

## Acknowledging the Role of Betaine in the Poultry Industry

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**Figure**

### Abstract

Heat stress is one of the major problems faced by the tropical countries. It interferes with the normal body functions of the birds leading to their poor growth and poor productive performance. Due to the heat stress birds do not eat in the right amount. Also, the energy of the body is used to maintain the homeostasis of the body in spite of being used for growth and production. Due to heat stress, there is increased water ingestion which results in hemodilution, thus decreasing the concentration of lipid levels,  $pCO_2$ , and  $HCO_3$  as well as electrolytes in blood. Prolonged heat stress reduces the visceral supply to the intestines and causes damage to epithelial cells in the gut thereby affecting feed digestion and absorption which also makes the birds prone to other intestinal infections. Because of all these reasons the heat stress is a major problem to the poultry industry and if not taken seriously it can cause a huge economic loss. In the recent years the use of betaine in alleviating the heat stress in birds has gained a major attention. Due to its methyl group donating property and osmoregulatory functions it can play a significant role in the poultry industry.

**Keywords:** Betaine; Poultry; Heat Stress

### Introduction

Our country has made a good progress in the poultry industry but still there are many problems which need to be combat in an effective way. Being a tropical country, one of the major problems

is the heat stress in the summer season which is worsen by high relative humidity. Poultry is very sensitive to heat stress as it has a high body temperature, lack of sweat glands and body is covered with feathers. High temperature increases the stress mechanism

of the birds leading to adverse effect on the production and well-being of the bird (Habibu., *et al.* 2014).

Heat stress impairs overall production performance of the birds by decreasing feed intake and negatively affecting intestinal development, leading to reduced nutrient digestibility. Apart from inducing high mortality rate, heat stress is known to depress growth rate and reduce meat yield in broiler birds. In layers lower feed intake impairs ovarian function, leading to decreased feed efficiency, egg production and egg quality. In addition, reduced immune functions such as thyroid activity and antibody production are also evident in heat stressed birds [1].

Controlling heat stress by way of good infrastructural facilities like providing an insulated house, air conditioners, more space to the birds is really very expensive. Also, the period of summer season is very long in major part of our country, so we have to find a cheap as well as an efficient alternative to combat the problem of heat stress and thereby reducing our production cost as well.

Nutritional therapy is one of the cheapest ways to tackle this problem. Using feed additive having positive effects for resisting thermal stress may be a viable solution. Betaine is an example of such a feed additive. It is a multi-nutritional agent that may help the birds to resist the heat stress. It has many important functions in the health and performance of broiler chickens, especially under the conditions of heat stress because it reduces the body temperature of the birds. The chief physiological role of betaine is to function as a methyl donor and an osmolyte. Betaine supplementation in feed improves growth performance and feed intake under heat stressed conditions (Hassan., *et al.* 2005).

In the present article the role of betaine in alleviating the heat stress, its mechanism and advantages have been discussed.

### Mechanism of action of betaine

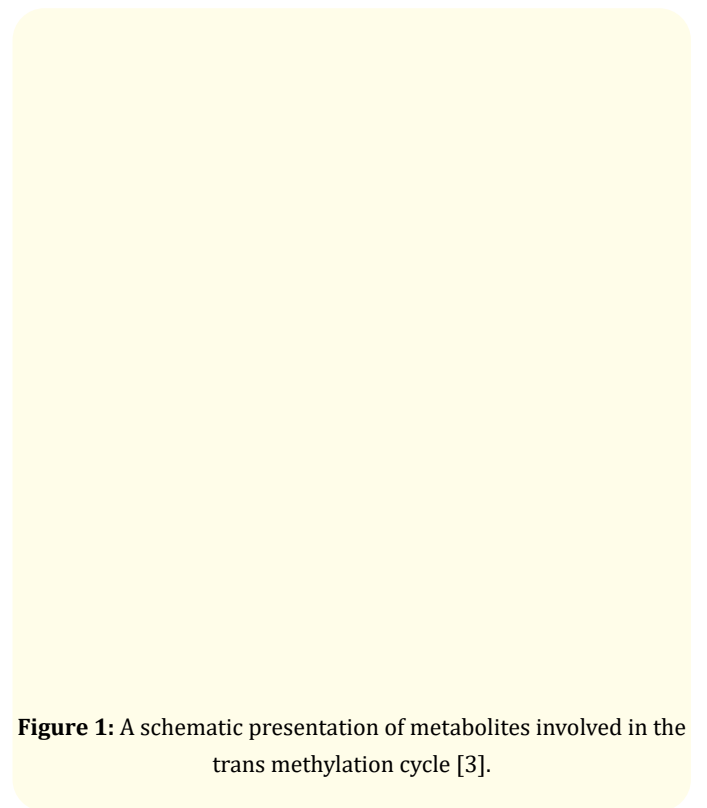
Natural betaine is found in several plants and organisms and it is commonly extracted and purified from beetroot [2].

It is a trimethyl derivative of amino acid glycine. It is a bipolar compound that has 3 hydrophobic methyl groups and a hydrophilic carboxyl group.

### Betaine plays two main roles in metabolism

It donates the methyl radicals for remethylation of homocysteine to methionine in chicken and to formulate useful compounds such as carnitine, creatine and phosphatidyl choline through the S-adenosyl methionine pathway.

Choline also acts as a methyl donor but only when it is oxidized to betaine in two step conversion in the liver mitochondria.



**Figure 1:** A schematic presentation of metabolites involved in the trans methylation cycle [3].

Due to its zwitterionic characteristics it acts as an osmolyte which helps to maintain cell water metabolism without affecting cell division.

### Advantages of using betaine in poultry

- It increases growth rate of poultry birds as it saves the energy used in Na<sup>+</sup>/K<sup>+</sup> pump at high temperature and allows this energy to be used for growth [4].
- It improves the dry matter, crude protein, crude fiber, ether extract and non-nitrogen fiber extract digestibility as it helps in the expansion of intestinal mucosa which improves absorption and utilization of nutrients [5].
- It improves the concentration of short chain fatty acids such as acetic acid and propionic acid which are beneficial to host bacteria i.e. *Lactobacillus* and *Bifidobacterium* in poultry so that they can inhabit sufficiently in the caecum and can inhibit the intestinal colonization by harmful bacteria [6].

- It increases the daily egg mass, serum estradiol and melatonin concentration in the laying hens [6].
- It attenuates the detrimental effects of coccidiosis, partially inhibiting coccidiosis development and improving intestinal structure and functions. Betaine is more effective than DL-Methionine especially for broilers under coccidiosis challenge [7].
- Betaine has been shown to interact with lipid metabolism by stimulating the oxidative catabolism of fatty acid via its role in carnitine synthesis and thus can be used as a mean to increase lean and decrease fat in poultry carcass (Saunderson and MacKinlay, 1990).
- The problem of wet droppings and consequent damp litter can be reduced by betaine supplementation in the drinking water as it promotes high water retention in the birds exposed to cyclic heat stress [8].
- Significant improvement in hematological parameters such as RBC and platelet count. Also, it reduces the heterophil number and increases the lymphocytes number. The reduction of lymphocytes during heat stress is due to the increase of inflammatory cytokines which stimulate the hypothalamic production of corticotrophin releasing hormones under heat stress [9].
- Betaine supplementation significantly improves FCR at the rate of 1.5 to 2.0g per kg feed (Attia., *et al.* 2009).
- It improves carcass weight, dressing percentage, thigh, breast and giblets percentage at a level of 0.1 to 0.2% in the feed [9].
- It increases antibody titer in the birds vaccinated against New Castle disease [10].

All these effects are directly or indirectly related to methionine biosynthesis and osmoregulatory action of betaine.

### Inclusion of betaine in poultry diet

The concentration of betaine required to supplement a broilers diet largely depends on the concentration of other labile methyl groups, environmental conditions and the health condition of the birds. Typically, betaine can be added at the rate of 0.05-0.08% in broiler diet. Benefits on coccidiosis lesion scores have been noted

at 0.05% but osmolyte activity increases as dose of betaine increases. During diarrhoea, when the osmotic balance is disturbed, the effective dose to control diarrhoea ranged from 0.15 - 1.5/kg body weight. Generally, the recommended concentration of betaine in the feed is 500 - 750 g/tonne. Utilization of betaine may be reduced at higher concentrations [11].

According to Floroupaneri., *et al.* [12] between 30% to 80% of supplemental methionine can be substituted by betaine without any negative effects on the performance of the birds [13-18].

### Conclusion

It is very important to produce the poultry products in a cost-effective and sustainable manner. The use of betaine to combat heat stress in the poultry birds is one of the most effective and the cheapest way. The birds fed with betaine have improved production performance during the time of heat stress. Moreover, it is more rapidly absorbed than methionine and choline. The use of betaine as feed additive in poultry diet has no harmful effects. Also, there is no kind of public health hazard unlike some other feed additives such as antibiotics which are used in the poultry diet. Still the literature about the methionine sparing effect of betaine is scarce. There is a need to broaden our knowledge regarding betaine and its importance in the poultry industry to cope with the heat stress problem.

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