Research Article

Thyroid Response to Temperature Humidity Index Incrossbred Pigs Supplemented with Antioxidants during Summer and Winter Season

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Abstract | The present experiment was conducted to study the changes oftriiodothyronine (T3) and thyroxine (T4) hormones in the crossbred pigs (Hampshire × Assam local) under tropical climate and high rainfall conditionof Assam, India. The experiment included a total of 36 numbers of crossbred weaned female pigs. Eighteen (18) animals were subjected to treatment separately during summer and winter. The selected animals were divided into three groups with six pigs in each group consisting of the control group (Treatment 1), one group was fed melatonin @3 mg/animal (Treatment 2) and the other group was fed Vitamin E @100 mg (Treatment 3) for both the seasons. The animals were maintained in the College of Veterinary Science (AICRP on Pig), Assam Agicultural University, Khanapara, Guwahati-781022. The Temperature-Humidity Index (THI) was calculated out by using standard formula. Triiodothyronine (T3) and thyroxine (T4) hormones were estimated by Radioimmunoassay (RIA) technique. Serum T4 concentrations was significantly ($P<0.01$) lower during summer as compared to winter in all the treatment groups. Serum T4 concentration showed significant difference between treatment, between season and also between treatment and season. The thyroid levels showed alteration with the change in season, at the same time antioxidant supplementation was found to counter the seasonal stress upto an extent.

Keywords | Antioxidants, THI, Pigs

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INTRODUCTION

Swine production is an integral part for most of the tribal population in the North East India. Over a quarter of all Indian pigs are found in this region. Pig production in this region is invariably a small scale, backyard but market oriented business. It is practiced mainly by farmers to generate income and to fulfil socio cultural and traditional obligations.

The effect of climate change in agriculture is well known but its effect especially in pig production is meagre. Some of the most important and evident effects of climate change especially with change in season in pig production is mediated through changes in environmental temperature, humidity etc.Swine are particularly susceptible to heat stress because they possess little tono functional sweat glands (Curtis, 1983). In addition, pigs maintain moresubcutaneous fat and this prevents effective heatdissipation (Mount et al., 1979).

Heat stress is one of the wide varieties of factors which cause oxidative stress *in-vivo* (Kumar et al., 2010). Reactive oxygen species (ROS), the major culprits for causing oxidative stress, are constantly generated *in vivo* as an integral part of metabolism. ROS may cause oxidative stress when their level exceeds the threshold value. They trigger progressive destruction of polyunsaturated fatty acids (PUFA), ultimately leading to membrane destruction. An antioxidant is a molecule that inhibits the oxidation of other molecules. Oxidation is a chemical reaction that transfers electrons or hydrogen from a substance to an oxidizing agent. Oxidation reactions can produce free radicals. In turn, these radicals can startchain reactions. When the chain reaction occurs in a cell, it can cause damage or death to the cell. Antioxidants terminate these chain reactions by removing free radical intermediates, and inhibit other oxidation reactions.

Vitamin E reacts or functions as a chain-breaking antioxidant, thereby neutralizing free radicals and preventing oxidation of lipids within membranes. At least one important function of vitamin E is to interrupt production of free radicals at the initial stage. Melatonin hormone is secreted by the pineal gland which is direct free radical scavenger acting as indirect antioxidant.

Hormonal profiles related to metabolism and stress levels are good marker of animal's adaptability for growth under extreme conditions of summer and winter seasons.Therefore the present experiment was conducted with the primary objective of studying the combined and specific effects of some climatic parameters and antioxidants on the thyroid hormone (T3 and T4) levels in the crossbred pigs.

MATERIALS AND METHODS

Experimental Design

The present experiment included 36 nos. of weaned, healthy and uniform sized crossbred (Hampshire X Assam local) female pigswith an average body weight of 10.30 kgs. Eighteen (18) pigs were subjected to treatment during summer and eighteenpigs (18) duringwinter. The selected animals were divided into three groups with six pigs in each group consisting of the control group (Treatment 1), animals of one group was fed melatonin (Meloset) @3 mg/animal (Treatment 2) and the other group was fed Vitamin E(Evion) @100 mg (Treatment 3) for both the seasons. The animals were fed as per standard feeding practices of the farm (Table A).

They had an access to an energy content of 3.16 Mcal/kg and crude protein content of 18.5% respectively. The animals were fed at 10 AM and 3 PM and had free access to water.

The experimental design was approved by the Institutional Animal Ethics Committee, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022, Assam, India.

Table A: Feed composition

Ingredients (%)	Ration
Maize	55
Wheat bran	14
Deoiled GNC	16
Soya bean	6
Fish meal	6
Min. mix	2.5
Common salt	0.5
Total	100

Temperature-Humidity Index (THI)

Temperature-Humidity Index was calculated for the entire period from the data obtained fromAutomatic Weather Station installed in the College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, India where the experimental animals were reared,using the following formula of Mader et al. (2006):

THI = (0.8 x Tdb) + [(RH/100) x (Tdb – 14.4)] + 46.4

THI = (0.8 x Tdb) + [(RH/100) x (Tdb – 14.4)] + 46.4 (Table 1)

Table 1: Temperature Humidity Index (THI) during summer and winter seasons

Season	THI
	Mean± SE
Summer	82.01±0.50
Winter	63.16±0.30

Summer: Tdb=29.28 and RH= 81.97; Winter: Tdb= 17.91 and RH= 68.75

Blood Collection

About 5 ml of blood was collected from each experimental animal from the cranial venecavawith 18 gauze needle aseptically at 15 days interval for the whole experimental period. Thecollected blood was allowed to coagulate and serum was separated and stored at -20°C for estimation of T3 and T4.

Hormone Assay

Serum triiodothyronine (T_3) andthyroxine (T_4) hormones were estimated by Radioimmunoassay (RIA) technique using RIA kits supplied by Immunotech, France. The tracer I-125 was used in the estimation technique which involved competition between free and isotope tagged hormones for binding to the limited antibody sites and subsequently quantification was made through calibration curve.

STATISTICAL ANALYSIS

The data were analysed (Analysis of variance) as per the method of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Temperature Humidity Index

THI was found significantly different (P<0.01) between seasons. It was 82.01±0.50 in summer and 63.16±0.30 in winter.

The present findings are in close relation to those reported by Silanikove (2000). He reported that in hot climates, high ambient temperature, humidity, wind speed and high direct and indirect solar radiation are the main environmental stressing factors that impose strains on animals . Kadzere et al. (2002) reported that THI level beyond 72 was indicative of mild heat stress, THI 75 to 78 denoted stressful condition and that beyond 78 could indicate severe stress due to heat and humidity. Antonio et al. (2003) observed that Temperature and humidity conditions affected livestock production in Central Argentina. This study evaluated the risk of thermal stress affecting dairy production. The temperature-humidity index (THI) was used to analyze the regional and seasonal effects of temperature and humidity. Statistically, the THI was found to be normally distributed. The probability of occurrence of a daily THI higher than 72 was 40 per cent for Río Cuarto during January. Regional variability of THI indicated a low risk of harmful extreme thermal stress conditions. The probability of THI being 78 or above ranges between 4 and 10 per cent for the main dairy region of Córdoba during January. Till recent times the north east India was partially untouched by the heat stress as compared to the other parts of India but now because of multiple known and unknown causes global warming has become the most important threat leading to heat stress in livestock including swine population causing various degrees of production losses. Davis and Mader (2002) reported that theTemperature-Humidity Index (THI) is a suitable climatic marker to correlate climatic stress on physiology and productivity of animals and also a reliable tool for effective management of livestock under different climatic condition. Stress is a reaction of body to stimuli that disturb homeostasis often with detrimental effects. Domestic animals undergo various kinds of stress such as physical, nutritional, chemical, psychological and thermal stress. Thermal stress is the perceived discomfort and physiological strains associated with an exposure to an extreme hot or cold environment. Thermal stress includes both heat stress during extreme summer season as well as cold stress during extreme winter season. In tropical and subtropical regions high ambient temperature is the major constraint on animal production (Marai et al., 2007), whereas extreme low temperature in temperate regions is also detrimental to the livestock. The effect of high temperature is further aggravated when heat stress is accompanied by high ambient humidity. Excessive heat stress may cause hyperthermia and potentially have several physiological side effects. These include electrolyte imbalances (West et al., 1991), oxidative stress and enzymatic dysfunction (David et al., 2001), aberration of reproductive functions (Roth et al., 2002), reduced meat quality (Kadim et al., 2004) and eventually severe economic losses resulting from increasedmortalities and decreased overall animal performance.

Serum T3 (Triiodothyronine)

In the present study the T3 values during summer was 0.63±0.01in treatment group 1, 0.62±0.01in treatment group 2 and 0.65±0.01 in treatment group 3 (Table 1a).

Serum T4 (Thyroxine)

The present findings (Table 1b) are in close association with the findings obtained by Djurdjevic et al. (1992). He studied the effect of different dietary levels on serum level of T_3 and T_4 in Swedish X Big Yorkshire X German Landrace gilts and found that normal level of T_3 and T_4 as 1.48 ± 0.28 and 46.57 ± 11.37 respectively at 4 months of age which were remained unchanged until first oestrus (about 6.5 months of age) in all gilts with a significant lower concentration of T_3 and T_4 only at 1-3 days before parturition. On the other hand Kallfelz and Erali (1973) demonstrated a fluctuating T4 and T3 value in suckling, young adult and mature pigs and reported that the serum T_4 concentration decreased significantly with age. They also found that the T_3 values were highest in young adult animals. The respective values for T_3 (%) and T_4(μg / 100 ml of blood) were 30.1 ± 2.52 and 8.40 ± 0.54, 3.17 ±1.18 and 4.70 ± 0.45 and 32.6 ±2.20 and 2.10 ± 6.42 in suckling, young adult and mature pigs.A slight bifurcating values in comparison to the present findings were also demonstrated by Reap et al. (1978).He reported the normal serum T_4 and T_3 values in pigs as 3.32±0.80 and 1.70± 4.68 μg/dl respectively whereas Anderson et al. (1993) reported that the concentration of total T_4, free T_4,total T_3 and free T_3 in pig serum as 53 ng/ml,21.7pg/ml,760pg/ml and 2.74 pg/ml respectively.

Blood thyroid hormones are considered to be good indicators of metabolic status of an animal (Magdub et al., 1982).Appropriate thyroid gland function and activity of thyroid hormones are considered crucial to sustain productive animals performance in domestic animals (Todini, 2007).Based on the metabolic and physiological status of the animals the level of thyroid hormones varies.As such season, breed and age of animals has significant effect on plasma concentration of 3-3-5 –triiodothyronine (T3) and thyroxine(T4) (Bhattacharya et al., 1994; Bhattacharya et al., 1995b; Dutta et al., 2002; Bhooshan et al., 2010). The

Table 1(a): Serum t_3 (ng/ml, mean±se) concentration in the different treatment groups during summer and winter season

Treatment	Season		Aggregate
	Summer (Mean±SE) THI=82.01±0.50	Winter (Mean±SE) THI=63.16±0.30	
1 (Control)	$0.63±0.01^b$	$1.22±0.01^a$	$0.92±0.04^a$
2(Meltonin)	$0.62±0.01^b$	$1.23±0.01^a$	$0.92±0.04^a$
3 (Vitamin E)	$0.65±0.01^b$	$1.23±0.01^a$	$0.94±0.04^a$
AGGREGATE	$0.63±0.01^b$	$1.22±0.01^a$	0.93±0.02

Values having same superscript do not differ significantly (both rows and columns)

Table 1(b): Serum t_4 (ng/ml, mean±se) concentration in the different treatment groups during summer and winter season

Treatment	Season		Aggregate
	Summer (Mean±SE)	Winter (Mean±SE)	
1(Control)	$21.33±0.11^c$	$31.55±0.16^{ab}$	$26.44±0.61^{ab}$
2(Melatonin)	$21.25±0.13^c$	$31.18±0.23^b$	$26.22±0.60^b$
3 (Vitamin E)	$21.23±0.10^c$	$32.01±0.12^a$	$26.62±0.64^a$
AGGREGATE	$21.27±0.06^b$	$31.58±0.11^a$	26.43±0.36

Values having same superscript do not differ significantly (Both rows and column)

thyroid gland is highly sensitive to the ambient temperature variation (Rasooli et al., 2004) and thyroid hormones are good indicators of heat stress, as exposure of animals to heat stress activates the hypothalamo-pituitary-adrenal axis (Abilay et al., 1975), and estimation of thyroid hormones could be one of the important indicators for assessment of stress in animals.

T3 and T4 concentrations in all the treatment groups during summer was found to be lower compared to winter. In summer the mean T3 concentration was lowest in treatment 2 (melatonin supplemented) followed by treatment 1 (control) and treatment (Vitamin E supplemented). Increased secretion of thyroid hormones increases body metabolism and hence heat production. Therefore decreased thyroid hormone levels during heat stress were an adaptive response and also might be an attempt to reduce metabolic rate and heat production (West et al. 1999). When the animal starts to suffer due to heat food ingestion is reduced and metabolism slows down, causing a hypo-function of the thyroid (McManus et al., 2009).Similar findings were observed by Prakash and Rathore (1999) in goats.They found significant decrease in thyroid hormones during summer months.On the other hand T3 and T4 concentration are found higher in all the treatment groups in winter compared to summer. Similar finding was reported by Hasin (2015) in goats.The T3 and T4 concentration during winter may be attributed to the fact that there is increased body metabolism contributed by increase in the food intake to maintain the body equilibrium which may be affected by the low environmental temperature leading to stimulative function of the thyroid gland.

CONCLUSION

Seasonal stress caused due to the changes in climatic parameters has profound effect on the hormonal profile of pigs which is manifested by the variation in the hormonal levels during summer and winter. However the harmful effects of seasonal stress can be effectively dealt by incorporating melatonin and Vitamin E inthe feed which can protect the animals by their cell damage preventing action. It also paves a way for further research in specifying the dose of antioxidants depending upon the degree of stress encountered by the animals.

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CONFLICT OF INTEREST

There is no conflict of interest.

AUTHORS CONTRIBUTION

This work was carried out in collaboration between all authors. 'Author AC, AB, BC, JG, AB, DJD, RK and DK' designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. 'Author AC, SN' and 'Author YV' managed the analyses of the study. 'Author DP' managed the literature searches.

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