species have different concentration of minerals due to browsing and sheep favor grazing. Different plant forms of feeding behavior have been seen in goats and diagnostic tool to evaluate many ailments. Unusual body or blood plasma is commonly taken as a
regarding the concentration of minerals in the animal Ben-Shahar and Coe, 1992; Khan, 2003; Khan et
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ABSTRACT
This investigation was carried out to determine the concentrations of certain essential elements (Zn, Mg and Cu) in soil and forages from two different sites in the pasture in Sargodha, Pakistan during two consecutive seasons of the year. The purpose of this study was to evaluate the concentrations of these essential elements (Zn, Mg and Cu) in soil and forages in relation to the needs of livestock grazing therein. The results showed that mean soil and forage values of these elements generally decreased from summer to winter seasons at both sites of the pastureland. Mean forage elements were found to be lower than the requirements of livestock consuming these forages in the studied pastureland. The Cu and Zn concentrations in soil were found to be closely related to required level for forage from the soil, but Mg was higher than the required level, indicating no need of soil amendment for enhancing the level of this element in soil for forage crops. Based on these findings, it was concluded the pasture soil should be amended with Cu and Zn containing fertilizers and the ruminants feeding on those forage species should also be continually supplemented with specifically tailored mineral mixture containing these elements to avoid diseases caused by deficiency of these mineral elements.

Key words: Magnesium, Copper, Zinc, Soil, Forage.

INTRODUCTION
Suitable amount of minerals is necessary for the growth, development and high yield of animals grazing in pastures (Underwood, 1981; Khan et al., 2006, 2007a, b). Although, food containing high amount of minerals does not make sure the availability to grazing livestock (Littledike and Goff, 1987). Grazing animals acquire minerals from the forages in normal browsing situations. On the other hand insufficient amount of minerals leads to less yield of animals (Minson et al., 1976; Khan et al., 2005a, b; Khan et al., 2007). The information regarding the concentration of minerals in the animal body or blood plasma is commonly taken as a diagnostic tool to evaluate many ailments. Unusual forms of feeding behavior have been seen in goats and sheep with dietary allusion. Goats have a preference of browsing and sheep favor grazing. Different plant species have different concentration of minerals due to marked seasonal variation (Tolma et al., 1987; Ben-Shahar and Coe, 1992; Khan, 2003; Khan et al., 2004). Therefore variation in seasons and feeding sites may have influence on the concentration of minerals. Different type of disorder in animal have been related to mineral imbalances in soil due to rapid industrialization and urbanization. (Al-yemeni et al., 2011a; Ahmad et al., 2008; McGrath et al., 1997). In grazing livestock, low level of Mg and high level of K produced hypomagnesaemia disorders because of less amount of Mg assimilation in gastrointestinal cavity (Ram et al., 1998; Schouveille et al., 1999). In spite all of these, for metabolic activities proper amount of minerals were necessary for ruminant and their uptake of minerals could be determined by the absorption of minerals in forages (McDowell, 2003; Yusuf et al., 2003). To increase the animal productivity magnesium supplementation was essential (Khan et al., 2008). In Punjab mineral supplementation can improve the production of livestock. In different regions of the world, very lower concentration of micro and trace minerals in soil, forage and livestock have very intimate association (Grace et al., 1996; McDowell and Arthigton, 2005). In Pakistan, investigations regarding mineral responsive conditions among grazing ruminants are available but related survey from different agro-climatic zones are scanty. In this
investigation, difference of minerals concentration in soil and different forages were investigated to check their effect on the livestock grazing therein in relation to their requirements.

**Experimental Procedure:** The current investigation was carried out in the suburb of Sargodha, Pakistan to evaluate the soil and forage magnesium zinc and copper. Soil and forage samples were collected during two seasons, each sampling was carried out three times in each season. The lowest and highest temperature during the investigation range from 7°C to 25°C respectively, with mean precipitation during this period was 200 mm.

Four species of wild forage plants were selected for minerals investigation. The forage species were those which mostly spread in that pasture and the main source of water for irrigation for these forages was rain in this area of study.

**Preparation of samples for analytical work**

After samples were collected, soil was dried in an incubator at 60°C for one week. 1g of soil sample was digested with 4ml conc. HNO₃ and 8ml H₂O₂ in a beaker by placing the digesting material on hot plate. When fumes stop to evaporate, removed the beaker and added 2ml of H₂O₂. Again heat and the process were continued until the material became colourless. Then digested material was removed and after filtration made the volume up to 50ml with double distilled water, labeled and kept in a plastic bottle. Similarly forage samples were wet digested for mineral determination. Soil and forage minerals were determined using the atomic absorption spectrophotometry.

**Statistical Analysis**

The data obtained was statistically analyzed through a soft ware called SPSS 12 and statistical significance was tested at 0.05, 0.01 and 0.001 levels of probability as suggested by Steel and Torrie (1986).

**RESULTS AND DISCUSSION**

**Magnesium (Mg)**

**Soil:** There was noticeable sampling periods consequence (P<0.001) on Mg concentration of soil (Table 1a). Soil Mg concentration speckled considerably with inconsistent trends in decrease or increase during different sampling times. The lowest level of soil Mg were observed in January at site 1 where as highest level of Mg concentration was found in November at site 1. Regular decrease was observed from 1st period to last one period. The concentration of Mg ranged from 7.95-45.7 mg/kg during all sampling times. Mean Mg ranged from 7.955-45.7 mg/kg at site 1 while 11.9-41.7 mg/kg at site 2.

<table>
<thead>
<tr>
<th>Source of variation (SOV)</th>
<th>Degree of freedom (df)</th>
<th>Soil</th>
<th>Mean Squares</th>
<th>Forages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Site 1</td>
<td>Site 2</td>
<td>Species 1</td>
</tr>
<tr>
<td>Sampling period(Summer)</td>
<td>2</td>
<td>96.070***</td>
<td>23.830***</td>
<td>28.6***</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>0.181</td>
<td>0.114</td>
<td>0.466</td>
</tr>
<tr>
<td>Sampling period(Winter)</td>
<td>2</td>
<td>53.192***</td>
<td>20.898***</td>
<td>9.436*</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>0.095</td>
<td>0.156</td>
<td>1.736</td>
</tr>
</tbody>
</table>

Data is expressed as mean squares significant at (P<0.05-P<0.001), vs. control where *=0.05, **=0.01, ***=0.001. ns= non significant

Species 1 = *Dactyloctenium aegyptium*
Species 2 = *Calotropis procera*
Species 3 = *Parthenium hysterophorus*
Species 4 = *Eragrostis pilosa*

**TABLE 1b:** Variation of Mg level in summer and winter soil at two different sites (Site 1 = contaminated site, Site 2 = uncontaminated soil)

<table>
<thead>
<tr>
<th>Soil Sample period</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>40.56600±0.194</td>
<td>38.80875±0.188</td>
</tr>
<tr>
<td>Nov</td>
<td>45.70750±0.185</td>
<td>41.71375±0.217</td>
</tr>
<tr>
<td>Dec</td>
<td>35.91000±0.251</td>
<td>36.86375±0.055</td>
</tr>
<tr>
<td>Jan</td>
<td>7.95500±0.068</td>
<td>13.12375±0.303</td>
</tr>
<tr>
<td>Feb</td>
<td>15.17625±0.213</td>
<td>16.39125±0.153</td>
</tr>
<tr>
<td>Mar</td>
<td>10.68000±0.143</td>
<td>11.98875±0.034s</td>
</tr>
</tbody>
</table>
TABLE 2b: Variation of Cu level in summer and winter soil at two different sites (Site 1= contaminated site, Site 2= uncontaminated soil)

<table>
<thead>
<tr>
<th>Soil Sample period</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>3.47625±0.187</td>
<td>3.11875±0.043</td>
</tr>
<tr>
<td>Nov</td>
<td>2.81575±0.066</td>
<td>3.79500±0.098</td>
</tr>
<tr>
<td>Dec</td>
<td>2.92888±0.026</td>
<td>3.37400±0.136</td>
</tr>
<tr>
<td>Jan</td>
<td>0.21575±0.004</td>
<td>0.55500±0.083</td>
</tr>
<tr>
<td>Feb</td>
<td>0.2500±0.02</td>
<td>0.37575±0.007</td>
</tr>
<tr>
<td>Mar</td>
<td>2.35500±0.116</td>
<td>0.17925±0.005</td>
</tr>
</tbody>
</table>

In the current investigation the soil Mg level was parallel to those standards reported previously by different researchers (Cuesta et al., 1993; Tiffany et al., 2001). All the soil samples of summer season analyzed were above the critical level of 30 mg/kg for Mg concentration (Rhue and Kidder, 1983). It was appropriate for the necessities of grazing ruminants. Likewise our values were in contrast to the values as reported by Hanlon et al. (1990). The concentration of Mg was below in winter season so in winter there was need of fertilizers application. They need no fertilizers for pastures imminent.

Forage

Analysis of variance shows that Mg concentration was affected (P<0.05, P<0.001)) significantly by the sampling periods of only one forage while non-significantly affected on all other
FIG 2a: Copper level fluctuations in soil at different sampling periods

FIG 1b: Magnesium level fluctuations in forage at different sampling periods
FIG 2b: Copper level fluctuations in forage at different sampling periods.

TABLE 3a: Analysis of variance for Zn concentrations in soil and forage at different sampling intervals.

<table>
<thead>
<tr>
<th>Source of variation (SOV)</th>
<th>Degree of freedom (df)</th>
<th>Soil Mean Squares</th>
<th>Forages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Site 1</td>
<td>Site 2</td>
</tr>
<tr>
<td>Sampling period(Summer)</td>
<td>2</td>
<td>0.090***</td>
<td>0.573***</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>0.004</td>
<td>0.059</td>
</tr>
<tr>
<td>Sampling period(Winter)</td>
<td>2</td>
<td>0.015***</td>
<td>0.001ns</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Data is expressed as mean squares significant at (P<0.05-P<0.001), vs. control where *=0.05, **=0.01, ***=0.001.

Species 1= Dactyloctenium aegyptium
Species 2= Calotropis procera
Species 3= Parthenium hysterophorus
Species 4= Eragrostis pilosa

TABLE 3b: Variation of Zn level in summer and winter soil at two different sites (Site 1= contaminated site, Site 2= uncontaminated soil)

<table>
<thead>
<tr>
<th>Soil Sample period</th>
<th>Site 1</th>
<th>Site 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct</td>
<td>1.47150±0.012</td>
<td>2.68625±0.156</td>
</tr>
<tr>
<td>Nov</td>
<td>1.68500±0.051</td>
<td>1.94225±0.068</td>
</tr>
<tr>
<td>Dec</td>
<td>1.39500±0.006</td>
<td>2.43375±0.123</td>
</tr>
<tr>
<td>Jan</td>
<td>0.33175±0.016</td>
<td>0.27825±0.005</td>
</tr>
<tr>
<td>Feb</td>
<td>0.43925±0.013</td>
<td>0.25750±0.014</td>
</tr>
<tr>
<td>Mar</td>
<td>0.33650±0.008</td>
<td>0.25300±0.020</td>
</tr>
</tbody>
</table>

The mean values ranged from 3.2-7.9 mg/kg in Dactyloctenium aegyptium in summer and 4.6-7.6 mg/kg in winter, 8.7-10.5 mg/kg in Calotropis procera in summer and 0.24-0.58 mg/kg, 7.3-10.2 mg/kg in Parthenium hysterophorus in summer and 8.4-11.7 mg/kg in winter, 4.2-4.5 mg/kg in Eragrostis pilosa in summer and 0.55-0.59 mg/kg in winter.

Lowest Mg concentration was found during winter and highest Mg concentration was observed in summer. Our values were below the critical limit reported by McDowell et al., (1984) as 0.20%. The values of present study is higher than the values reported by Prabowo et al. (1990) and below from the values already established by Fujihara et al. (1992) and Khan et al. (2009). The present study showed that the level of Mg were in the safe limit.

Copper (Cu)

Soil: Soil Cu concentration data was affected significantly (P<0.05) by sampling periods at site 1
but more significant \(P<0.001\) at site 2 (Table 2a). The value of soil Cu content ranged from 0.21 to 3.47 mg/kg at site 1 while 0.17 to 3.79 at site 2. The concentration of Cu in soil decreased continuously during summer to winter but a sudden increase in March at site 1 (Fig 2a).

The standards found all through at hand study were elevated than the critical value of 0.3 mg/kg by (Rhue and kidder, 1983; McDowell, 1984; Rojas, 1993). And also lower than the values already observed by Jerez et al. (1984) in Florida. The values were similar to the critical level studied by Khan et al. (2008).

Forage: The analysis of variance for Cu concentration in case of forage indicated significant effect \(P<0.05\) during summer but significant \(P<0.001\) during winter (Table 2a). The mean values ranged from 1.49-2.3 mg/kg in Dactyloctenium aegyptium in summer and 3.5-4.3 mg/kg in winter, 1.4-2.73 mg/kg in Calotropis procera in summer and 0.31-0.66 mg/kg, 1.17-1.64 mg/kg in Parthenium hysterophorus in summer and 0.003-0.005 mg/kg in winter. The values were lower than critical value suggested as 8 mg/kg and 10 mg/kg by (Merkel et al., 1990; Anon, 1996, 2006; Rhue and kidder, 1983). The variation in Cu forage concentration from 1\(^{st}\) to last sampling period illustrates inconsistent pattern. Low concentration of Cu in forages grazed by ruminants in the study area was indicative of quantity and availability of this element in soil (Reid and Horvath, 1980). Data seemed to demonstrate that the Cu concentration of forage species were affected by the soil, where they were grown. This finding corroborate with findings of Norton and Poppi (1995) that they reported trace mineral values of forages were more indicative of the soil types than any other factor. High Mo (molybdenum) intake depressed Cu availability and may produce physiological changes in ruminants (Underwood and Suttle, 1999).

The values was almost similar to the values observed by (Dey et al., 1996) when he was working on the plants under polluted area of industry in India. He examined mean concentrations of metals like lead, copper and cadmium as 46, 1.116 and 1.075 mg/kg respectively.

Zinc (Zn)

Soil: Analysis of variance for soil exhibited significant effect \(P<0.001\) of sampling periods (Table 3a). Soil Zn amounts were different at all sampling periods. This variation was mainly the result of leaching of Zn with water.

Total content of Zn metal in soil was determined by wet digestion of concentrated acid
FIG 3b: Zinc level fluctuations in forage at different sampling periods

and measured on Atomic Absorption Spectrophotometer. Mean content in soil ranged from 0.33-1.68 at site 1 and from 0.25-2.68 mg/kg at site 2. The highest soil Zn was found at site 2 in summer season. Critical level for Zn is 0.5 mg/kg by (Sanchez, 1976; Anon, 1980). The values of winter season were similar to this investigation but in summer slightly above values were found. Zn level in summer was similar to values given by Rhue and Kidder, 1983. So there is no need of any fertilizer for Zn level balance.

According to Dabkowsca Naskret et al. (2004), low level of available Zn because in neutral soil is due to the form of Zn bound to Iron oxide (FeO) making it unavailable to plants, but in our study sufficient amount of Zn was found than the normal requirement for plant growth.

Forage: The forage Zn concentration rendered non significant effect during different sampling intervals (Table 3a). Zn content in forage was highest during summer season rather than winter. However, zinc showed inconsistent trend in increase or decrease at different sampling times. Its values varied from 9.11-12.1 mg/kg in Dactyloctenium aegyptium, 3.96-6.5 mg/kg in Calotropis procera, 14.6-18.5 mg/kg in Parthenium hysterophorus and 10.8-13.4 mg/kg in Eragrostis pilosa in winter season. All the forage values were deficient than the critical level established for ruminants by NRC (1996). Zn content of forage was fairly lower than the standard. Similar forage Zn concentration in forage had been reported by Fujihara et al. (1992) in China and Espinoza et al. (1991) in Florida.

Its values varied from 14.6-15.7 mg/kg in Dactyloctenium aegyptium, 13.6-16.8 mg/kg in Calotropis procera, 0.29-0.52 mg/kg in Parthenium hysterophorus and 3.2-3.73 mg/kg in Eragrostis pilosa in winter season. Zn values were lower than reported by (McDowell et al., 1982). These values for forage Zn were lower than those had already being reported by (Tiffany et al., 2001) in Florida.

All the forage values were deficient than the critical level established for ruminants by NRC (1996). Zn content of forage was fairly lower than the standard. Similar forage Zn concentration in forage had been reported by Fujihara et al. (1992) in China and Espinoza et al. (1991) in Florida.

Zn concentration may be occasionally as high as 30 ppm. But this can decline rapidly as plant matures (McDowell et al., 1982). Contrary to present findings various workers has reported higher values of Zn in forages (Khan et al., 2007; Prabowo et al., 1990). Zn concentration was comparatively less in broad leaved plants as compared to grasses (Malik et al., 2010).
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