SEASONAL VARIATIONS IN PHYSIO-BIOCHEMICAL AND ENDOCRINE PROFILES IN GHUNGROO AND LARGE WHITE YORKSHIRE PIGS UNDER INDIAN SUB-TROPICAL SEMI-ARID CLIMATE

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The present study was carried out to see the alterations in physio-biochemical and endocrine profiles of Ghungroo and Large White Yorkshire pigs during different seasons. Respiratory rate, rectal temperature, blood biochemical parameters and hematological parameters were determined during summer, spring and winter season. Results showed that respiratory rate of Large White Yorkshire (LWY) increased significantly ($P>0.05$) during summer whereas rectal temperature decreased during winter. Hemoglobin of LWY was lower during winter whereas packed cell volume (PCV) of both breeds was lower during winter. Both AST and ALT activity of both breeds increased significantly during summer. Total protein concentration and albumin to globulin ratio of both breeds decreased during summer as compared to winter. Creatinine concentration of Ghungroo was lowest during winter. Triglycerides concentration of both Ghungroo and LWY was higher in summer than in spring. T_3 and T_4 concentration of both Ghungroo and LWY decreased during summer season than in winter. Cortisol of LWY increased significantly ($P<0.05$) during summer as compared to spring and winter while there was no change in case of Ghungroo. The study concluded that Ghungroo pigs are more heat tolerant than LWY in terms of physio-biochemical parameters.

Key words: Ghungroo, Large White Yorkshire, Physio-biochemical parameters, Pig, Season

Pig, the “Mortgage lifter” is considered as poor man’s animal protein source next to egg as it produces cheapest meat which can be afforded by the weaker section of the society due to faster growth and high prolificacy (Trivedi, 2013). Moreover, they are the most efficient converters of feedstuffs, household and agricultural

wastes into edible meat. India possesses a number of good indigenous pig breeds namely, Ghungroo (West Bengal), Niam Megha (Meghalaya), Tenyi Vo (Nagaland) Nicobari (Andaman & Nicobar) etc. (ICAR- National Bureau of Animal Genetic Resources; <http://www.nbagr.res.in/regpig.html>) and some non-descript breeds,

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which are well adapted in the Indian sub-tropical semi-arid climate. Some exotic stock of pigs were also introduced in India due to higher feed conversion efficiency and faster growth rate and have higher growth potential than indigenous breeds (Mishra *et al.*, 1989). The energy requirement in pigs depends on the ambient temperature and thus season has tremendous influence on the meat quality, carcass composition, and quality of pork (Lé Bret *et al.*, 2002; Rosenvold and Andersen, 2003). Physio-biochemical profiles are considered as important parameters to evaluate the adaptation of animals to a given geographical location (Sejian *et al.*, 2014; Ribeiro *et al.*, 2015). Therefore, monitoring of these parameters will help to select the animals for climate resilient animal husbandry system as well as to adapt suitable breeding, feeding and management strategies for efficient production performance. To the best of our knowledge, a very little information is available on the physio-biochemical profile of Ghungroo pigs and its comparison with exotic breeds of pigs during different seasons particularly under Indian sub-tropical semi-arid climate. Therefore the present study was undertaken to evaluate the seasonal variations in physio-biochemical profiles of Ghungroo and Large White Yorkshire (LWY) pigs under Indian sub-tropical semi-arid climate.

MATERIALS AND METHODS

Selection of experimental animals : For this investigation Ghungroo (N=30) and Large White Yorkshire (LWY; N =30) male pigs of 7-9 month of age with an average body weight of 65-95 kg were selected from Regional Pig Breeding

Station, Haringhata Farm, Mohanpur, Nadia, West Bengal. The animals were maintained under well ventilated and proper hygienic conditions. The animals had restricted access to feed and *ad libitum* access to drinking water. Routine deworming and vaccination were carried out as followed in the farm.

Blood samples (10 mL) were collected from all the experimental animals from anterior vena cava in heparinized vacutainer during three seasons namely winter (December to January), spring (mid February to mid March) and summer (mid April to mid June) consecutively for two times in each season on fortnight interval. A part of the blood sample was used for hematological analysis and the rest portion of blood was subjected to centrifugation (3000 rpm for 30 min) for separation of plasma.

Recording of meteorological data: All the climatological data (Dry bulb, wet bulb, relative humidity) were obtained from Meteorological unit of the Department of Agricultural Meteorology and Physics, Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia District, West Bengal. Temperature humidity index (THI) was calculated using the formula $THI = 0.72 (T_{db} + T_{wb}) + 40.6$ (Johnson *et al.*, 1963).

Recording of physiological responses: Respiration rate per minute of each of the animals was recorded by visual observations of inward and outward abdominal movement. Rectal temperature was recorded with a digital thermometer by keeping the thermometer in contact with rectal mucosa until the reading stabilizes.

Evaluation of physio - biochemical parameters: Hematological parameters (hemoglobin level, packed cell volume) were determined by routine hematological procedure. Biochemical parameters (ALT, AST, total protein, albumin, albumin:globulin, triglycerides, creatinine) were evaluated by commercially available kits as per manufacturer's instruction. Hormones viz. cortisol, total T_3 and total T_4 were measured by commercially available RIA Kit based on the manufacturer's directions.

Statistical analysis: The statistical significance of differences in means was assessed using SPSS software version 20.0. Two way ANOVA was used for determining the variation in physiological and biochemical parameters with respect to breed and season.

RESULTS

Meteorological parameters: The meteorological data of the experimental site during different seasons under study has been presented in Fig. 1. The average mean ambient temperature was 16.36°C, 21.74°C

and 29.36°C during winter, spring and summer, respectively. Respective RH (%) and rainfall (mm) were 80.88, 78.75, 74.69 and; 0, 14, 2.26. Wind speed (Km/hr) of 2.85, 2.63 and 3.62 were recorded during winter, spring and summer season, respectively. During the experimental days, the average THI during spring season was 70.57 indicating a thermo-neutral condition. During summer season, THI was 82.14 representing heat stress and during winter it was 63.19 indicating cold stress.

Physiological responses: Values of different parameters (physiological and biochemical) of Ghungroo and Large White Yorkshire pigs during winter, spring and summer season have been presented in Table 1. There was no significant difference between seasons in respiratory rate and rectal temperature of Ghungroo while a significant increase ($P<0.05$) in the respiration rate was found in LWY during summer. However, rectal temperature of LWY found to decrease significantly ($P<0.05$) in winter season compared to spring and summer.

Fig. 1. Average environmental conditions at Mohanpur, West Bengal (Latitude: 22°56'N and Longitude: 88°32' E, Altitude: 9.75 meters above mean sea level)

Table 1. Mean values ($\pm$ S.E) of different parameters of Ghungroo and Large White Yorkshire pigs during winter, spring and summer season

Parameters	Ghungroo (n=30)			Large White Yorkshire (n=30)		
	Spring	Winter	Summer	Spring	Winter	Summer
a. Physiological parameters						
Respiration Rate (/min)	25.58 $\pm$ 0.93 ^{ax}	21.0 $\pm$ 1.81 ^{ax}	24.47 $\pm$ 2.11 ^{ax}	25.66 $\pm$ 0.48 ^{ax}	19.58 $\pm$ 0.49 ^{bx}	30.45 $\pm$ 0.55 ^{cy}
Rectal Temp (°F)	99.82 $\pm$ 2.16 ^{ax}	96.36 $\pm$ 1.74 ^{ax}	99.38 $\pm$ 0.67 ^{ax}	101.04 $\pm$ 0.29 ^{ax}	95.06 $\pm$ 0.58 ^{bx}	100.96 $\pm$ 0.61 ^{ay}
b. Hematological parameters						
Hemoglobin (g/dL)	16.53 $\pm$ 0.45 ^{ax}	16.17 $\pm$ 0.33 ^{ay}	15.06 $\pm$ 1.03 ^{ax}	18.24 $\pm$ 0.23 ^{ay}	14.31 $\pm$ 0.48 ^{bx}	16.72 $\pm$ 0.86 ^{ax}
PCV (%)	39.0 $\pm$ 0.73 ^{ax}	37.0 $\pm$ 0.73 ^{ax}	47.8 $\pm$ 1.74 ^{bx}	42.5 $\pm$ 0.76 ^{ay}	39.5 $\pm$ 1.02 ^{ax}	48.42 $\pm$ 1.56 ^{bx}
c. Biochemical parameters						
ALT (IU/L)	22.72 $\pm$ 5.32 ^{abx}	10.11 $\pm$ 1.19 ^{ax}	36.84 $\pm$ 4.59 ^{bx}	23.66 $\pm$ 4.35 ^{ax}	66.85 $\pm$ 8.88 ^{cy}	136.84 $\pm$ 8.18 ^{by}
AST (IU/L)	28.45 $\pm$ 5.71 ^{ax}	43.42 $\pm$ 3.61 ^{ax}	73.66 $\pm$ 4.85 ^{bx}	24.29 $\pm$ 3.04 ^{ax}	147.10 $\pm$ 9.53 ^{by}	156.64 $\pm$ 6.99 ^{by}
Total Protein (g/dL)	10.26 $\pm$ 0.81 ^{ax}	12.73 $\pm$ 0.35 ^{bx}	6.89 $\pm$ 0.59 ^{cx}	11.84 $\pm$ 0.66 ^{ax}	12.12 $\pm$ 0.86 ^{ax}	8.59 $\pm$ 0.48 ^{by}
Albumin (g/dL)	3.12 $\pm$ 0.19 ^{ax}	3.79 $\pm$ 0.35 ^{ay}	3.01 $\pm$ 0.16 ^{ax}	2.78 $\pm$ 0.18 ^{ax}	2.87 $\pm$ 0.09 ^{abx}	3.37 $\pm$ 0.20 ^{bx}
Albumin: Globulin	1.39 $\pm$ 0.17 ^{ax}	0.45 $\pm$ 0.04 ^{bx}	0.96 $\pm$ 0.14 ^{cx}	0.33 $\pm$ 0.04 ^{ax}	0.35 $\pm$ 0.04 ^{ax}	0.69 $\pm$ 0.07 ^{bx}
Triglycerides (mg/dL)	10.26 $\pm$ 0.81 ^{ax}	45.20 $\pm$ 3.58 ^{bx}	45.16 $\pm$ 4.83 ^{bx}	33.18 $\pm$ 4.77 ^{ay}	48.35 $\pm$ 4.81 ^{abx}	61.21 $\pm$ 4.37 ^{by}
Creatinine (mg/dL)	5.22 $\pm$ 0.51 ^{ax}	2.02 $\pm$ 0.22 ^{bx}	5.00 $\pm$ 0.51 ^{ax}	4.65 $\pm$ 0.33 ^{ax}	4.02 $\pm$ 0.22 ^{ay}	4.49 $\pm$ 0.61 ^{ax}
d. Endocrinological profile						
Total Triiodothyronine (T ₃) (nM)	1.10 $\pm$ 0.16 ^{ax}	1.13 $\pm$ 0.02 ^{ax}	1.21 $\pm$ 0.04 ^{ay}	0.94 $\pm$ 0.04 ^{ax}	1.32 $\pm$ 0.06 ^{bx}	0.90 $\pm$ 0.05 ^{ax}
Total Thyroxine (T ₄) (nM)	4.60 $\pm$ 1.37 ^{ax}	41.56 $\pm$ 7.86 ^{bx}	3.83 $\pm$ 1.41 ^{ax}	65.35 $\pm$ 5.18 ^{ay}	44.79 $\pm$ 5.09 ^{bx}	32.77 $\pm$ 3.94 ^{by}
Cortisol (nM)	493.03 $\pm$ 27.24 ^{ay}	373.83 $\pm$ 19.37 ^{by}	566.9 $\pm$ 18.62 ^{ay}	364.66 $\pm$ 44.22 ^{ax}	315.97 $\pm$ 22.98 ^{ax}	337.16 $\pm$ 41.46 ^{ax}

The parameters with different superscript (a, b, c) in a row differ significantly (P<0.05) between season in a breed

The parameters with different superscript (x, y) in a row differ significantly (P<0.05) between breeds in a season

Hematological parameters: During winter the hemoglobin level (g/dL) of LWY decreased significantly ($P<0.05$) whereas no significant ($P>0.05$) difference was found in case of Ghungroo (Table 1). In summer, the packed cell volume (PCV) of Ghungroo and LWY increased significantly ($P<0.05$) as compared to other seasons.

Biochemical profile: The concentration of total protein was increased significantly ($P<0.05$) during winter and decreased during summer compared to spring season (Table 1). In LWY the total protein concentration decreased significantly ($P<0.05$) during summer season. No significant ($P>0.05$) difference was found in albumin concentration among different seasons in Ghungroo, whereas the value was increased significantly ($P<0.05$) in summer in LWY. Albumin/Globulin ratio was found to be decreased significantly ($P<0.05$) in Ghungroo but the concentration increased significantly ($P<0.05$) during summer in LWY. There was no significant difference ($P>0.05$) in creatinine concentration among different seasons in LWY, whereas its concentration found to be decreased significantly ($P<0.05$) during winter season in Ghungroo breed. Triglycerides found to be increased significantly ($P<0.05$) in winter as well as in summer season in Ghungroo but in LWY, triglycerides concentration increased significantly ($P<0.05$) during summer season compared to other seasons. In both the breeds, ALT and AST activity were increased significantly ($P<0.05$) in summer

compared to spring and winter in both the breeds.

Endocrine profile: In LWY, T_3 concentration increased significantly ($P<0.05$) in summer season compared to control and winter, whereas no significant ($P>0.05$) difference was found in T_3 concentration in different seasons in Ghungroo. In Ghungroo, T_4 concentration increased significantly ($P<0.05$) in winter season, whereas in LWY the concentration decreased significantly ($P<0.05$) in both the summer and winter. In Ghungroo, the cortisol concentration increased significantly ($P<0.05$) during summer with respect to control and winter. In contrast, there was no significant ($P>0.05$) difference in cortisol concentration among different seasons in LWY.

DISCUSSION

In pigs, THI above 80 is more stressful (Pourouchottamane *et al.*, 2013). In present investigation, the THI during summer was 82.14, indicating heat stress compared to spring (70.57) and winter (63.19). During spring season the body temperature of animal is maintained at constant level and therefore minimal energy is spent for thermoregulation (Mount, 1968).

The respiratory rate and rectal temperature had no effect on season in Ghungroo, suggesting that it can withstand the variation of environmental conditions without any external physiological changes. But the respiratory rate of LWY was

increased significantly during summer. Increased respiration rate is the first physiological indicator of heat stress along with increased water-to-feed ratio, followed by decreased heat production and feed intake as reported previously (Pourouchottamane *et al.*, 2013).

During winter, the decreased hemoglobin concentration of LWY was supported by the findings of Chmielowiec-Korzeniowska *et al.* (2012). In present study, higher level of PCV during summer found in both Ghungroo and LWY, that indicates the possible reason of dehydration during heat stress causing a release of erythrocytes concentrated in the spleen (Reece, 2005). According to Hicks *et al.* (1998), PCV and Hb concentration were not influenced by season in pigs which is not in accordance to our study.

In Ghungroo breed, the concentration of total protein was increased significantly ($P < 0.05$) during winter and decreased significantly ($P < 0.05$) during summer compared to spring season, whereas in LWY the total protein value decreased significantly in summer season but there was no significance difference between spring and summer season. It may be due to the fact that during summer the basal metabolic rate (BMR) decreases due to heat stress, so also the total protein value (Pourouchottamane *et al.*, 2013). Similar observations were seen in albumin concentration whereas albumin to globulin ratio increases during summer compared to

winter. It may be due to lower immunity status during heat stress (Chmielowiec-Korzeniowska *et al.*, 2012). A significant increase in the triglycerides value in both the breeds during summer season compare to spring is in accordance to authors reported previously (Chmielowiec-Korzeniowska *et al.*, 2012). The reason behind this may be the cortisol amount increases during acute stress which further aggravates lipolysis causing release of triglycerides to the serum. There was no significant difference ($P > 0.05$) in creatinine concentration among different seasons in LWY, whereas a decreased creatinine concentration during winter season in Ghungroo breed might be due to less activity of creatinine kinase in winter (Chmielowiec-Korzeniowska *et al.*, 2012).

The serum ALT and AST activity was significantly increased during summer in both the breeds under study. The activities of plasma enzymes such as ALT and AST increase in humans after severe exercise (Kayashima *et al.*, 1995) and in Friesian calves after exposure to heat during summer season (Marai *et al.*, 1995). Similar observation was found in the present study also.

Total triiodothyronine (T_3) and total thyroxine (T_4) concentration was significantly less during summer season compared to winter and spring season. This is might be due to the fact that during hot season there is low BMR which indicates the lower values of T_3 and T_4 as reported

earlier (Pourouchottamane *et al.*, 2013). In LWY, the cortisol concentration increased significantly ($P<0.05$) during summer with respect to spring and winter which is in accordance to previous report (Hicks *et al.*, 1998). The cause behind the non significant increase in the cortisol concentration in Gungroo breed among different seasons might be due to the reason that this native indigenous breed is better adopted to our climatic condition than the cross breed.

In conclusion, it is substantiated the adaptability of native Gungroo breed to withstand heat stress compared to exotic LWY breed under Indian sub-tropical semi-arid climate and thus can be propagated for climate resilient animal farming. All the animals were able to maintain their body

homeostasis during spring or thermo-neutral conditions without showing much alterations in their physio-biochemical and endocrine profiles compared to summer and winter season, so as the feeding and other managerial interventions can be formulated accordingly.

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