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IMPORTANCE OF TRACE ELEMENTS IN ANIMAL REPRODUCTION: A REVIEW

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Abstract: Importance of trace elements in livestock nutrition is undisputed. As the name implies, even small amounts of these elements have large and diverse effects on the animal organism. The function of enzymes and hormones is essentially linked to trace elements. These trace elements, though required in minute quantities, are essential for maintaining reproductive health. They are involved in growth, production and reproduction. Trace elements act as cofactors of enzymes which are important to the reproduction of animal. Superoxide dismutase, glutathione reductase, glutathione peroxidase, thioredoxin reductase, ceruloplasmin and catalase are important enzymes that have trace elements as cofactors. Overall, trace elements improve reproductive performance and reproductive health.

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INTRODUCTION

The mineral constitute only one of the groups of nutrients that play important parts in animal nutrition. Some mineral elements, like calcium and phosphorus, are needed in large amounts, while others, like iodine, are required only in very minute traces. Out of these the seven main trace elements include copper, iron, zinc, cobalt, iodine, manganese and selenium.[1] Iron (1.0-2.0 ppm) is most abundant in serum followed by zinc (0.8-1.2 ppm) [1,2] and copper (0.57-1.0). Along with these cobalt (1-3 µg/dl), iodine (2.4-14 µg/100ml), manganese (18-19 µg/dl) and selenium (50-220 ng/L) are required in least amounts [1,2]. As the required in minute amounts, they are highly essential for health and immunity.[2,3] They contribute to growth [4,5], production [4,6,7] and reproduction [2,8]. Trace elements act as cofactors of enzymes like superoxide dismutase (SOD) [9,10], glutathione reductase, glutathione peroxidase, thioredoxin reductase [11,12], ceruloplasmin [13] and catalase [14]. These enzymes are important to maintain the immunity of animals [4,15]. They act as antioxidants [2,16] and prevent oxidative stress by neutralizing oxidants produced under different stresses like environmental or production stress or stress related to infections or diseases [4]. Trace minerals mainly needed for reproduction.

REPRODUCTION

Trace elements are essential for reproduction Earlier Manspeaker et al. [19] reported that importance of trace minerals in reproduction in cattle. Rabiee et al. [17] reported higher conception rates with organic trace elements in cattle. Trace minerals are important for reproductive performance in livestock [20] because their supplementation improves reproduction [21]. Studies show that the ovarian activity of ruminants is influenced by mineral deficiency [11].They are also involved in synthesis of hormones that are important for reproduction. Their deficiency affects both steroid [11] and thyroid [22] hormone production.

For reproduction the most important trace elements are copper and zinc play an important role in regulating progesterone production by luteal cells via involvement of superoxide dismutase [23]. Copper is also involved in steroidogenic enzymes cytochrome P_{450}, 17α-hydroxylase and cytochrome P_{450} side-chain cleavage and lysyl oxidase [24]. Copper deficiency impairs secretion of tyrosine hydroxylase and dopamine beta-enzyme systems which are both copper containing, in the hypothalamic neurons. This causes inhibition of synthesis of thyroid hormone releasing factor. The copper containing peroxidase enzyme of the thyroid gland impairs thyroid hormone secretion [32].

Zinc is involved in the reorganization of ovarian follicles which are the source of progesterone. This occurs through the involvement of metalloproteinase-2 (MMP-2) enzyme, which is a member of zinc endopeptidase family [25]. Zinc also plays an important role in the secretion and function of male hormone testosterone through the enzymes that control the arachidonic acid

cascade [26,27]. Zinc is required for thyroid hormone secretion and function. Overall the zinc plays an essential role in sexual development and spermatogenesis. Involvement of manganese in the synthesis and production of oestrogen and progesterone may be due to the fact that it acts as a cofactor in the synthesis of cholesterol, a precursor for steroids, including estrogen and progesterone [18]. Inadequate zinc levels have been associated with decreased fertility, abnormal oestrus, and abortions [30,31]. Slight decrease in serum levels of zinc and copper may induce or predispose animals to repeat breeding and anoestrus. Organic minerals have a beneficial role to play in the resumption of follicular growth and fertility in dairy cows. Importance of trace elements in reproduction has been widely reported [8].

Iron which is also plays an important role in ovarian activity [28]. Positive correlation was reported between serum progesterone level and copper-zinc in cows [29]. Also this trace elements are important for reproduction [17,27] also via contributing to the normal health of reproductive organs and reproductive cycles. Selenium is important in normal cattle production systems as its apparent direct link to postpartum uterine involution. The important trace mineral copper, iron and zinc are all important for thyroid hormones due to their role in synthesis or conversion of thyroid hormones [22]. Iron deficiency lowers thyroid peroxidase (TPO) activity and thereby interferes with iodine metabolism in the thyroid [32]. The T_3 receptor is thought to require zinc to adopt its biologically active conformation. Some of the effects of zinc deficiency, therefore, may be due to loss of zinc from the T_3 receptor and the subsequent impairment of T_3 action [33]. The role of seleno-proteins in thyroid hormone synthesis is well known [34-38].

CONCLUSION

Trace elements are essential not only for health, growth and production but also for normal the reproduction. They are essential for functioning of a number of components of the reproductive system. Thus, they contribute to maintaining proper reproductive health. They are important for functioning of a number of enzymes and proteins which are involved in many physiological and biochemical processes of reproduction. These physio-biochemical processes are also related to growth and production. Hence trace elements affect the reproductive health of animals.

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