasma of Egyptian Baladi bull and Friesian x Baladi bulls

Elements	Baladi bull	Friesian x Baladi bulls	Overall me
Pb	0.012 ± 0.01	0.011 ± 0.01	0.01 ± 0.01
Cd	0.0005 ± 0.0001^a	0.001 ± 0.001^b	0.0008 ± 0.0001

^{a, b}: values within the same row having different superscripts are different at ($P < 0.05$).

6- Concentrations of Se and Zn in muscle of Egyptian Baladi bulls and Friesian x Baladi bulls

The overall mean concentration of selenium and zinc in the muscle was 0.170 ± 0.027 and 33.5 ± 5.5 mg/kg, respectively (Table 4). The results indicate that the concentration of selenium in crossbred bulls was higher, 0.172 ± 0.031 than Baladi bulls 0.168 ± 0.027 , mg/L, respectively (Table 4), but the

difference was insignificant ($P < 0.05$), however, concentration of Zn in muscle of crossbred bulls was significantly higher 35.8 ± 5.84 than Baladi bulls 31.2 ± 3.97 mg/L ($P < 0.05$). The obtained results agree with that reported by Leheska *et al.* (2008) who found that the concentration of selenium in *Bos indicus x Bostaurus* cattle muscle was 0.18 mg/kg, while the present result was higher than that

reported by Dermauw *et al.* (2014) who found that the concentration of selenium in bovine muscle was 0.10 mg/kg. In addition, Denise *et al.* (2012) and Garcia-Vaquero *et al.* (2011) reported that the concentration of selenium in bovine muscle was 0.083 ± 0.011 and 0.10 mg/kg, respectively. The obtained results are lower than those found by Cabrera *et al.* (2010) who reported that the concentration of selenium in *Bostaurus x Bosindicus* cattle muscle was 0.62 mg/kg. Zinc concentration in the current study was near the concentration obtained by Garcia-Vaquero *et al.* (2011) who found that

concentration of zinc in *Bostaurus* cattle muscle was 35.0 mg/kg in Spain, but the obtained results of zinc concentration were higher than that reported by Dermauw *et al.* (2014) and Cabrera *et al.* (2010) who reported that the concentration of zinc in bovine muscle was 27.0 and 25.0 mg/kg, respectively, in Ethiopia and Uruguay, respectively. The obtained results of zinc concentration in bovine muscle are lower than those found by Denise *et al.* (2012) and Leheska *et al.* (2008) who reported that concentration of zinc in bovine muscle was 149 ± 10 $\mu\text{g/g}$ and 41.0 mg/kg in Brazil and USA, respectively.

Table 4. Concentrations ($X \pm \text{SEmg/kg}$, ppm) of Se and Zn in muscle of Egyptian Baladi bulls and Friesian x Baladi bulls

Elements	Baladi bull	Friesian x Baladi bulls	Overall me
Se	0.168 ± 0.027	0.172 ± 0.031	0.170 ± 0.027
Zn	31.2 ± 3.97^a	35.8 ± 5.84^b	33.5 ± 5.5

^{a,b}: values within the same row having different superscripts are different at ($P < 0.05$).

Table 5. Concentrations ($X \pm \text{SE mg/kg}$, ppm) of toxic metals Pb and Cd in muscle of Egyptian Baladi bulls and Friesian x Baladi bulls

Elements	Baladi bull	Friesian x Baladi bulls	Overall mean
Pb	0.05 ± 0.01^a	0.07 ± 0.01^b	0.06 ± 0.01
Cd	0.0029 ± 0.0007^a	0.007 ± 0.0014^b	0.0049 ± 0.0023

^{a,b}: values within the same row having different superscripts are different at ($P < 0.05$).

7- Concentrations of toxic metals Pb and Cd in muscle of Egyptian Baladi bulls and Friesian x Baladi bulls

The overall mean concentration of lead and cadmium in muscle was 0.06 ± 0.01 and 0.0049 ± 0.0023 mg/kg, respectively (Table 5). The results indicated that the concentration of lead and cadmium in muscle crossbred bulls was higher 0.07 ± 0.01 and 0.007 ± 0.0014 than Baladi bulls 0.05 ± 0.01 and 0.0029 ± 0.0007 mg/L, respectively (Table 5), and the difference was significant ($P < 0.05$). These results agree with that reported by Abou-Donia (2008) and Denise *et al.* (2012) who found that the concentration of lead in cattle muscle ranged between 0.037 and 0.1 mg/kg, however, the results were higher than that reported by Akan *et al.* (2010) and Lukacova *et al.* (2014) who found that the concentration of lead in beef ranged between 0.003 and 0.025 mg/kg. The concentration of cadmium in bovine muscle in this study was lower than that reported by Denise *et al.* (2012) who found that concentration of cadmium in bovine muscle was 0.012 ± 4.0 mg/kg.

8- Concentrations of Se and Zn in liver of Egyptian Baladi bulls and Friesian x Baladi bulls

The overall mean concentration of selenium and zinc in liver was 0.39 ± 0.17 and 48.2 ± 12.4 mg/kg, respectively (Table 6). The results indicate that the concentration of selenium in crossbred bulls was significantly higher 0.43 ± 0.16 than that in Baladi bulls 0.34 ± 0.17 , mg/L, respectively ($P < 0.05$) (Table 6). Concentration of zinc in the liver of the Baladi

bulls was significantly higher 51.5 ± 14.2 than in liver crossbred bulls 44.8 ± 11.1 , mg/L respectively ($P < 0.05$) (Table 6). The obtained results of selenium concentration in liver is close to the findings of Korsrud *et al.* (1985) and Nriagu *et al.* (2009) (0.3-0.4, mg/kg). However, the present result of selenium concentration in liver was higher than that reported by Lopez-Alonso *et al.* (2004) and Dermauw *et al.* (2014) 0.2 mg/kg. On the contrary, Denise *et al.* (2012) found higher concentration of selenium in bovine liver (0.75 mg/kg). The concentration of zinc in liver in the present study agrees with that reported by Lopez-Alonso *et al.* (2004) and Dermauw *et al.* (2014) 49, 47, mg/kg in Spain and Ethiopia, respectively. However, the present results are higher than that reported by Nriagu *et al.* (2009) who found that the concentration of zinc in bovine liver was 0.30, mg/kg in Jamaica, but the same results were lower than that reported by Denise *et al.* (2012) who found that the concentration of zinc in bovine liver 138 mg/kg in Brazil.

9- Concentrations of toxic metals Pb and Cd in liver of Egyptian Baladi bulls and Friesian x Baladi bulls

The overall mean concentration of lead and cadmium in liver was 0.351 ± 0.14 and 0.277 ± 0.1 mg/kg, respectively (Table 7). The present results indicated that concentrations of lead and cadmium in liver crossbred bulls were significantly higher 0.464 ± 0.12 and 0.358 ± 0.08 than Baladi bulls 0.238 ± 0.02 and 0.196 ± 0.09 mg/L, respectively (Table 7), the difference was significant ($P < 0.05$). The obtained results of concentration of lead in liver was close to

the findings of that reported by and Abou Donia (2008) 0.36 mg/kg in liver of cattle collected from urban area of Egypt. However, Abou-Arab (2001) reported a higher concentration of lead in liver cattle (0.4- 0.56 mg/kg). Lower concentration of lead in the

liver cattle was reported by Denise *et al.* (2012) 0.12 mg/kg. Cadmium concentration in liver was lower than that reported by Denise *et al.* (2012) who found that concentration of cadmium in bovine liver was 0.471 mg/kg.

Table 6. Concentrations ($X \pm SE$ mg/kg, ppm) of nutritional essential metals Se and Zn in liver of Egyptian Baladi bulls and Friesian x Baladi bulls

Overall me	Friesian x Baladi bulls	Baladi bull	Elements
0.39 \pm 0.17	0.43 \pm 0.16 ^b	0.34 \pm 0.17 ^a	Se
48.2 \pm 12.4	44.8 \pm 11.1 ^b	51.5 \pm 14.2 ^a	Zn

^{a,b}: values within the same row having different superscripts are different at ($P < 0.05$).

Table 7. Concentrations ($X \pm SE$ mg/kg, ppm) of toxic metals Pb and Cd in liver of Egyptian Baladi bulls and Friesian x Baladi bulls

Overall me	Friesian x Baladi bulls	Baladi bull	Elements
0.351 \pm 0.14	0.464 \pm 0.12 ^b	0.238 \pm 0.02 ^a	Pb
0.277 \pm 0.1	0.358 \pm 0.08 ^b	0.196 \pm 0.09 ^a	Cd

^{a,b}: values within the same row having different superscripts are different at ($P < 0.05$).

CONCLUSION

The present study demonstrated that the level of cadmium metal was decreased as blood plasma selenium concentration was increased and the correlation between selenium and cadmium concentration in blood plasma of the Egyptian Baladi bulls was higher ($P < 0.05$) and negative ($r = -0.82$) than Friesian x Baladi bulls ($r = -0.24$). Positive correlation between zinc and cadmium concentration was observed in Egyptian Baladi bulls and Friesian x Baladi bulls ($r = 0.66$) and ($r = 0.95$), respectively.

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شكل العناصر المعدنية في بلازما الدم ، العضلات والكبد في العجول البلدية المصرية وخليط العجول البلدية مع الفريزيان

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أجريت هذه الدراسة لتقدير تركيزات العناصر المعدنية (السلينيوم ، الزنك ، الرصاص والكاديوم) في بلازما الدم ، العضلات و الكبد في العجول البلدية المصرية وخليط البلدى مع الفريزيان لتقدير المعادن تم استخدام جهاز الامتصاص الذرى. وأظهرت النتائج أن المتوسط العام لتركيز السلينيوم في بلازما الدم ، العضلات و الكبد في العجول البلدية وخليط كالتالي: 0.044 ± 0.019 ملليجرام/ لتر، 0.027 ± 0.039 ملليجرام/ كجم على التوالي. كان تركيز الزنك في بلازما الدم ، العضلات و الكبد في العجول البلدية وخليط 0.14 ± 0.014 ملليجرام/ لتر، 0.033 ± 0.05 ، 0.082 ± 0.012 ملليجرام/ كجم. كان المتوسط العام لتركيز المعادن السامة الرصاص و الكاديوم في بلازما الدم ، العضلات و الكبد في العجول البلدية المصرية وخليط كالتالي: 0.01 ± 0.001 ، 0.008 ± 0.0001 ملليجرام/ لتر، 0.06 ± 0.01 ، 0.049 ± 0.0023 و 0.351 ± 0.14 ، 0.277 ± 0.1 ملليجرام/ كجم على التوالي. وجد أن هناك ارتباط سالب (-0.82) (0.05) بين تركيز السلينيوم والكاديوم في بلازما الدم في العجول البلدية المصرية، لكن هذا الارتباط كان غير معنوي في العجول البلدية (-0.24) (0.05). وجد أن هناك ارتباط موجب (-0.66) (0.05) بين تركيز الزنك والكاديوم في بلازما الدم في كلا من العجول البلدية المصرية وخليط على التوالي (0.05). أظهرت الدراسة انخفاض مستوى الكاديوم في بلازما الدم كلما زاد مستوى السلينيوم ، كان هذا الارتباط بين السلينيوم والكاديوم واضحاً بدرجة عالية في بلازما الدم في العجول البلدية المصرية عن العجول البلدية.