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INFLUENCE OF DIETARY COPPER SUPPLEMENTATION ON GROWTH PERFORMANCES OF RUMINANT ANIMALS: REVIEW

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Abstract
Copper is an essential trace element required by animals for numerous functions such as its growth promoting effect. Cu supplemental diets significantly improved the growth performance such as the dry matter intake (DMI), feed conversion ratio (FCR) and average daily weightgain (ADG) of animals favouring the ideal rumen Cu concentration essential to enhance rumination. Mineral supplementation is essential to livestock in order to overcome the detrimental influences it has on animal performance.
In conclusion, for the fact ruminants are more vulnerable to copper deficiency than any other living organism simply because of the complex nutritional interaction occurring in the rumen, thus this necessitated the need to always supplement dietary copper in their diet.
Keywords: Antagonisms, Ceruloplasmin, **Hypocuprosis**, **Immunity**, **Rumen**, **Thiomolybdate**.

INTRODUCTION

Copper (Cu) are micronutrients required in very minute amounts having important roles in the body metabolic activities, growth, production and reproduction. Ruminants often develop signs of copper deficiency simply known as hypocuprosis in cases where the Cu level >10ppm. This occurs when copper antagonists are high in ingested diet. Minerals that antagonize Cu include molybdenum (Mo), sulphur (S) and iron (Fe) (Suttle, 2010). Primary Cu deficiency is simply described as the inadequate intake of copper while secondary Cu deficiency is when the less supply of copper in pastures is due to dietary interfering factors. When the ratio of Cu to Mo ranges from 5 to 1 or 10 to 1, cattle perform wonderfully. In addition, secondary Cu deficiency is as a result of the excess amount of molybdenum coupled with sulphur (S), thus, forming thiomolybdate complexes; poorly absorbed from the lower gastro intestinal tract (Ahmad *et al.,* 2009). Molybdenosis is simply referred to high molybdenum levels in the blood causing looseness of bowels in cows. Higher level of Mo content had been reported by Mills *et al.* (1976) to cause Cu insufficiency in ruminants. Although cupric sulfate had been referred to as the standard source of copper supplementation, in which other copper sources are compared to (Spears, 2003). In an experiment conducted by Ward *et al.* (1996), copper proteinate was more bioavailable than cupric sulfate in cattle fed diets containing high level of molybdenum but not in others (Wittenberg *et al.,* 1990). Monogastric animals are capable of absorbing 30-75% while adult ruminants absorbed 1-10% of the dietary copper supplied. However, before the functional rumen fully developed, copper absorption can be as high as 70-85% of the dietary copper supplied in ruminants (Underwood and Suttle, 1999; Linder, 2002). Complex interactions occurring in the rumen compartment had been attributed as the major cause of low absorption

of copper in adult ruminants (Spears, 2003), thus includes Cu-S-Mo (Suttle, 2010), and Cu-S (Arthington and Pate, 2002) antagonisms. Dietary copper needed to supply Cu requirements for maintenance, growth and lactation varies with the age of the animal, the chemical form of dietary Cu and the presence of dietary substances interfering with Cu absorption.

Influence of Copper supplementation on growth performances

The growth promoting effect of Cu is well established and is amply reviewed by different researchers (Wittenberg *et al.,* 1990; McDowell, 1992; Aina *et al.* 2010). Mineral supplementation is essential to the livestock in order to overcome the detrimental influences it has on animal performance. Several reports had

revealed that minerals supplementation improved animals' performance (Lall *et al.*, 2000). In a previous study conducted by Ward *et al.* (1993) on steers, the growth rate of animals fed $CuSO_4$ supplemented diet was higher when compared with those fed Cu-lysine supplementations within the first 21 days while no disparity were recorded after 98 days. More so, other parameters such as feed efficiency, feed intake, humoral, cellular immune response and ceruloplasmin activity, were not influenced by Cu source (Ward *et al.*, 1993). Higher weight gain was reported for steers on Cu proteinate supplementation (Wittenberg *et al.*, 1990). Datta *et al.* (2007) reported an increased higher body weight gain for goat kids fed organic Cu supplemented diet when compared with those fed inorganic Cu supplementation. Aina *et al.* (2010) reported an increase in weight gain for West African dwarf sheep fed different copper ($CuSO_4$ and $CuNO_3$) supplemented diet. Thus, agreed with Asare-Bediako and Aina (2013) who reported that Cu supplemental diets improved growth performance of animals in such a way that dry matter intake (DMI), feed conversion ratio (FCR) and average daily weightgain (ADG) were significantly higher in the Cu treated group when compared with those in control. This was attributed to the fact that Cu supplemental diets might have provided the ideal rumen Cu concentration essential to enhance rumination. The faster growth rate of Cu supplemented groups might be due to improved feed utilization rather than feed consumption. Feed consumption among Cu-treated group seemed to show similar even though, growth performance differed. Significantly improved DMI and feed conversion ratio (FCR), eventually improved average daily weight gain (ADG) of goats offered Cu salts-based diets. More so, finishing cattle fed Cu supplementation had increased performance (Engle and Spear, 2000). Furthermore, Zhang *et al.* (2007) reported an increase in average daily weight gain and feed efficiency of cashmere goats fed a basal diet containing 7.38mg Cu/kg DM supplemented with 10mg Cu/Kg DM. Although the observation of Cheng *et al.* (2008) contradicted the observation of previous researchers who reported Cu supplementation at 10 or 20 mg/kg DM had no effect on the weight gain and feed efficiency of lambs. Luginbuhl *et al.* (2000) also reported that 10 or 30 mg Cu kg DM over 88 days had no effect on average daily feed intake and daily weight gain of weaned goat kids. Contradicting performance results exist in ruminant fed Cu supplemented diets and the reasons for this variation were ambiguous because several factors could potentially influence an animal's response to Cu supplementation; forms of Cu supplementation (either organic or inorganic), the absence and presence of dietary Cu antagonists (S, Mo, Zn, Fe), initial Cu status of the animal, environmental and health factors, Cu supplemental level and the experimental diets (Arthington and Pate, 2002) and lastly the breed differences in Cu metabolism (Mullis et al., 2003). In the presence of adequate amount of elemental Zn in the system, excessive Cu might not influence daily weight gain in the prehaemolytic period(Zervas *et al.*, 1990).In addition to the essential roles played by Cu in metabolic processes, thus it can also produce pharmacological responses under certain conditions which may improve animal's performance. The performance response to Cu in this present study, as reported by Solaiman *et al.* (2006; 2007), may have been pharmacological rather than physiological.

Conclusions

Ruminants are more vulnerable to copper deficiency because of the complex nutritional interaction occurring in the rumen. However, in order to overcome these detrimental influences on animal performance, there is need to always supplement dietary copper in ruminant's diet.

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