

## Vitamin C Deficiency in Guinea Pigs

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ARTICLE ID: 54

### Abstract

Vitamin c also known as ascorbic acid is an water soluble vitamin and a deficit vitamin in species such as: Guinea pigs, humans, some primates (monkeys, apes, birds like parrot, and cockatiels) which are unable to synthesize it are at high risk of diseases of species of immune system, musculoskeletal system and cardiovascular system; so have to be given dietary supplementation of vitamin c on regular basis. Alex Holst and Theodor frolic by chance produce scurvy in guinea pigs in 1928. Albert szent gyorgyi isolate a substance from adrenal gland and named it hexuronic acid. Four year later Charles glen king isolate vitamin c in lab and concluded that it is same as hexuronic acid.

**Keywords:** collagen, elastin, laminin, vitamin c, mutation, antioxidant, musculoskeletal system.

### Introduction

Vitamin c present in lemon and orange juice has been known to prevent scurvy in human beings of which haemorrhage constitute as the most important clinical finding. It is necessary for collagen synthesis, which is essential to support blood vessel, cartilages, capillary walls, in case of deficiency they become very fragile. Gingivitis, hip dysplasia, and various locomotor diseases are very commonly encountered abnormalities in scorbutic guinea pigs and other animals unable to synthesize it. Vitamin c is also an essential product of vegetable and fruits, but alkali and oxygen tend to destroy it and it is a heat labile vitamin. Some lesion of

vitamin c deficiency is remarkably like vitamin a deficiency, but difference is in increased capillary fragility, and extensive haemorrhage in areas of bone growth. Wound healing is also impaired in of deficiency due to immature fibroblast {help in fibroblast maturation} which help in formation of collagen and important for treatment of hip dysplasia due to weakening if supporting cartilages.

### **Physiological function**

Vitamin c performs various physiological functions in body. It is the most powerful reducing agent available to cells and is of general importance in as an antioxidant because of its high reducing potential it serves as an electron donor to various enzymatic reactions especially hydroxylation (necessary for the formation and cross linking of hydroxy proline and hydroxylysine) and mediation. It is particularly important for collagen synthesis and conversion of lysine to carnitine {help mitochondria keep in pace with demand of energy} and folic acid to folinic acid. promotes amidating activity of enzyme which is involved in processing of certain peptide hormones e.g., oxytocin, vasopressin, and cholecystokinin. Help in reduction of ferric to ferrous ion thus assist in absorption from GI tract. It is present in high concentration in immune cells and consumed quickly during infections and modulates phagocytosis and production of cytokines and lymphocytes. It is also known as natural antihistamines as it increases its detoxification.

### **Etiopathology and effects of hypovitaminosis c in guinea pigs**

Vitamin c deficiency led to impaired production of collagen, laminin, elastin causing various type of physical and physiological problems ranging from lameness due to painful swollen joint to dental, skin, digestive, problems. As vitamin c is known to maintain the morphological appearance of endothelium and smooth muscles components in guinea pigs blood vessel and help in collagen synthesis and blood vessel elasticity, but in case of vitamin c deficiency in guinea pigs leads to the expression of the protein which help in the synthesis of the collagen specifically type IV collagen fibre there is also decreased expression of the type-I and type-ii collagen in other tissue. Type IV collagen fibre which has a triple helical collagenous structure is one of the major components of endothelial basement membrane which it serves as a structural and functional unit. It interacts with other protein of basement membrane endothelial cells from both arteries and veins. Another structure expressed in blood

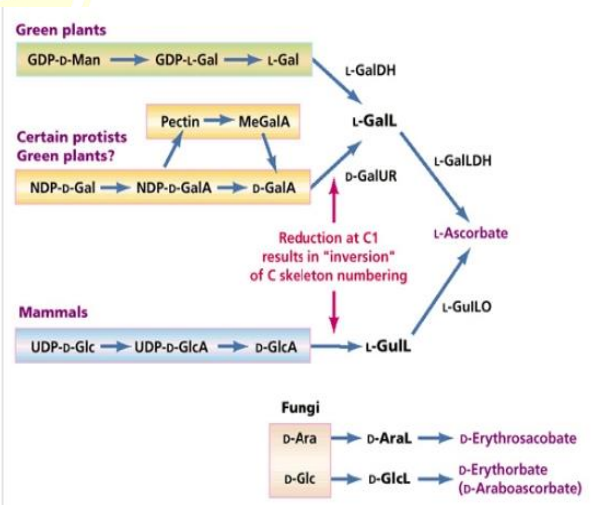
vessel laminin which also play a key role in basement membrane proliferation and differentiation. It is a cross shaped molecule having three separate polypeptide chain  $\alpha$ ,  $\beta$ ,  $\gamma$ . Elastin is also an important structure synthesised by smooth muscle in tunica media as soluble precursor known as tropoelastin.

- Vitamin c deficiency also hampers digestive and absorptive functions in Guinea pigs.
- Vitamin c deficiency also affects the absorption of copper in liver.
- Guinea pigs do not have the gene necessary to produce L-gulonolactone oxidase, which is required for converting L-gulonolactone to L-ascorbic acid. Ascorbic acid is essential in hydroxylase reactions that are necessary for the formation and cross-linking of hydroxyproline and hydroxylysine in collagen. Additionally, it is necessary for the metabolism of amino acids, carbohydrates, and cholesterol to bile acids.
- A deficiency in ascorbic acid can cause fragmentation of collagen and intercellular ground substance.

#### Biosynthesis of vitamin c and its loss of synthesis in guinea pigs

Vitamin c biosynthesis is a cascade mechanism in which a substrate is converted into product and product of first reaction become the substrate for second reaction until final product is obtained.

- In case of guinea pigs the last crucial step in i.e., the conversion of L-gulonolactone into vitamin c which is catalysed by the enzyme gulonolactone oxidase does not occur because the gene encodes for oxidase enzyme is present in Guinea pigs but is dormant due to the mutation accumulation it turns into a non-functional pseudogene [nishikimi and Yagi 1991]. It also responsible for the non-formation of sugar in used for vitamin synthesis.



**Figure 1: The diversity of biosynthetic pathways for ascorbate and its analogs**

Abbreviations: Ara/AraL, arabinose/arabinolactone; Gal/GalA/GalL, galactose/galacturonic acid/galactonolactone; L-GalDH, galactose dehydrogenase; L-GalLDH, galactonolactone dehydrogenase; D-GalUR, galacturonic acid reductase; Glc/GlcA/GlcL, glucose/gluconic acid/gluconolactone; GulL, gulonolactone; L-GulO, gulonolactone oxidase; GDP, guanosine diphosphate; Man, mannose; MeGalA, methyl D-galacturonic acid; NDP, nucleoside diphosphate; UDP, uridine diphosphate.


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Figure Detail

### **Clinical signs and symptoms**

Individual variation can influence the onset of signs, but if no vitamin C is provided at all, guinea pigs can start showing signs within two weeks. common symptoms ranging from least to severe are as follows:

- Lethargy
- Depression
- Rough or poor hair coat with patches.
- Poor appetite
- Anaemia
- Impaired wound healing
- Scurvy {most common}
- Weight loss due to poor appetite
- Low bone density and risk of fractures and ligament degradation
- Progressive arthritis with inflammation
- Sepsis
- Progressive neurological disorder like paralysis
- Respiratory failure
- Birth defects
- Death

### **Diagnosis**

- Clinical signs and symptoms
- Radiological tests are not used to diagnose deficiency however x-ray is used to diagnose other health condition.
- Plasma Ascorbate concentration test
- Blood vitamin c concentration {0.5-2.0 mg/dl}
- Serum chemistry panel and CBC for information about overall health

### **Treatment**

- To treat Vitamin C deficiency in guinea pigs, adjust their diet to provide the accurate daily requirement of 10mg/kg/day for healthy adults, 30mg/kg/day for younger growing or pregnant pigs.

- In severe cases, a veterinarian can give an injection of vitamin C.
- Vitamin C can be provided via treats, fortified diets, water additives, and fresh produce.
- Fortified treats/pellets are only effective if they are less than 6 months old and some recommendations ask to use them within 90 days of their manufacture date.
- The content of vitamin C in feed can be reduced by dampness, light, heat, and prolonged storage. In commercial pelleted feed manufactured for guinea pigs, up to 50% of activity can be lost in 3-6 months. Some manufacturers now use a stabilized form with a longer shelf-life. Guinea pig pellets should be stored in dry, cool conditions and dated.
- Foods marketed for rabbits are not appropriate for guinea pigs. Seed-based guinea pig diets are not sufficient, and it is not recommended. Fresh hay, herbs, and vegetables such as cabbage, kale, and parsley can also be fed to supply vitamin C.
- It is not recommended to add vitamin C to water as a primary source because it loses potency quickly.

### **Conclusion**

Guinea pig is deficit from vitamin c and cause low bone density, low appetite. Guinea pig should provide vitamin c in the regular diet.