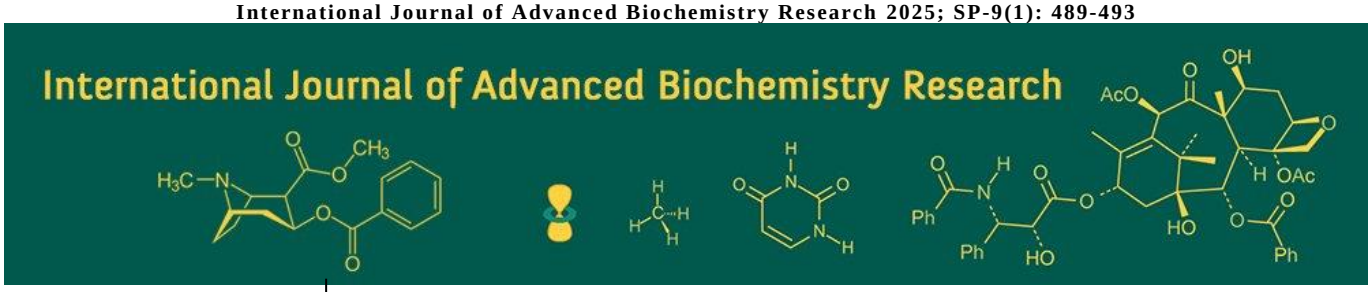


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# A review on: Effect of dietary chromium and selenium supplementation on phsio-biochemical, antioxidant activity and immune function of Vrindavani cattle exposed to thermal stress

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**Abstract**
Heat stress has harmful effect on the animal's physio-biochemical, hormonal, antioxidant activity and immunity of animals which hampers the overall productive potential of animals. There is an urgent need to address the problem of heat stress so that the productivity of animals may be maintained up to some extent. Antioxidants are added in animal's diets as part of nutritional management to minimize oxidative damage during heat stress (Chauhan *et al*., 2020). Now a days a number of feed additives, such as niacin, vitamin A,C, E, selenium (Se) and chromium (Cr)are added in animal's diet to reduce the adverse consequences of heat exposure by preventing oxidative damage in the animals experiencing heat stress (Chauhan *et al*., 2020). Selenium (Se) is dietary trace element which acts as an essential co-factor of glutathione peroxidase. Dietary selenium supplementation has been demonstrated to improve gastrointestinal health, reproductive physiology, and production performance during heat stress (Zheng *et al*., 2022). Chromium (Cr) is essential micro mineral which is vital for the metabolism in animals (Lashkari *et al.*, 2018). The dietary supplementations of Cr in heat stressed calves helps in maintaining their health and immune system (Shan *et al*., 2020). Further research is urgently required to study the combined effect of Se and Cr on productive and reproductive potential of cattle exposed to thermal stress.

**Keywords:** Heat stress, antioxidants, selenium, chromium, oxidative damage, nutritional management

## Introduction
India is the country with the largest dairy herd in the world compared to industrialized countries that produce milk (Rhoads *et al*., 2009) [34]. The vast climatic condition in India influences the adaptive capabilities and immunity of different milch breeds of cow which intern reduces the milk production. During the heat stress animal adopt various biological mechanism to maintain their internal milieu by reducing their feed intake, altered endocrine status and reduction in rumination (Collier *et al*., 2006) [11]. Antioxidants are added in animal's diets as part of nutritional management to minimize oxidative damage during heat stress (Chauhan *et al*., 2020) [7]. Now a days a number of feed additives, such as niacin, vitamin A,C, E, selenium (Se) and chromium (Cr) are added in animal's diet to reduce the adverse consequences of heat exposure by preventing oxidative damage in the animals experiencing heat stress (Chauhan *et al*., 2020) [7].
Selenium (Se) is a dietary trace element which acts as an essential co-factor of glutathione peroxidase and acting as an antioxidant enzyme which is very essential for the animal's productivity. Dietary selenium supplementation has been demonstrated to improve gastrointestinal health, reproductive physiology, and production performance during heat stress (Zheng *et al*., 2022) [45]. Chromium (Cr) is essential micro mineral which is vital for the metabolism in animals (Lashkari *et al.*, 2018) [21]. Cr plays a crucial role in the cellular breakdown of fat, protein, and carbohydrates and is a very important component of the glucose metabolism and it also act as an antioxidant role. The dietary supplementations of Cr in heat stressed calves helps in maintaining their health and immune system up to some extent.

It is an affective antioxidant that inhibits the lipid peroxidation caused by heat stress and also increases the activity of insulin in tissues which helps in enhancing animal production (Chouraddi *et al*., 2022) [9]. In this review, we summarized the effect of chromium and selenium feeding on physio-biochemical response, anti oxidant activity and immune function in Vrindavani cattle exposed to thermal stress.

**Physiological response status**

The various physiological responses like body temperature, heart rate and respiration rate are drastically affected by the fluctuation in the environmental condition. In addition to this these parameters also act as an indicator of severity of environmental stress (Maurya *et al.*, 2020) [25].

The change in rectal temperature by 1 °C have its impact on feed intake of animals. (Ranjitkar *et al*., 2020) [33]. A heat stress which generally affects the rectal temperature of the animal and also it has negative impact on milk yield and fertility of animals (Mousavi *et al*., 2019) [28]. The response of RT elevated when ambient temperature was higher. Research indicates that heat stress elevates the body temperature cattle's (Kargar *et al*., 2018) [19]. Studies has indicated that while under heat stress, growing calves and lams have an increased heart rate and rectal temperature (Maurya *et al*., 2010; Kargar *et al.*, 2018) [23, 19]. Mudgal *et al* (2008) [29], reported an ameliorative effect of Se and chromium on rectal temperature rise.

The Respiration Rate (RR) is very crucial parameters which used to increase during heat exposure (Maurya *et al*., 2020) [25]. Respiratory rate is an marker of heat stress that is measurable noninvasively (Chrast *et al.*, 2023) [10]. Aleena *et al* (2020) [1], reported that in a hot environment, breathing rate of animals increases to dissipate heat form the body and to maintain a normal body temperature. (Djelailia *et al.*, 2021) [15] reported that the reparation rate of cow increases when they are being exposed to elevated temperature. The supplementation of selenium and chromium reduces the respiration rate during summer as compared to nontreated animals (Srikandakumar *et al.*, 2004) [41].

The pulse rate serves as an important indicator of circulatory balance and the overall metabolic state of animals in various environmental conditions (Maurya *et al.*, 2015; Hooda and Upadhyay., 2015) [22, 18]. The exposure to heat stress may affects the distribution of blood to peripheral tissues and resulting in increased heat loss through sensible and insensible means respectively (Mohr *et al*., 2002) [27]. In all exposure environments, PR was much greater in crossbred Vrindavani animals than in Tharparkar cattle, possibly due to an acclimation process of a breed that may able to generate excess heat. Beneficial effect of 1.0 ppm of dietary chromium supplementation in 42 °C ambient temperature exposed a calves was reported by (Yari *et al.*, 2010) [44]. According to reports a selenium dose of 0.3 mg / kg DMI in the male buffalo calve was sufficient to maintain pulse rate under thermal stress (Shinde *et al.*, 2009) [39].

**Stress Hormones status**

Heat stress drastically affects the kinetics of various endocrine glands, causing the production of various hormones such as cortisol, thyroxine, adrenaline, and nor-adrenaline respectively (Djelailia *et al*., 2021) [15]. The cortisol is a stress hormone produced by adrenal gland and plays a vital role and significant role in immune system (Degen and young 2002) [14]. It has been reported by Shaji *et al* (2017) [37], that heat stress stimulates the hypothalamo-pituitary axis which results release glucocorticoids from the adrenal glands and secretion of cortisol as well. Cortisol is a good biomarker for determining the level of stress in different animals (Chen *et al*., 2023) [8]. Ghorbani *et al* (2012) [17], observed that Se supplementation to stressed transportation stress or birth stress calves decreased blood cortisol. (Raghunandan *et al*., 2022) [32] reported a decrease in cortisol levels when animal were supplemented with chromium and selenium as compared to non-supplemented animals under thermal stress. The thyroid is responsible for accurately maintaining both body temperature and heat production. Thyroid gland activity varies seasonally and is influenced by surrounding temperature and humidity levels (Maurya *et al.*, 2015) [15]. T3 and T4 hormones are involved in thermogenesis in animals and also act as significant indicator for adaptability of animals during stress (Maurya *et al.*, 2018) [24]. However (Mousavi *et al*., 2019) [28] reported higher concentration of T3 in heat stressed animal supplemented with Cr and selenium as compared to the non-stressed animals.

**Biochemical parameters status**

Sejian *et al* (2012) [36], reported the considerable decreased the value of albumin and total protein under heat exposure conditions. Garcia *et al.* (2015) [16] observed that in heat stressed cow experiencing minor dehydration due to reduced feed intake, there was a notable decrease in albumin levels. Al-Saiady *et al* (2004) [3], conducted a study on cow supplemented with chromium and found that there was reduction in the total blood proteins and globulins under heat stress conditions. Contrastingly Yadav *et at*., (2016) [43], reported an rise in the total protein concentration in dairy cattle under to heat stress condition. Mousavi *et al* (2019) [28], supplemented Cr and Se in summer exposed dairy calf and found that the concentration of total protein and albumin was higher in supplemented animal as compared non supplemented calves.

The heat stress affects the urea and serum creatinine levels in animals significantly, which also depend upon other factors such as intensity and duration of heat exposure, age, breed and manage mental practices (Saeed *et al*., 2021) [35]. In one study Bernabucci *et al* (2010) [4], reported that cross-bred dairy calves exposed to heat stress exhibited higher blood creatinine and blood urea nitrogen (BUN) levels. Cr and Se in feeding animal during heat stress condition reduce the blood creatinine and blood urea nitrogen (BUN) levels (Kargar *et al* 2018; Alhidary *et al*., 2015) [19, 2]. In addition to this Raghunandan *et al.* (2022) [32] also reported a decrease level of AST and ALT heat exposed calf as compared to control animals.

**Heat Shock Proteins status**

Heat Shock Proteins are very important and potent molecular chaperons which help in reducing stress and enhance stress tolerance in farm animals. (Pearl *et al*. 2008). HSP70 is the most sensitive of all the HSPs and is regarded as a crucial regulator of thermal adaptation in animals under heat stress (Dangi *et al*., 2014) [13]. HSP70 helps animals adjust to heat stress by promoting correct folding of recently synthesized proteins and restoring denatured proteins to their original condition (Kishore *et al*., 2014) [20]. Increased HSP70 synthesis cells under heat stress may indicate that

HSP70 is involved in reducing the harmful effect of elevated temperature to preserve goat cell structure and equilibrium (Mishra and Palai 2014) [26]. The dietary supplementation Cr and Se reduces the HSP 70 expression in heat exposed cows (Son *et al.*, 2022) [40]. In continuation of previous finding (Parashuramulu *et al.*, 2015) [30] also reported that Cr and Se feeding reduces the HSP 70 expression. HSP-90 is an important molecular chaperon and highly abundant in the endoplasmic reticulum, cytoplasm and nucleus and is responsible for protein translocation under normal conditions. (Bharti *et al.*, 2017) [5]. It is regarded as a flexible chaperone protein that, in the face of heat stress, preserves cellular integrity and homeostasis (Kishore *et al*., 2014) [20]. Dangi *et al.* (2012) [12] reported a higher level of HSP-90 in goat exposed to elevated temperature. In heat-exposed cows, the dietary supplements Cr and Se decrease expression of HSP 90 (Son *et al.*, 2022) [40]. In continuation of previous finding (Parashuramulu *et al.*, 2015) [30] also reported that Cr and Se feeding reduces the HSP 90 expression.

**Antioxidants status**

Catalase (CAT), total antioxidant capacity (TAC), glutathione peroxidase (GPx), and SOD are the primary components of the intracellular antioxidant defense system (Shaji *et al*., 2017) [37]. The enhanced SOD activity during the summer results in increased production of $H_2O_2$ and protection from this ROS would only be conferred by the coordinated elevate in the activity of CAT and GPx (Chandra and Aggarwal, 2009) [6]. According to Sun *et al*. 2018, GPx activity in calves and dairy cows increase with Dietary Se supplementation. According to Kumbhar *et al*., 2018, increased SOD activity with Se supplementation have been observed in broilers. During the summer, Tharparkar cattle had the highest total antioxidant activity and catalase (CAT), followed by Sahiwal cattle and then crossbred cattle (Tejaswi *et al*., 2020) [42]. Found that CAT and T-AOC activities increased in the serum, indicating that Cr and Se supplementation improved the antioxidant capacity of heat-stressed dairy cows. (Kargar *et al*., 2018) [19] reported that Cr and Se feeding to heat stressed Holstein calve increases in the activity of catalase and and T- AOC .

**Conclusion**

The heat stress drastically affects animal production and reproduction. There is an urgent need to have some strategies so that live stock owner can manage their animal's productive potential during thermal stress. The Chromium and Se supplement could serve as a nutritional strategy to help animals to reduce negative effects on their production performances and health during heat stress period. The Cr and Se restores productive performance, antioxidant profile and immune status up to some extent. Therefore, dietary supplementation of Cr and Se may be used as nutritional strategy to minimize the negative effects of heat stress in Vrindavani cattle.

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