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) and crossbred bull was (r=-0.82), 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 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. Leheskæt 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 (Bosindicus) were higher than of (Bosbaurus). 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 3000C v1.30, England, the wavelength was used 196.0 nm for (Se), 213.9 (Zn), 217.0 (Pb) and 228.8 (Cd). Measurement model: 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)

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

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
- \( \mu \) = 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, \( \sigma^2 \))

### 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 μg/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 μg/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 μg/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 0.069and 0.034 ppm, respectively.
The correlation between selenium and cadmium concentration in blood plasma of Egyptian Baladi bulls and Friesian x Baladi bulls

The linear 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.

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

Negative linear 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.

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

Positive linear correlation coefficients 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 hepatocel 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.

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

<table>
<thead>
<tr>
<th>Elements</th>
<th>Baladi bull</th>
<th>Friesian x Baladi bulls</th>
<th>Overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Se</td>
<td>0.048 ± 0.023</td>
<td>0.040 ± 0.014</td>
<td>0.044 ± 0.019</td>
</tr>
<tr>
<td>Zn</td>
<td>0.72 ± 0.12</td>
<td>0.90 ± 0.11</td>
<td>0.81 ± 0.14</td>
</tr>
</tbody>
</table>

* *: values within the same row having different superscripts are different at ($P < 0.05$).
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 of 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 µg/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 0.011and 0.002 ppm. Chronic toxicity in the human occurs at blood lead levels of about 40–60 µg/dL (Flora et al., 2012). WHO (1995) has established a Provisional Tolerable Weekly Intake (PTWI) for lead of 25 µg/kg of body weight (equivalent to 3.5 µg/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 ± SE/mg/l, ppm) of toxic metals Pb and Cd in blood plasma of Egyptian Baladi bull and Friesian x Baladi bulls

<table>
<thead>
<tr>
<th>Elements</th>
<th>Baladi bull</th>
<th>Friesian x Baladi bulls</th>
<th>Overall mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb</td>
<td>0.012 ± 0.01</td>
<td>0.011 ± 0.01</td>
<td>0.01 ± 0.01</td>
</tr>
<tr>
<td>Cd</td>
<td>0.0005 ± 0.0001</td>
<td>0.001 ± 0.001</td>
<td>0.0008 ± 0.0001</td>
</tr>
</tbody>
</table>

*: 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 Bosindicus x Bostaurus cattle muscle was 0.18 mg/kg, while the present result was higher than that.
reported by Demauw 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 García-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 were 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 García-Vaquero et al. (2011) who found that concentrations 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 Demauw 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 were 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 μg/g and 41.0 mg/kg in Brazil and USA, respectively.

| Table 4. Concentrations (X ± 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 mean    |
| Se                              | 0.168 ± 0.027   | 0.172 ± 0.031   | 0.170 ± 0.027   |
| Zn                              | 31.2 ± 3.97a    | 35.8 ± 5.84b    | 33.5 ± 5.5      |

*: values within the same row having different superscripts are different at (P <0.05).

| Table 5. Concentrations (X ± 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 ± 0.01d    | 0.07 ± 0.01e    | 0.06 ± 0.01     |
| Cd                              | 0.0029 ± 0.0007a| 0.007 ± 0.0014b | 0.0049 ± 0.0023 |

*: 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 than that in Baladi bulls 0.05± 0.01 and 0.0029± 0.0007 μg/g, 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) (0.3-4.0 mg/L). However, the present result of selenium concentration in liver was higher than that reported by Lopez-Alonso et al. (2004) and Demauw et al. (2014) 0.2 mg/L. 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 Demauw et al. (2014) 49, 47, mg/kg in Spain and Ethiopia, respectively. However, the present results are lower 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 0.35±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 0.46± 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 of 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 ± SE mg/kg, ppm) of nutritional essential metals Se and Zn in liver of Egyptian Baladi bulls and Friesian x Baladi bulls

<table>
<thead>
<tr>
<th>Overall me</th>
<th>Friesian x Baladi bulls</th>
<th>Baladi bull</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.39 ± 0.17</td>
<td>0.43 ± 0.16a</td>
<td>0.34 ± 0.17a</td>
<td>Se</td>
</tr>
<tr>
<td>0.48 ± 1.2</td>
<td>44.8 ± 11.1b</td>
<td>51.5 ± 14.2b</td>
<td>Zn</td>
</tr>
</tbody>
</table>

*ab: values within the same row having different superscripts are different at (P <0.05).

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

<table>
<thead>
<tr>
<th>Overall me</th>
<th>Friesian x Baladi bulls</th>
<th>Baladi bull</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.351 ± 0.14</td>
<td>0.464 ± 0.12a</td>
<td>0.238 ± 0.02a</td>
<td>Pb</td>
</tr>
<tr>
<td>0.277 ± 0.1</td>
<td>0.358 ± 0.08b</td>
<td>0.196 ± 0.09b</td>
<td>Cd</td>
</tr>
</tbody>
</table>

*ab: 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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