

## CHAIN BREAKING ANTIOXIDANTS IN RESPONSE TO BRONCHOPNEUMONIA IN CALVES

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### SUMMARY

The present study aimed to investigate the alteration of some chain breaking antioxidant levels as an indicator for the oxidative status of respiratory distress-affected calves. A total number of 20 calves were subjected to the study, of which, 10 animals were selected with various clinical manifestation of bronchopneumonia, while the other 10 calves were apparently healthy and used as a control group. Serum concentrations of  $\beta$ - carotene, vitamin A and ascorbic acid were measured in all animals. The results of the study revealed the presence of significant reduction ( $p < 0.01$ ) in serum  $\beta$ - carotene, vitamin A and ascorbic acid levels in bronchopneumonia affected calves as compared with control group. These

findings suggest the elevation of the oxidative stress, manifested by the reduction of the chain breaking antioxidants, with the subsequent pathological affection in calves suffering from bronchopneumonia. The study points to the importance of vitamins supplementation during the treatment of respiratory distress-affected calves.

**Key words:** Chain breaking antioxidant, Bronchopneumonia, Ascorbic acid,  $\beta$ - carotene, Vitamin A, Calves.

### INTRODUCTION

Bovine Respiratory Disease (BRD) is a complex condition results from multi-factorial

interaction of stressors, animal susceptibility, and respiratory pathogens (Cusack et al., 2003). Economic losses resulting from considerably high morbidity and mortality rates which associate bovine respiratory disease in cattle continue to plague the beef cattle industry

(Galyean et al., 1999). Two primary factors contribute to the high incidence of BRD especially among underweight, newly received calves. The first factor is represented by the weaning and transportation stresses, which has a negative impact on the animal immune system (Blecha et al., 1984). The second factor is the exposure of these animals to a variety of infectious agents during management, transporting and marketing with the subsequent increase of the oxidative stress. Oxidative stress occurs when the production of reactive oxygen metabolites (ROM) exceeds the capacity of the antioxidant system of the cell, tissue, or body. Certain nutrients act as antioxidants or components of antioxidant enzymes and have a direct effect on oxidative stress. The prevalence and severity of several important health disorders in dairy cows including retained fetal membranes, udder edema, and mastitis appear to be related to oxidative stress (LeBlanc et al., 2004).

Nutritional deficiency, including vitamins, as a results of incorrect pre-weaning management or due to decreased feed intake could even

complicate the BRD condition via increasing of the oxidative stress. Reportedly, antioxidant vitamins such as E, C, and A protect the cells from damage against free oxygen radicals (Chuenkova et al., 1989 and Herdt and Stowe

, 1991). Vitamin C (ascorbic acid) is probably the most important water soluble antioxidant in mammals. Most forms of vitamin C are extensively degraded in the rumen, therefore the cow must rely on tissue synthesis of vitamin C. Cows can synthesize vitamin C and it is not considered an essential nutrient for cattle (Cole, 1996). The concentration of ascorbic acid is high in neutrophils (important immune cells with respect to mastitis) and increases as much as 30-fold when the neutrophil is stimulated during infection (Hornig, 1975).  $\beta$ -carotene (precursor of Vitamin A) and others carotenoids have lipid-soluble antioxidant activity. They partially or completely protect intact cells against oxidant-induced lipid peroxidation (Martin et al., 1996). Vitamin A has a chief role in maintenance of the healthy condition of epithelial tissue lining of respiratory, digestive and reproductive tract as well as skin. Body deposits of vitamin A are low at birth and young animals have smaller reserves than older animals that have consumed diets high in vitamin A activity. Young animals fed vitamin A-deficient rations usually show deficiency symptoms sooner than older animals (Velásquez-Meléndez et al., 1995).

The goal of the present study was to determine the serum levels of some chain breaking antioxidants namely, Vitamin C, A and  $\beta$ -carotene as indicators for the oxidative stress associated with calves bronchopneumonia.

## **MATERIALS AND METHODS**

### **1- Animals:**

The current study was conducted on a total number of 20 cross breed Holstein male calves with age range 4-8 month old. The animals were selected from two different private farms in Assiut Governorate, Egypt during the period of December and January of 2006. Out of this number, 10 calves were selected from a single private farm with typical signs of bronchopneumonia, mainly depression, fever, mucopurulent bilateral nasal discharges, productive cough, extended head and neck, dyspnea and anorexia. The affected calves were recently purchased from the markets and no vaccination history of their dams was available. The offered ration for those animals based mainly on green fodders and concentrates but no vitamins or minerals were supplemented. Ten other calves were selected from other private farms that were fed on balanced ration with adequate vitamins and minerals

supplementation. Those selected calves were found clinically healthy after precise clinical and laboratory examinations that included complete blood picture and parasitological examination and were used as a negative control group for the study.

### **2- Samples and adopted methods:**

Blood serum samples were collected from all animals and were used for measuring serum levels of  $\beta$ - carotene ( $\mu\text{g/ml}$ ) and vitamin A ( $\mu\text{mol/l}$ ) according to Suzuki and Katoh (1990), and ascorbic acid ( $\mu\text{mol/l}$ ) according to Omaye et al. (1979) using Digital Ultraviolet Spectrophotometer (CE 292, series 2, Cecil instruments, Cambridge England, Series No. 52.232). The results were statistically analyzed by one-way ANOVA using Statistical Package for the Social Sciences for Windows (SPSS, version 10.0, Chicago, IL, USA).

## **RESULTS**

The results of the study showed significant reduction ( $p<0.01$ ) in serum  $\beta$ - carotene, vitamin A and ascorbic acid levels in respiratory distress-affected calves as compared to the control group (Table 1).

**Table 1. Mean and standard deviations values (X ± SD) in serum of control and diseased cattle.**

	$\beta$ - Carotene ( $\mu\text{g/ml}$ )	Vitamin A ( $\mu\text{mol/l}$ )	Ascorbic acid ( $\mu\text{mol/l}$ )
Control group (n=10)	1.27± 0.16	2.29 ± .06	39.75 ± 9.08
Bronchopneumonia group (n=10)	1.03± 0.071**	1.22 ± 0.13**	22.71 ± 3.40**

\*\* : Highly significant (P<0.01)

## DISCUSSION

Production of reactive oxygen metabolites (ROM) or alternatively known as free radicals are resulting from various biochemical interactions that take place in the body. These free radicals if not immediately removed by scavenging enzymes such as superoxide dismutase, catalase and glutathione peroxidase, they can exert their deleterious effect on different tissues and organs of the body through peroxidation of lipid membranes with the subsequent production of peroxides and other radicals, which are responsible for the initiation of the so-called "free radical pathologies" (Halliwell 1989, Halliwell and Gutteridge 1990). However, chain breaking antioxidant such as vitamin C and  $\beta$ -carotene can counteract the deleterious effect of these free radicals (Kanter, 1998).

The currently recorded low levels of the studied chain breaking antioxidants in the BRD-affected calves is expected to contribute to the increased oxidative stress of the affected calves. The significant reduction ( $p<0.01$ ) of serum vitamin A level in BRD affected calves as shown in the present study could be attributed to the increased vitamin A consumption to restore the tracheo-bronchial epithelium which destroyed during infectious process, which also increase the urinary excretion rate of vitamin A (Herdt and Stowe 1991). Furthermore, acute circulatory changes due to systemic stress cause an increase in vitamin A consumption and a reduction of liver mobilization rather than depletion of reserves (Velásquez-Meléndez et

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al., 1995). The significant reduction ( $p<0.01$ ) of the serum  $\beta$ -carotene could be attributed to its consumption to protect intact cells against

oxidant-induced lipid peroxidation (Martin et al., 1996), as much of the evidence has supported the hypothesis that lipid oxidation or oxidative stress may be the underlying mechanism in chronic diseases and that  $\beta$ -carotene would act as an antioxidant *in vivo* (Burton and Ingold, 1984).

Ascorbic acid plays an important role as an antioxidant (Kanter, 1998) and plays a protective role in the immune system as a scavenger of free-radicals generated by phagocytic cells (Anderson and Lukey, 1987). Results of the present study have showed significant reduction ( $p < 0.01$ ) of Ascorbic acid serum level in BRD-affected calves, which is in accordance with previous studies that reported low ascorbic acid concentrations in blood plasma of calves with pneumonia (Jagos et al., 1997). This reduction could be explained in the light of the antioxidant role of Vitamin C, which has also been suggested to be of value in alleviating both physiological and pathological stresses in different animal species (Jagos et al., 1997 and Jaeschke, 1984).

In conclusion, the results of the present study may indicate the possible important role played by chain breaking antioxidants in counteracting the pathological effect of oxidative stress-generated free radicals in respiratory diseases.

Moreover, the study denotes the requirement of BRD affected calves for treatment with vitamin C and A sources along with the traditional systemic treatment to overcome the oxidative stress during the course of the disease. Moreover ration supplementation with vitamin A sources is essential in order to avoid the impact of its deficiency on the epithelial lining healthy condition of the respiratory tract with the subsequent possible complications of the

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## العلاقة بين مضادات الأكسدة و الأمراض التنفسية في العجول

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استهدفت الدراسة فحص تأثير على مستوى مضادات الأكسدة مثل حامض الأسكوربيك وفيتامين أ والبيتاكاروتين في  
مصل الحيوانات المصابة. تم إجراء الدراسة على عدد 10 عجول تظهر عليها أعراض اكلينيكية مختلفة للالتهابات الرئوية  
والشعبية في العجول كما تم استخدام عدد 10 عجول أخرى خالية من أي أعراض مرضية وتم استخدامها كمجموعة ضابطة في  
الدراسة. تم قياس مستوى حامض الأسكوربيك وفيتامين أ والبيتاكاروتين في مصل جميع الحيوانات. أظهرت الدراسة وجود  
 $(P < 0.01)$  والبيتاكاروتين  $(P < 0.01)$  وفيتامين أ  $(P < 0.01)$  انخفاض معنوي في مستوى مضادات الأكسدة حامض الأسكوربيك  
في الحيوانات المصابة بالمقارنة بالحيوانات السليمة. هذا وقد أظهرت الدراسة زيادة التأثير السلبي للعوامل المؤكسدة التي  $(0.01)$   
انعكست على الحيوانات المصابة في صورة الانخفاض المعنوي في مضادات الأكسدة وعلى ذلك توصى الدراسة باستخدام مصادر  
فيتامينات كإضافات علائق للحيوانات المصابة وذلك لتلافى التأثير السلبي للعوامل المؤكسدة على الحيوانات المصابة.