**COPPER DEFICIENCY:**

**- ETIOLOGY**

Copper deficiency may be primary , when the intake in the diet is inadequate, or secondary (conditioned) when the dietary intake is sufficient but the utilization of the copper by tissues is impeded.

**- Primary copper deficiency:**

 The amount of copper in the diet may be inadequate when the forage is grown on deficient soils or on soils in which the copper is unavailable. **Secondary copper deficiency:**

 In secondary copper deficiency, the amount of copper in the diet is adequate, but conditioning dietary factors interfere with the utilization of the copper.

A high molybdenum intake can induce copper deficiency even when the copper content of the pasture is quite high and a higher copper intake can overcome the effect of the molybdenum , also Zinc, iron, lead, calcium carbonate and Dietary inorganic sulfate are also conditioning factors. the administration of selenium to sheep on copper-deficient pastures increases copper absorption and improves the growth rate of lambs. The use of zinc sulfate for the control of facial eczema may cause a depression of plasma

copper.

**Risk factors :**

Several factors influence the plasma and tissue concentrations of copper , particularly in ruminants, including:

1- Age of animal 2- Demands of pregnancy and lactation

3- Stage of growth,4- Mineral composition of feed

5- Season of the year,6- Soil characteristics and its mineral composition

7- Breed of animal ,8- Concentration of minerals, such as sulfur and molybdenum, which can interfere with the availability of copper.

**-PATHOGENESIS:**

**1-Effects on tissues.**

The consequences of hypocuprosis include a failure of copper metalloenzymes, many of which form part of the antioxidant defense system such as copper/zinc superoxide dismutase (Cu/Zn SOD) , ceruloplasmin, and cytochrome oxidase activity Copper , as well as other essential trace elements, is an atypical antioxidant because it functions indirectly. Copper is acatalytic cofactor for Cu/Zn SOD and ceruloplasmin. Cu/Zn SOD catalyzes dismutation of the superoxide anion Copper deficiency can affect the antioxidant defense system resulting in oxidative damage to cellular components. The activity of Cu/Zn SOD and glutathione peroxidase is decreased in animals with copper deficiency.

**2-Chromosomal abnormalities**

 The association between copper deficiency and DNA damage in cattle has been examined copper deficiency in cattle is associated with an increase in the frequency of chromosomal aberrations as well as in DNA migration.

 **3-Wool**

The straightness and stringiness of this wool is due to inadequate keratinization, probably due to imperfect oxidation of free thiol groups. Provision of copper to such sheep is followed by oxidation of these free thiol groups and a return to normal keratinization within a few hours.

**4-Body weight:**

In the later stages of copper deficiency, the impairment of tissue oxidation causes interference with intermediary metabolism and loss of condition or failure to grow .

**5-Diarrhea:**

The pathogenesis of copper deficiency in causing diarrhea is uncertain and there is little evidence that a naturally-occurring primary copper deficiency will cause diarrhea. There are no histological changes in gut mucosa, although villous atrophy is recorded in severe, experimentally produced cases. Diarrhea is usually only amajor clinical finding in secondary copper

deficiency associated with molybdenosis.

**6-Anemia**

The known importance of copper in the formation of hemoglobin accounts for the anemia in copper deficiency. The presence of hemosiderin deposits in tissues of copper-deficient animals suggests that copper is necessary for the reutilization of iron liberated from the normal break down of hemoglobin. There is no evidence of excessive hemolysis in copper-deficiency states. Anemia may occur in the later stages of primary copper deficiency, but is not remarkable in the secondary form.

**Bone7-**

The osteoporosis that occurs in some natural cases of copper deficiency is

caused by the depression of osteoplastic activity, Copper deficiency in foals

 causes severe degenerative disease of cartilage characterized by breaking of articular and growth plate cartilage.

**8- Connective tissue**

Copper is a component of the enzyme lysyl oxidase, secreted by the cells involved in the synthesis of the elastin component of connective tissues and has important functions in maintaining the integrity of tissues such as capillary beds, ligaments, and tendons.

**9-Heart**

The myocardial degeneration of falling disease may be a terminal manifestation of anemic anoxia, or be due to interference with tissue oxidation.

**10-Blood vessels**.

Experimentally produced copper deficiency has also caused sudden death due to rupture of the heart and great vessels in a high proportion of pigs fed a copper deficient diet.

**11. Pancreas**:

Lesions of the pancreas may be present in normal cattle with a low blood copper status. The lesions consist of an increase in dry matter content and a reduction in the concentrations of protein and copper in wet tissue.

**12-Nervous tissue**

Copper deficiency halts the formation of myelin and causes demyelination in lambs, probably by a specific relationship between copper and myelin sheaths.

**13-Immune system:**

 Copper is an essential trace mineral with an import ant role in the immune response but the precise mechanism is not well understood. Copper deficiency results in decreased humoral and cell-mediated immunity, as well as decreased non-specific immunity regulated by phagocytic cells, such as macrophages and neutrophil, The decreased resistance to infection in sheep is responsible for treatment with copper and genetic selection.

**- Copper -molybdenum-sulfate** **relationship**:

The interaction between copper , molybdenum, and sulfur in ruminant nutrition is unique in its effects on health and production. Copper, molybdenum, and sulfur from organic or inorganic sources can combine in the rumen to form an un absorbable triple complex, copper tetrathiomolybdate and deplete the host tissues of copper. It is proposed that thiomolybdates form in the rumen from the reaction of dietary molybdenum compounds with sulfides produced from the reduction of dietary sulfur compounds by rumen bacteria. The thiomolybdates reduce the absorption of dietary copper from the intestine and also inhibit a number of copper-containing enzymes, including ceruloplasmin, cytochrome oxidase and superoxide dismutase.

Copper utilization :

Sulfate and molybdate can interfere with mobilization of copper from the liver , inhibition of copper intake by the tissues, inhibition of copper transport both into and out of the liver and inhibition of the synthesis of copper-storage complexes.

Hepatic storage:-

The copper status of the liver depends on whether the animals are receiving adequate dietary copper. With adequate dietary levels, the liver copper levels are less in the presence of molybdate and sulfate.

**CLINICAL FINDINGS:-**

The general effects of copper deficiency are the same in sheep and cattle, **General syndrome**:

- Primary copper deficiency :

 Primary copper deficiency causes unthriftiness, loss of milk production, and anemia in adult cattle. The coat color is affected red and black cattle changing to a bleached rusty red and the coat itself becomes rough and staring calves grow poorly and there is an increased tendency for bones to fracture, particularly the limb bones and the scapula. Ataxia may occur after exercise, with a sudden loss of control of the hind limbs and the animal falling or assuming a sitting posture. Itching and hair-licking are also recorded as manifestations of copper deficiency in cattle Although diarrhea may occur, persistent diarrhea is not characteristic of primary copper deficiency and its occurrence should arouse suspicion of molybdenosis or helminthiasis.

**Secondary copper deficiency** This syndrome includes the signs of primary copper deficiency, except that anemia occurs less commonly, probably due to the relatively better copper status in the secondary state, anemia being largely aterminal sign in primary copper deficiency.

**-Falling disease**

The characteristic behavior in falling disease is for cows in apparently good health to throw up their heads, bellow, and fall Death is instantaneous in most cases, but some fall for a few minutes with intermittent bellowing and running movement attempts to rise. Rare cases show signs for up to 24 h or more. These animals periodically lower their heads and pivot on the front legs Sudden death usually occurs during one of these episodes.

**- Peat scours ('teart)**

Persistent diarrhea with the passage of watery , yellow-green to black feces with an inoffensive odor occurs soon after the cattle go on to affected pasture, in some cases within 8-10 days. The feces are released without effort, often without lifting the tail. Severe debilitation is common' although the appetite remains good The hair coat is rough and depigmentation is manifested by reddening or gray flecking especially around the eyes, in black cattle.

**- Unthriftiness (pine) of calves :**

 The earliest signs are a stiffness of gait and unthriftiness. The epiphyses of the distal ends of the metacarpus and metatarsus may be enlarged and resemble the epiphysitis of rapidly growing calves deficient in calcium and phosphorus vitamin D or

**- Swayback and enzootic ataxia in lambs and goat kids:**

 These diseases have much in common Swayback is the only authentic manifestation of a primary nutritional deficiency of copper . The incidence can vary greatly among breeds of sheep reflecting the genetic differences in copper metabolism both between and within breeds of sheep. Enzootic ataxia affects only unweaned lambs. In severe outbreaks, the lambs may be affected at birth, but most cases occur in the 1-2-month age group The first sign to appear in enzootic ataxia is incoordination of the hindlimbs, appearing when the lambs are driven. Respiratory and cardiac rates are also greatly accelerated by exertion. As the disease progresses, the incoordination becomes more severe and may be apparent after walking only a few yards. There is excessive flexion of joints, knuckling over of the fetlocks, wobbling of the hind quarters and finally falling.

**Necropsy findings**

 Anemia, emaciation, hemosiderosis, osteodystrophy, demyelination in enzootic ataxia, myocardiopathy.

**Diagnostic confirmation**

 Low serum and hepatic copper and response to treatment.

**Differential diagnosis list**

Copper deficiency must be differentiated from herd problems associated with the following clinical findings:

• Unthriftiness due to intestinal parasitism

• Malnutrition due to energy-protein deficiency

• Lameness caused by osteodystrophy due to calcium, phosphorus, and

 vitamin D im balance

• Anemia

• Neonatal ataxia in lambs (congenital swayback and enzootic ataxia) from

 border disease; cerebellar hypoplasia (daft lamb disease); hypothermia;

 meningitis

• Sudden death due to other causes .

**Treatment** Copper sulfate orally; copper glycinate parenterally.

**Control** Provide source of copper by oral dosing or dietary supplementation in feed or on pasture. Parenteral administration of copper at strategic times. Copper oxide needles orally for prolonged effectiveness. Genetic selection. Removal of sulfates from water supply.