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Effect of swine-origin probiotic *Pediococcus acidilactici* FT28 on maintenance of antioxidant status, blood haematology and biochemical profile in early weaned grower-finisher pigs

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ABSTRACT

An experiment was conducted with early weaned crossbred piglets (36) to evaluate antioxidant status and blood biochemical profile in grower-finisher pigs. The piglets were distributed into three groups (4 replicates of 3 each) and supplemented with basal diet either without probiotics (T0) or with a probiotic of dairy based (*Lactobacillus acidophilus* NCDC-15; T1) or swine based (*Pediococcus acidilactici* FT28; T2). Blood was collected at 45, 90 days (grower phase) and 136, 180 days (finisher phase) of feeding and analysed for various antioxidants and metabolites. Results of the study revealed that supplementation of probiotics improved superoxide dismutase (SOD), catalase and reduced glutathione (GSH) activity in early weaned grower-finisher pigs. Whereas, GSH activity was better in *P. acidilactici* FT28 fed group compared to *L. acidophilus* fed group. Serum glucose level was reduced in both T1 and T2 groups compared to control, which was further reduced in T2 group compared to T1. The total protein, albumin and globulin level in serum remained higher in T2 group in comparison to other dietary groups. Serum triglyceride and LDL-cholesterol was lower in *P. acidilactici* FT28 fed group. The HDL-cholesterol level was better by probiotic supplementation in grower-finisher pigs. It was concluded that supplementation of host-origin probiotic was effective to reduce stress besides having potential to improve blood biochemical profile.

Key words: Antioxidant, Biochemical, Haematology, *Pediococcus acidilactici*, Pigs, Probiotic, Weaning stress

Weaning of piglets is a natural process which occurs over several weeks or months. But due to modern practices of intensive farming, piglets are weaned early between 15–28 days of age to maximise annual sow productivity and uniform body weight at slaughter (Smith *et al*. 2008). Weaning leads to abrupt change of diet from liquid to solid feed, which made piglets more susceptible towards *E. coli* infection and diarrhoea. However, use of antibiotics to treat infectious diseases induce weaning stress leading to development of resistance in bacteria and presence of residues in animal product (Jin *et al.* 1998). This resulted in introduction of probiotic, which may prevent colonization of pathogens by stimulating growth of healthy microbiota with increased intestinal permeability (Lee *et al*. 2012). The positive outcome of probiotic feeding depends on source of the probiotic because adhesion of probiotics and its colonization in intestine is species-specific (Chiang *et al*. 2015). Therefore, supplementation of *Pediococcus acidilactici* FT28 (swine origin) in feed, expelled *Escherichia coli* and increased lactic acid bacteria (LAB) population resulting in healthy gut microbiota and reduced diarrhoea scores (Dowarah *et al.* 2017); also superior to *Lactobacillus acidophilus* NCDC-15 (dairy based) in terms of nutrients utilization, and immune responses in grower-finisher pigs (Dowarah *et al*. 2016).

Weaning leads to production of various reactive oxygen species (ROS) and prolonged excess of ROS may oxidise host biomolecules like lipids, proteins and DNA resulting in dysbalance of functional anti-oxidative network of the host (Petrof *et al*. 2004). Probiotics exhibit antioxidant activity by releasing small-molecular-weight molecules and free-radical scavenger glutathione which may help in management of oxidative stress in gut lumen, mucosal cells and blood (Capcarova *et al*. 2010,Kumar *et al*. 2016). There are lots of new discovery of LAB strains with potential probiotic properties but scanty information is available regarding their action in blood haematology and biochemical profile and antioxidant modulation, particularly of species-specific probiotics in pigs. Keeping the above background in view, we hypothesized that dietary supplementation of host-origin probiotic could improve blood biochemical profile and antioxidant status in early weaned grower-finisher pigs.

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MATERIALS AND METHODS

Animals, experimental design and probiotic supplementation: The study was approved by Institutional Animal Ethics Committee followed by CPCSEA, Govt. of India. A total of 36 weaned (28 day old), Landrace × local crossbred piglets with an average weight of 7.56±0.45 kg were reared at the Swine Production Farm, ICAR-Indian Veterinary Research Institute, India. The piglets were divided into 3 groups with 4 replicates of 3 each using completely randomized design and fed nutritional adequate basal diet as per NRC (1998). The following treatments of the animals were arranged: T0, group received basal diet; T1, group received basal diet with dairy origin live *Lactobacillus acidophilus* NCDC15 (10^9 CFU/ml in MRS broth) and T2 group received basal diet with swine origin live *Pediococcus acidilactici* FT28 (10^9 CFU/ml in MRS broth). Host-origin probiotic was developed in our laboratory and identified as *Pediococcus acidilactici* FT28 (GenBank Accession Number -KU837245, KU837246, KU837247).

The probiotics were supplied through fermenting the ground maize with either of the overnight culture (Agarwal *et al*. 2002) and fed @ 200g/day/head. Probiotic product was mixed into the basal diet in the morning (0900 h) by subtracting the equal amount of maize. Clean freshwater and feed were given *ad lib.* throughout the experimental period of 180 days.

Blood sampling and analyses: Blood samples were collected from cranial vena cava in the morning (before watering and feeding) into anticoagulated vaccutainer tubes from all the pigs at 45 and 90 day (grower phase); 136 and 180 day (finisher phase) of feeding trial.The haematological profile *viz.* haemoglobin (Hb), packed cell volume (PCV), red blood cell (RBC) and white blood cell (WBC) of the whole blood was analyzed with Haematology Analyser by Clindiag system B.V.B.A according to manufacturer condition. The blood serum was separated from whole blood by centrifugation at 3000 *g* for 30 min.The metabolites like glucose, total protein, total cholesterol, HDL-cholesterol and triglycerides were determined colorimetrically using commercial diagnostic kits (Span Diagnostics Pvt. Ltd., India) by UV-VIS dual beam PC scanning spectrophotometer model UV-2601 (Labomed, USA). The globulin concentration was calculated by subtracting the albumin from total protein. LDL-cholesterol was calculated from total cholesterol, HDL-cholesterol and triglyceride as per Basoglu *et al*. (2002).

Superoxide dismutase (SOD) in the haemolysate was estimated by using nitro blue tetrazolium as a substrate after suitable dilution as per the method of Marklund and Marklund (1974) with certain modifications (Menami and Yoshikawa 1979). Catalase was analysed by the spectrophotometric method using H_2O_2 as a substrate (Bergmeyer 1983). Reduced glutathione (GSH) activity in packed RBC was measured by 5,5-dithiobis-(2-nitro-benzoic acid; DTNB) method as per the procedure of Prins and Loos (1969). Whereas, the haemolysate and RBC suspension were prepared from whole blood as per the

Table 1. Effect of feeding different probiotic on general blood metabolic profile of pigs

Treatment†	Days				Mean	Significance‡		
	Grower phase		Finisher phase			T	P	T×P
	45	90	136	180				
Red blood cell (10^{12}/*l*)								
T0	4.50±0.19	4.51±0.10	4.82±0.09	4.71±0.06	4.63^{A}±0.06	<0.001	0.467	0.100
T1	4.76±0.06	5.13±0.13	5.02±0.13	4.91±0.07	4.95^{B}±0.05			
T2	5.00±0.00	4.65±0.11	4.76±0.09	4.89±0.08	4.82^{B}±0.04			
Average	4.75±0.08	4.76±0.08	4.86±0.06	4.84±0.04				
White blood cell (10^{9}/*l*)								
T0	9.61±0.59	12.38±0.84	18.91±0.64	19.25±0.79	15.04±0.82	0.730	<0.001	0.052
T1	12.38±1.15	13.19±0.83	18.05±0.86	18.30±0.70	15.47±0.65			
T2	9.50±0.59	14.46±0.50	18.05±0.79	19.21±0.98	15.31±0.76			
Average	10.49^{X}±0.53	13.34^{Y}±0.45	18.34^{Z}±0.43	18.92^{Z}±0.47				
Haemoglobin (*g/dl*)								
T0	8.70^{bcd}±0.15	10.50^{f}±0.33	9.96^{e}±0.33	9.44^{de}±0.21	9.96^{B}±0.17	<0.001	<0.001	<0.001
T1	8.50^{abc}±0.33	7.76^{a}±0.31	9.13^{cd}±0.25	8.78^{bcd}±0.21	8.54^{A}±0.16			
T2	8.50^{abc}±0.19	8.03^{ab}±0.28	8.46^{abc}±0.14	9.33^{de}±0.17	8.58^{A}±0.13			
Average	8.50^{X}±0.13	8.76^{Y}±0.31	9.18^{Z}±0.19	9.18^{Z}±0.12				
Packed cell volume (*%*)								
T0	35.17^{cd}±0.52	28.32^{a}±1.14	31.18^{b}±0.44	36.33^{d}±0.61	32.75^{A}±0.62	<0.001	<0.001	<0.001
T1	35.38^{cd}±1.10	29.17^{ab}±0.77	33.58^{c}±0.77	34.44^{cd}±0.68	33.14^{A}±0.59			
T2	35.25^{cd}±0.56	41.75^{e}±0.96	34.96^{cd}±0.96	35.07^{cd}±0.53	36.76^{B}±0.62			
Average	35.27^{Y}±0.43	33.08^{X}±1.39	33.24^{X}±0.53	35.28^{Y}±0.37				

†No probiotics (T_0), *L. acidophilus* (T_1) and *P. acidilactici* FT28 (T_2). $^{ABC/XYZ}$Means with different superscript within a column (ABC) or row (XYZ) differ significantly. ‡Significant effects of dietary treatment (T), period (P) or their interaction (T×P).

standard protocol (Choubey *et al*. 2015). Albumin content of grower-finisher pig blood was assayed by spectrophotometer UV 2061 using commercial kit (Span Diagnostics Pvt. Ltd., India) according to manufacturer instruction.

Statistical analysis: The data were statistically analyzed using the software package SPSS statistics for Windows (Version 20.0, IBM Crop., Armonk, NY). A two-way analysis of variance (ANOVA) was used for comparison of means according to Duncan's multiple range tests (Duncan 1995). The effects were considered to be significant at P<0.05 and P<0.01.

RESULTS AND DISCUSSION

The measurement of haematology and serum biochemistry in farm animals can provide a significant evidence about the health and metabolism of the animals (Friendship and Henry 1992).

Haematological profile: The supplementation of basal diet with either of the probiotic improved (P<0.001) RBC count in grower-finisher pigs compared to control (Table 1). No significant variation was observed in case of RBC count due to period-wise comparison. The WBC counts remained similar among the dietary groups, however, period-wise variation showed a significant (P<0.001) increase of WBC count at finisher phase (136 and 180d) in comparison to grower phase (45 and 90d).This was in agreement with Chen *et al*. (2005) who observed no significant effect on WBC and lymphocyte count due to supplementation of complex probiotics (*L. acidophilus*, *B. subtilis* and *S. cerevisiae*) in growing pigs. Previous studies also showed a positive correlation between dietary levels of probiotics and haematological indices like, RBC and WBC in rabbit (Onifade and Tewe 1993) and broiler chickens (Onifade 1997). On the contrary, Prieto *et al*. (2014) revealed that pigs on *B. pumilus* treatment had lower (P<0.05) different leucocytes count compared to control and medicated (apramycin and zinc oxide) groups.The Hb concentration decreased (P<0.001) in both the probiotic fed groups accompanying with a significant (P<0.001) treatment × period interaction. However, period-wise comparison showed higher (P<0.001) level of Hb in finisher pigs compared to grower pigs. In the same line, Hossein *et al*. (2014) showed that feeding of *B. subtilis* and *B. licheniformis* (Bioplus 2B) @ 0.5 or 1 g/kg of feed in growing lambs resulted in a significant (P<0.05) decrease in the level of Hb, PCV, and increase in mean corpuscular volume (MCV) and mean corpuscular hemoglobin (MCH) levels. An opposite picture was obtained in PCV value indicating better (P<0.001) effects of probiotic supplementation; whereas, period-wise average values were significantly (P<0.001) higher at 45 and 180 day of experiment as compared to 90 and 160 day. A significant interaction between treatment × period was achieved in PCV values, resulting in highest (P<0.001) PCV level at 90 day of experiment by *P. acidilactici* FT28 supplementation.The contrast results observed in various studies may be due to using of different strains, various doses and concentration of probiotic in different species and length of treatment periods (Jahreis *et al*. 2002).

Table 2. Effect of feeding different probiotic source on blood energetic profile of pigs

Treatment†	Days				Mean	Significance‡		
	Grower phase		Finisher phase			T	P	T*P
	45	90	136	180				
Glucose (*mg/dl*)								
T0	84.00±2.21	111.4±3.69	97.25±4.35	102.9±2.03	98.88^{C}±2.35	<0.001	<0.001	0.178
T1	81.25±4.39	94.01±4.41	93.15±2.79	96.74±5.62	91.29^{B}±2.36			
T2	79.25±1.94	87.30±2.65	81.50±3.11	88.28±4.65	84.08^{A}±1.67			
Average	81.50^{X}±1.73	97.56^{Z}±2.92	90.63^{Y}±2.37	95.97^{YZ}±2.70				
Triglyceride (*mg/dl*)								
T0	46.79±9.03	38.75±3.16	38.01±5.21	75.47±4.56	49.77^{B}±3.56	0.002	<0.001	0.312
T1	46.65±6.90	30.00±1.33	31.18±2.36	71.59±8.33	44.76^{AB}±4.62			
T2	33.69±10.1	37.99±4.18	28.09±3.82	58.88±4.83	39.02^{A}±4.59			
Average	41.52^{Y}±4.98	35.58^{XY}±1.91	32.43^{X}±2.35	68.38^{Z}±4.78				
Total protein (*g/dl*)								
T0	5.65^{ab}±0.10	6.08^{bc}±0.35	6.43^{bc}±0.09	5.81^{abc}±0.20	5.99^{A}±0.12	<0.001	0.005	0.002
T1	5.07^{a}±0.19	5.18^{a}±0.16	6.32^{bc}±0.14	6.67^{c}±0.54	5.79^{A}±0.19			
T2	7.65^{d}±0.32	8.79^{e}±0.38	7.85^{d}±0.32	8.24^{de}±0.26	8.14^{B}±0.17			
Average	6.06^{X}±0.26	6.67^{Y}±0.36	6.87^{Y}±0.19	6.90^{Y}±0.29				
Globulin (*g/dl*)								
T0	2.03^{a}±0.28	2.66^{ab}±0.27	2.70^{ab}±0.12	2.32^{ab}±0.23	2.43^{A}±0.12	<0.001	0.016	0.007
T1	2.56^{ab}±0.18	2.14^{ab}±0.22	2.65^{ab}±0.10	2.26^{ab}±0.42	2.40^{A}±0.13			
T2	4.26^{cd}±0.35	4.85^{d}±0.39	4.00^{c}±0.27	3.03^{b}±0.30	4.03^{B}±0.20			
Average	2.92^{XY}±0.24	3.22^{Y}±0.29	3.12^{Y}±0.16	2.53^{X}±0.19				

†No probiotics (T_0), *L. acidophilus* (T_1) and *P. acidilactici* FT28 (T_2). $^{ABC/XYZ}$Means with different superscript within a column (ABC) or row (XYZ) differ significantly.‡Significant effects of dietary treatment (T), period (P) or their interaction (T×P).

Table 3. Effect of feeding different probiotic source on blood cholesterol status of pigs

Treatment†	Days				Mean	Significance‡		
	Grower phase		Finisher phase			T	P	T×P
	45	90	136	180				
Total cholesterol (*mg/dl*)								
T0	58.93^{a}±17.5	96.73^{bc}±16.1	141.4^{ef}±9.87	107.3^{cd}±6.18	101.1±8.32	0.101	<0.001	<0.001
T1	57.45^{a}±11.9	81.81^{b}±17.4	158.8^{f}±14.5	122.2^{de}±6.42	104.9±9.05			
T2	39.89^{a}±6.06	87.92^{b}±10.8	107.6^{cd}±12.1	138.8^{ef}±8.57	93.57±8.02			
Average	52.12^{X}±7.56	88.82^{Y}±8.75	135.8^{Z}±8.67	122.8^{Z}±4.77				
HDL-cholesterol (*mg/dl*)								
T0	21.00^{de}±1.56	18.81^{bcd}±2.67	13.78^{ab}±2.34	13.18^{a}±1.78	16.71^{A}±1.26	0.008	<0.001	0.032
T1	18.09^{abc}±1.02	27.75^{f}±2.12	15.47^{abc}±1.17	18.59^{abc}±1.73	19.97^{B}±1.12			
T2	20.89^{cde}±2.10	23.87^{f}±1.20	18.31^{abc}±0.89	17.36^{b}±1.20	20.12^{B}±0.74			
Average	20.02^{Y}±0.94	23.48^{Z}±1.38	15.85^{X}±0.96	16.40^{X}±1.07				
LDL-cholesterol (*mg/dl*)								
T0	31.66^{ab}±6.74	70.25^{de}±7.35	121.9^{f}±9.64	82.20^{e}±6.49	76.50^{B}±7.71	0.001	<0.001	0.014
T1	30.05^{ab}±5.65	48.00^{bc}±9.63	120.5^{f}±7.30	81.85^{e}±2.79	70.11^{B}±6.99			
T2	14.04^{a}±3.76	56.38^{cd}±5.26	81.73^{e}±9.19	80.09^{e}±1.59	58.06^{A}±4.74			
Average	25.25^{X}±3.49	58.21^{Y}±4.62	108.0^{Z}±6.21	81.38^{XY}±2.32				

†No probiotics (T_0), *L. acidophilus* (T_1) and *P. acidilactici* FT28 (T2). $^{ABC/XYZ}$Means with different superscript within a column (ABC) or row (XYZ) differ significantly.‡Significant effects of dietary treatment (T), period (P) or their interaction (T×P).

Blood energetic profile: The plasma glucose level was reduced (P<0.001) in both probiotic supplemented group with lowest glucose value in *P. acidilactici* FT28 fed group compared to *L. acidophilus* supplemented group (Table 2). A significant period effect was observed for plasma glucose level which reflected increasing trend with increase in phase of the growth. Probiotic supplementation could alter gut microflora, which may be responsible for modification of gut hormone secretion and improvement of glucose homeostasis (Yadav *et al.* 2008). In contrast to our results, previous studies reported increased (P<0.05) serum glucose level in pigs (Kumar *et al*. 2012) and broilers (Hedayati *et al*. 2015) by supplementation of *Saccharomyces cerevisiae* and probiotic + acidifier, respectively.

The serum triglyceride level decreased (P=0.002) in *P. acidilactici* FT28 fed group compared to control, where *L. acidophilus* supplemented group had intermediate value. Hypolipemic effect of *P. acidilactici* FT28 may be due to either by lowering intestinal absorption of lipids or by higher catabolism of lipid (Taranto *et al*. 1998). However, period wise comparison showed that the lowest (P<0.001) level of serum triglyceride was observed at 136 day of experiment, while treatment × period interaction did not show any significant effect. The present findings were in agreement with recent study of Gilliland *et al*. (1985), who reported a significant decrease of serum triglyceride level in pigs after administration of *Lactobacillus*.

The plasma protein concentration at any given time would reflect the function of hormonal balance, nutritional status, water balance and other factors affecting the state of health.A positive effect (P<0.001) was obtained on serum total protein content in *P. acidilactici* FT28 supplemented group as compared to *L. acidophilus* and control (Table 2). However, period-wise average means were significantly (P=0.005) lower at 0–45 day period compared to rest of the periods. Treatment × period interaction also showed higher (P<0.05) serum protein values in T2 group as compared to T0 and T1 groups during entire growth period. Unlike serum total protein, the serum globulin level was higher (P<0.005) in T2 group compared to other dietary groups. Period-wise comparison showed significantly (P<0.05) lower serum globulin on day 180, which was comparable with 45 day of the measurement. Treatment × period interaction revealed in consistently higher (P<0.05) serum globulin content in T2 group compared to T0 and T1 groups. Dong *et al*. (2013) also observed that dietary supplementation of *L. plantarum* GF103 and *B. subtilis* B27 in weaned piglets, increased (P<0.05) serum concentrations of total protein, albumin and globulin creatinine as compared to control animals post 14 days of feeding, while our results were in disagreement with Chen *et al*. (2005) who reported that there was no significant effect on total serum protein and albumin level by feeding of complex probiotics in growing pigs.

Blood cholesterol status: The serum total cholesterol levels did not differ significantly due to supplementation of both the probiotic; however, treatment × period interaction exhibited lower (P<0.001) serum total cholesterol level in grower phase compared to finisher phase (Table 3). The serum levels of HDL-cholesterol was higher (P=0.008) in T2 group as compared to T0 group and level for T1 group was intermediate and comparable to both. A significant (P<0.032) interaction between period and treatment revealed with improved serum HDL-cholesterol in probiotic fed (T1 and T2 groups) animals compared to control at 90 day of estimation. Reduced (P=0.001) LDL-cholesterol level in serum was obtained by supplementation of *P. acidilactici* FT28, which was further lowered

Table 4. Effect of feeding different probiotics source on erythrocytic antioxidant profile of pigs

Treatment†	Days				Mean	Significance‡		
	Grower phase		Finisher phase			T	P	T*P
	45	90	136	180				
Reduced glutathione (*mg/100 ml packed RBC*)								
T0	$1.26^{a}\pm0.06$	$1.21^{a}\pm0.07$	$2.39^{d}\pm0.17$	$1.90^{bc}\pm0.09$	$1.69^{A}\pm0.10$	<0.001	<0.001	0.018
T1	$1.19^{a}\pm0.06$	$1.73^{b}\pm0.12$	$2.35^{d}\pm0.10$	$2.01^{c}\pm0.07$	$1.82^{B}\pm0.09$			
T2	$1.34^{a}\pm0.04$	$1.69^{b}\pm0.04$	$2.67^{e}\pm0.09$	$2.29^{d}\pm0.08$	$2.00^{C}\pm0.10$			
Average	$1.26^{W}\pm0.03$	$1.54^{X}\pm0.07$	$2.47^{Z}\pm0.08$	$2.06^{Y}\pm0.06$				
Catalase (*Unit/mg Hb*)								
T0	60.99±8.16	49.02±1.97	39.54±1.91	48.88±1.87	$49.61^{A}\pm2.50$	<0.001	0.002	0.574
T1	68.41±7.02	65.74±4.09	41.75±2.64	53.66±2.91	$57.39^{B}\pm2.86$			
T2	74.15±7.14	68.62±2.95	43.83±2.46	55.32±2.08	$60.48^{B}\pm2.91$			
Average	$67.85^{Z}\pm4.27$	$61.13^{Z}\pm2.49$	$41.71^{X}\pm1.35$	$52.62^{Y}\pm1.41$				
Superoxide dismutase (*Unit/mg Hb*)								
T0	71.24±1.74	131.6±12.5	84.14±4.44	82.30±1.95	$92.32^{A}\pm5.26$	<0.001	<0.001	0.843
T1	74.42±2.51	155.5±9.77	103.8±6.49	93.98±5.35	$106.9^{B}\pm6.22$			
T2	87.94±9.14	159.1±6.07	111.7±9.78	100.3±5.81	$114.7^{B}\pm6.17$			
Mean	$77.86^{X}\pm3.42$	$148.7^{Z}\pm5.97$	$99.88^{Y}\pm4.67$	$92.18^{Y}\pm3.02$				
Albumin (*g/dl*)								
T0	$3.62^{cde}\pm0.26$	$3.42^{bc}\pm0.14$	$3.72^{cde}\pm0.11$	$3.49^{bc}\pm0.13$	$3.56^{A}\pm0.08$	<0.001	<0.001	<0.001
T1	$2.51^{a}\pm0.07$	$2.99^{b}\pm0.12$	$3.67^{cde}\pm0.10$	$4.40^{f}\pm0.23$	$3.39^{A}\pm0.14$			
T2	$3.39^{c}\pm0.13$	$3.95^{e}\pm0.18$	$3.85^{de}\pm0.10$	$5.21^{g}\pm0.13$	$4.10^{B}\pm0.14$			
Average	$3.13^{X}\pm0.13$	$3.45^{XY}\pm0.12$	$3.75^{Y}\pm0.06$	$4.37^{Z}\pm0.17$				

† No probiotics (T_0), *L. acidophilus* (T_1) and *P. acidilactici* FT28 (T_2).$^{ABC/XYZ}$Means with different superscript within a column (ABC) or row (XYZ) differ significantly. ‡Significant effects of dietary treatment (T), period (P) or their interaction (T×P).

(P=0.001) at 45 day of measurement. The interaction of treatment × period also had positive impact on serum levels of LDL-cholesterol. In the same line, Du Toit *et al*. (1998) reported that isolated *L. johnsonii* and *L. reuteri* from swine faeces had high bile-salt hydrolase activity by which serum cholesterol levels were lower after three weeks of feeding in grower-finisher pigs. Similarly, Khan *et al*. (2011) indicated that feeding of three different probiotics to broilers *viz.* protexin, biovet and yoghurt in drinking water had reduced (P<0.05) serum cholesterol contents compared to control.

Erythrocytic antioxidant status: The GSH activity in packed RBC was higher (P<0.001) in T1 and T2 groups compared to T0, which was better in *P. acidilactici* FT28 fed (T2) animals than *L. acidophilus* (T1) supplemented pigs (Table 4). The effect was significantly (P<0.001) higher in finisher pigs in comparison to grower animals. Further, it was confirmed by interaction of treatment × period with higher (P=0.012) GSH activity in T2 group amongst the other groups during finisher phase. In the same line, Cai *et al*. (2014) observed that suckling piglets administered with *L. fermentum* increased (P<0.05) plasma concentration of glutathione, the glutathione peroxidase activity and total antioxidant capacity. On the contrary, Castex *et al*. (2010) showed no significant influence of probiotic supplementation on the GSH levels. The catalase activity was increased in probiotic supplemented groups as compared to non-supplemented pigs. Period-wise comparison showed higher (P<0.001) catalase activity at grower phase compared to finisher. While, interaction of treatment × period did not show any significant effect on catalase activities.The concentration of SOD was higher (P<0.001) in supplemented groups compared to control. No significant variation was observed among probiotic fed groups. The effect of period was significant (P<0.001) for SOD, with higher value at 90 day. The present finding was in agreement with Wang *et al.* (2009) who observed that addition of *L. fermentum* (2×10^7 CFU/g) in the diet increased total serum antioxidant capacity (P<0.01) in grower pigs, while SOD and glutathione peroxidase increased (P<0.01) in finisher pigs. Wang *et al.* (2012) reported that supplementation of *L. plantarum* ZLP001 (6.8×10^7) in weaning piglets increased (P<0.05) serum concentration of superoxide dismutase, glutathione peroxidase and catalase. The present findings suggests that supplementation of swine origin *P. acidilactici* FT28 was effective in improving antioxidant status of the pigs, when compared with *L. acidophilus* (dairy origin).The serum albumin content was improved (P<0.001) by supplementation of host-specific probiotic (T2 group), which increased (P<0.001) gradually as the experiment progressed and being highest at 180 day of feeding.

In conclusion, the results of the present experiment showed that supplementation of probiotics had a positive effect on raising antioxidant status, blood haematology and energetic profile in early weaned grower-finisher pigs. Whereas, *Pediococcus acidilactici* FT28 was more effective as compared to *Lactobacillus acidophilus* NCDC15 in

maintenance of glucose homeostasis, lipid profile and antioxidant status. Therefore, the use of host-origin probiotic is more appropriate technology for maintaining health status of the animals.

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