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https://dx.doi.org/10.4314/nvj.v39i1.10 **ORIGINAL ARTICLE**

Comparative Evaluation of Growth Performance, Serum Biochemical Profile and Immunological Response of the Nigerian Indigenous and Large White x Landrace Crossbred Pigs

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SUMMARY

This study was conducted to compare growth performance, immunological response, and biochemical profile between local or Nigerian indigenous pigs (NIP) and exotic Large White x Landrace crossbred pigs (LWL). Twenty weanling pigs, aged six weeks were divided into groups A (NIP) and B (LWL); each group was randomly assigned into two replicates of five pigs. Feed and animal management were similar and study lasted ten weeks. Their feed and water intake, average daily weight gain (ADG), and gain: feed or feed efficiency were determined. All the pigs were vaccinated with1 ml of 10 % sheep RBC per pig at week 4 and boosted at week 7. Their antibody titres and serum biochemical profiles were determined using standard procedures. Daily feed and water intake and weight gain were significantly ($p < 0.05$) higher in LWL than NIP. There was no significant ($p > 0.05$) difference in their gain: feed but figures were higher in NIP. Although LWL had higher antibody titres at weeks 1 of initial and revaccination, NIP recorded higher titres at weeks 2, 3 and 4 of initial and 2 of revaccination, respectively. Albumin levels in both groups showed a significant ($p = 0.003$, $t = 8$) difference in their mean on week 1 following initial vaccination, their values being 4.29 ± 0.05 and 4.67 ± 0.08 g/dL for groups A and B, respectively.The NIP showed significantly ($p < 0.05$) higher total protein and globulin throughout the period of assay. Although the LWL grew faster and had better immediate immunological performance, the NIP recorded slightly higher feed efficiency and more sustained antibody titres post vaccination with Sheep RBC.

Key words: Swine, growth performance, serum biochemistry, sheep RBC, antibody titres, Nigeria

INTRODUCTION

According to FAO report, the estimated world pig population was 977 million in 2013, with about 8.01 million in Nigeria (FAO, 2015). Available breeds of pig in Nigeria include exotic pigs, their crosses and

local or indigenous pigs (FLD, 1992; Oseni, 2008). Indigenous pigs; although generally known to be slow in growth and poor in reproductive and productive traits, is known to be rich in genetic variability that enable them resist diseases and adapt well to variable tropical climatic conditions than exotic pigs (Fetuga *et al*., 1976; Agbagha *et al*., 2001; Oseni, 2008). These poor productive traits, if not improved, could make them unfit for the much desired commercial swine enterprise in the tropics (Umesiobi, 2000; Aladi *et al*., 2008).

Productivity of any breeding stock is dependent on its reproductive efficiency, growth rate and feed conversion efficiency (Aladi *et al*., 2008; Bogoro, 2017). Livestock productivity can be best maximized when the animals concerned are healthy and or can respond fast immunologically through the production of antibodies against invading pathogenic organisms. The best indicator of animal's well-being and potential for production is its health status (Jain, 1986).

The most common methods used for accessing health status in animals are through the determination of their haematological and biochemical profiles, immune status or the three (Kahn and Line 2010). These parameters have been found useful in disease diagnoses, prognoses, therapy and feed stress monitoring in man and animals (Eze *et al*., 2015).

Antibody response to Sheep RBC is the most sensitive endpoints available in assessing alterations to the immune system (Holsapple, 1995). Thus, assessment of the primary antibody response to a T-dependent antigen such as sheep RBC (SRBC) has been reported to provide one of the best predictors of immunotoxicity in mice (Luster *et al*., 1992). This endpoint has subsequently become the cornerstone of recent guidelines for assessing the potential immunotoxicity of xenobiotics (Holladay and Smialowicz, 2000).

The determination of these parameters also reflects the physiological responsiveness of the animals to its internal and external environments (Esonu*et al.,* 2014). They are also excellent medium for the measurement of potential biomarkers, because their collection is relatively noninvasive and encompasses an enormous range of physiological process in the body at any given time (Anderson *et al*., 2002; Ginsburg and Haga, 2006).

Data on these parameters will no doubt be valuable in the improvement of NIP strain which is an important strategy for the overall development of the pig industry in Nigeria.

Although haematological and biochemical profiles of exotic pigs have been widely documented (Radostits *et al*., 2003; Blood *et al*., 2007; Kahn and Line 2010), among the Nigerian strains, available data are mostly from those with naturally acquired infectious diseases. There is also paucity of information on comparative immune profile between NIP and the exotic pigs or their crossbreed. The specific objectives of this study were therefore to (i) compare production parameters of NIP with LWL managed under similar conditions, (ii) compare theirserum biochemical profiles and (iii) determine and compare their immune responseswhen challenged with sheep RBC; a non-infectious complex antigen.

MATERIALS AND METHODS

Animal selection and management

This study was carried out at the Teaching/Research Farm of the Faculty of Veterinary Medicine, University of Nigeria Nsukka, Nigeria. To avoid potential differences due to age, gender or season, only male pigsborn within the same week were used. Experimental animals comprised10 NIP and 10 LWL male pigs that averaged 42 ± 3 days of age and weighed 3.10 ± 0.29 and 6.90 ± 0.43kg, respectively.

While the LWL (exotic) were purchased from the Piggery Unit of Veterinary Teaching/ Research Farm, University of

Nigeria Nsukka., the NIP (local) were F_2 progeny of a boar and two sows sourced from Katsina-Alah Local Government Area of Benue State, North Central Nigeria but had been maintained for more than three years at the Department of Animal Science Farm, University of Nigeria, Nsukka for teaching and research.

After selection, the pigs were stabilized for 2 weeks during which they were fed the same weaner diet, screened for ecto and endo parasites. Thereafter, they were de-wormed with Ivomec Super® (Merial, France) and given antibiotic cover; using Temadox® L.A. 20% (Hebei Huarun Pharmacy Co. limited China).

Experimental design

After the two weeks of stabilization, the two animal groups were transferred to a grower house that is well-ventilated, fly proof and has concrete floors equipped with feeding and drinking troughs. They were kept in twopens of equal dimension and each group randomly assigned to two replicates of five pigs. They were fed same grower diets containing 4.86kcal ME/kg and 16% crude protein *ad libitum* and had free access to clean drinking water throughout the study period. During this period, data on their weekly feed and water intake, weight gain, gain: feed ratio (feed efficiency) and biochemical parameters were recorded. The pigs were vaccinated with washed sheep RBC at week 4 and a booster was administered at week 7 of study.

Data collection

The weekly weight gain of pigs and feed intake were determined using a hoist scale (Diamond®, Taiwan) by subtracting respective weights (kg) at the previous week from the weights (kg) at the present week. Their weight gain to feed intake ratio was determined by dividing the weekly weight gained (kg) by feed consumed in kg. Daily weight gain and feed intake were determined by dividing their respective weekly figures by seven. Antibody titres were determined after vaccination of the animals with the sheep RBC.

Collection and preparation of sheep red blood cell

During the preparation of sheep red blood cells (SRBC) suspension, blood was obtained from healthy sheep. About 15 ml of sheep blood was collected under aseptic conditions from the jugular vein in anticoagulant Alsever solution. The red blood cells were washed three times with equal volume of Phosphate Buffered Saline (PBS). After the final wash, the packed cells were brought to 10% and 1% vol/vol solution in PBS (Martins *et al*., 1990). After this, 1ml of the prepared RBC in phosphate buffered saline was used to immunize all the experimental animals intravenously on week 4 and a booster dose administered on the 7th week of study.

Serology

About 1.5 ml of blood were collected intravenously with sterile syringe from each of the experimental animals, and emptied into two sterile bottles, without any anticoagulant. After serum extraction, one was used for the determination of biochemical indices while the other was used for the determination of serum antibody levels against the sheep RBC.

Haemagglutination (HA) test procedure

Total antibody titres to SRBC were determined by agglutination with routine procedure (Van Der Zijpp and Leenstra, 1980). Antibody titres measure against SRBC was expressed as $\log^2$ of the reciprocal of highest plasma dilution giving complete agglutination. All titrations were assessed the same day in 96-microtitre plates, using erythrocytes from the same sheep to immunize the pigs.

Serum Biochemical Techniques

Total serum protein was determined in each sample following the biuret method using the standard Randox diagnostic kit (Randox

Laboratories, LED UK). Serum albumin concentration was determined following the bromocresol green method (Doumas, 1971), using the standard Randox diagnostic kit (Randox Laboratories, LED UK). The serum globulin fraction was calculated by subtracting the value of the albumin fraction from the total serum protein.

Statistical analysis

Data generated on growth performance was analyzed by independent sample t-test. Result on biochemical tests were analyzed with t-test in Graph-pad Prism Statistical software version 5.02. Significance was accepted at $p < 0.05$. On the other hand, results on immune response were converted to $\log^2$ of the antibody titre (Fetuga *et al*., 1977).

RESULTS

Growth performance

Average daily feed and water intake and ADG of the LWL were significantly ($p < 0.05$) higher than those of NIP (Table I). Similarly, mean initial and final body weights of LWL were significantly ($p < 0.05$) higher than those of NIP pigs. However, mean gain: feed of both breeds were not statistically ($p > 0.05$) significant but was higher among the NIP (Table I).

Serum biochemistry

Statistically, values of serum albumin in both groups indicated no significant ($p > 0.05$) difference (Table II). At week 3, the LWL recorded significantly ($p < 0.05$) higher serum albumin concentration than NIP ($p = 0.003$, $t = 8$). From week 4, the weekly mean albumin levels of both groups appeared to have stabilized and showed no significant ($p > 0.05$) differences. However, LWL pigs generally had higher numerical values of albumin than NIP throughout the 10-week study period (Table II).

The baseline value of the serum globulin level of the NIP was significantly ($p < 0.05$) higher than that of LWL pigs ($P = 0.038$, $t = 8$). From week 4, the NIP also showed a significantly ($p < 0.05$) higher globulin fraction than LWL at weeks 3 and 5, respectively ($P = 0.007$, $t = 8$; $P = 0.003$, $t = 8$). All through, the assay period, the NIP breed maintained higher serum globulin when compared to its LWL counterpart (Table III).

The serum total protein levels of NIP and LWL followed similar trend with that of globulin fraction. The NIP showed significantly ($p < 0.05$) higher serum total protein values than LWL at weeks 0 ($P = 0.00$, $t = 8$), 3 ($P = 0.034$, $t = 8$) and 5 ($P = 0.011$, $t = 8$), respectively (Table IV).

Immune responses

Antibody response to sheep RBC in both groups of experimental animals prior to vaccination was zero (Figure I). One-week post vaccination, their antibody responses rose slightly to 2.1 and 1.5 GMT in LWL and NIP, respectively. The antibody titres of 2.8, 3.2 and 2.3 GMT recorded in NIP on weeks 2, 3 and 4of initial vaccination were higher than 2.3, 2.0 and 1.5 GMT obtained among the LWL pigs within the same period

TABLE I: Comparative growth performance of Nigerian indigenous and Large White x Landrace pigs (mean ± SEM)

Parameters	Nigerian Indigenous pigs	Large Whit x Landrace pigs
Average initial body weight (kg)	3.10 ± 0.29^{b}	6.90 ± 0.43^{a}
Average daily feed intake(kg)	0.32 ± 0.03^{b}	0.60 ± 0.07^{a}
Average daily water intake(L)	0.53 ± 0.07^{b}	1.64 ± 0.09^{a}
Average daily weight gain (kg)	0.07 ± 0.00^{b}	0.12 ± 0.02^{a}
Gain: feed	0.28 ± 0.03^{a}	0.21 ± 0.03^{a}
Average Final Body Weight (kg)	8.96 ± 0.90^{b}	15.18 ± 0.83^{a}

Means on the same column with different superscript are significant at 5 %

TABLE II: Comparative weekly serum albumin (g/dL) levels of the Nigerian indigenous and Large White x Landrace pigs following vaccination with sheep RBC

Group statistics					
Weeks	Group	N	Mean (g/dL)	t-value	p-value
0	Local Pigs	10	3.64±0.25	8	0.263
	Exotic Pigs	10	3.30±0.12		
1	Local Pigs	10	3.50±0.12	8	0.823
	Exotic Pigs	10	3.56±0.21		
2	Local Pigs	10	3.63±0.09	8	0.256
	Exotic Pigs	10	3.77±0.07		
3	Local Pigs	10	3.29±0.05	8	0.003
	Exotic Pigs	10	3.67±0.08		
4	Local Pigs	10	3.82±0.10	8	0.803
	Exotic Pigs	10	3.87±0.17		
5	Local Pigs	10	3.87±0.19	8	0.106
	Exotic Pigs	10	3.32±0.16		
6	Local Pigs	10	4.40±0.11	8	0.111
	Exotic Pigs	10	4.67±0.10		

Significance taken at p <.05

TABLE III: Comparative weekly serum globulin (g/dL) levels of the Nigerian indigenous and Large White x Landrace pig following vaccination with sheep RBC

Group Statistics					
Week	**Group**	**N**	**Mean (g/dL)**	**t-value**	**p-value**
0	Local Pigs	10	3.46 ± 0.29	8	0.038
	Exotic Pigs	10	2.64 ± 0.16		
1	Local Pigs	10	3.20 ± 0.25	8	0.264
	Exotic Pigs	10	2.83 ± 0.18		
2	Local Pigs	10	3.47 ± 0.14	8	0.052
	Exotic Pigs	10	3.09 ± 0.08		
3	Local Pigs	10	3.11 ± 0.25	8	0.007
	Exotic Pigs	10	2.06 ± 0.15		
4	Local Pigs	10	3.63 ± 0.13	8	0.321
	Exotic Pigs	10	3.36 ± 0.22		
5	Local Pigs	10	3.91 ± 0.17	8	0.003
	Exotic Pigs	10	3.01 ± 0.12		
6	Local Pigs	10	2.13 ± 0.36	8	0.406
	Exotic Pigs	10	1.72 ± 0.29		

Significance taken at p < 0.05

(Figure I). At week 1 of revaccination, both breeds showed a peak in antibody responses, with LWL recording higher titre than the NIP (21.1 vs.13.9 GMT). However, atweek 2 post revaccination (week 6 of assay), there was a sharp decline in antibody titres of both groups, with the values of 9.8 GMT in NIP pigs being higher than 9.2 GMT recorded for LWL (Figure I).

DISCUSSION

Our observation that daily feed intake and ADG values were significantly higher (p < 0.05) in LWL than NIP (Table I) is in line with the report other study where they reported average feed intake of 0. 147 and 0.326 kg/ day and daily gain of 0.078 and 0.126kg/pig for the Nigerian local and Large

TABLE IV: Comparative weekly total protein (g/dL) levels of the Nigerian indigenous and Large White x Landrace pigs following vaccination with sheep RBC

			Group Statistics		
Weeks	Group	N	Mean (g/dL)	t - value	p - value
0	Local Pigs	10	7.10 ± 0.13	8	0.000
	Exotic Pigs	10	5.95 ±0.06		
1	Local Pigs	10	6.70 ± 0.21	8	0.295
	Exotic Pigs	10	6.39 ± 0.18		
2	Local Pigs	10	7.10 ± 0.20	8	0.285
	Exotic Pigs	10	6.84 ± 0.11		
3	Local Pigs	10	7.40 ± 0.22	8	0.034
	Exotic Pigs	10	6.73 ± 0.08		
4	Local Pigs	10	7.45 ± 0.13	8	0.336
	Exotic Pigs	10	7.23 ± 0.18		
5	Local Pigs	10	7.78 ± 0.12	8	0.011
	Exotic Pigs	10	7.33 ± 0.06		
6	Local Pigs	10	6.53 ± 0.39	8	0.760
	Exotic Pigs	10	6.39 ± 0.22		

Significance taken at $p < 0.05$

White breeds reared in Ibadan, South Western Nigeria (Ilori and Adepoju, 1980).

We noted that NIP was more curious and restless than LWL; an observation that is consistent with other findings (Ilori and Adepoju, 1980). This curiosity and restlessness may have contributed to the low feed intake noted among the NIP and should be considered when adopting appropriate husbandry technique for NIP.

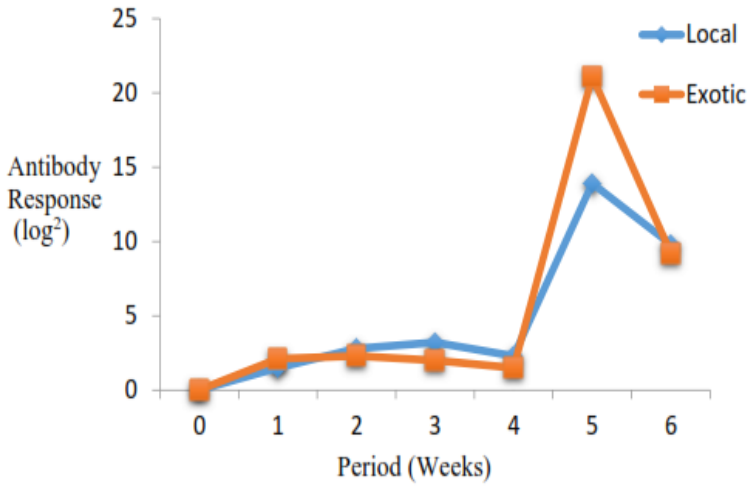

Figure I: Geometric mean antibody titres (GMT) of Nigerian indigenous (local) and Large White x Landrace (exotic) pigs

However, the daily weight gain of the NIP in our study is lower than figures reported by other researchers (Goonewardene *et al.*, 1984; Pathiraja and Oyedipe 1990; Serres, 1992). The Nigerian indigenous pigs unlike the exotic breeds have not been standardized and developed (Omeke, 1989; Pathiraja and Oyedipe 1990). Therefore, these discrepancies could be attributed to genotypic variation across different agro-ecological zones of Nigeria.

Average daily gain of 0.32 kg /day recorded for LWL in our study (Table I) is lower than the values that have been reported in other exotic crossbred pigs within the tropical regions of Africa (Ilori *et al.*, 1976; Oseni, 2008). In the farms where the LWL was sourced, available records showed that a lot

of inbreeding has been taking place within the herd for some years now.

Inbreeding is a mating system in which mated individuals have one common ancestor appearing several times up to three to four generations back in the pedigree (Damron, 2009). The comparative low ADG and viability in LWL we observed in this study might have been caused by inbreeding depression which usually accompanies such practice (Udo, 1982; Damron, 2009).

There was no statistical significant ($p > 0.05$) difference in gain: feed of LWL and NIP; although these figures were in favour of the NIP (Table I). This is in line with the work of another researcher (Codjo,2003), who compared the performance of indigenous and exotic pigs on restricted feed intake and found that although the exotic pigs exhibited faster growth rates with leaner carcasses, the indigenous pigs had higher gain: feed.

However, our finding is at variance with the report of another study in Seri Lanka (Goonewardene *et al.*, 1984), where they compared pre-weaning traits of their indigenous pigs, pure-bred Large White, and indigenous × Large White crosses and noted that the Large White was significantly better in feed efficiency than the indigenous pigs. These variations tend to support the reported rich genetic variability of indigenous pigs found within the tropical countries (Fetuga *et al*., 1976; Agbagha *et al*., 2001; Oseni, 2008).

The comparative slightly higher gain: feed of the NIP when compared to LWL in this study might also be due to lower crude protein content of the feed used (16%). The gain: feed of indigenous pigs of West Africa is known to be higher when they are fed low crude protein (Pathiraja and Oyedipe, 1990) and low energy (Guthrie, 2011) diets. This variation in nutrient requirements would therefore necessitate the adoption of appropriate feeding regimen while raising the NIP.

In this study, average daily water consumption, was significantly ($p < 0.05$) higher in the LWL than NIP (1. 64 vs. 0.53 L). The figure for LWL was within the range values of daily water consumption by grower pigs (Kaysen *et al*., 1989; Adenkola *et al*., 2009; Almond, 2011), while that of NIP was below. Since water intake is correlated to feed intake, variation in their water intake could be due to the fact LWL, consumed significantly more feed (Table I). Again the system of husbandry of NIP unlike the exotic pigs is usually extensive in which they may not always have access to drinking water (FLD, 1992) and may therefore have adapted to low water intake.

The comparative higher growth performance of the exotic pigs or their crosses over the indigenous breeds which has further been observed in this study was earlier reportedto be the reason for their present dominance in most intensive piggeries of Sub-Saharan Africa countries (Udo, 1982; Omeke, 1989). Notwithstanding, higher gain: feed of the NIP when maintained on low protein diet as we noted could be an advantage it has over the LWL. This is particularly important in view of the fact that in most tropical countries, cost of animal feed ingredients particularly protein sources is very high (Aka *et al*., 2009; Bogoro, 2017) and could therefore be beyond the reach of many pig farmers.

Biochemical tests which refers to the analysis of blood plasma or serum represents the functioning of organs or systems (Villegas and Purchase, 1989) and related data could be used to determine health status (Dubreuil and Lapierre, 1997; Eze *et al*., 2015). Thus, comparative serum biochemical profile analysis for the pigs was determined in this study with a view to understanding their physiological changes when immunized with a non-infectious complex antigen such as the sheep RBC.

In this study, we used the biochemical reference values for pigs (Villegas and Purchase, 1989) as our guide. An interesting finding was that baseline (week 0) values of total protein, albumin and globulin which were within the reference values were higher

in NIP than in LWL pigs (Tables II, III and IV). Again total protein and globulin fraction were higher in NIP than LWL but also within our reference values throughout the period of immunization. Since the two animal groups were of the same age and under similar management condition, this could possibly suggest a more efficient protein intake or absorption (Villegas and Purchase, 1989) or an earlier maturation of digestive system (Cooper *et al*., 2014) of the NIP than LWL and possibly lays credence to other reports (Udo, 1982; Holness, 1991), that the African indigenous pigs mature and attain puberty earlier than their pure breed counterparts.

We also observed that the clotting time of NIP blood was much shorter than that of LWL pigs. Although, data on this our observation is not available, it has not been reported to best of our knowledge. Therefore, more studies might be required in this regard. Comparing our result with the reference values, albumin levels were within normal range before the immunization and on weeks 1, 2 and 4 following immunization for both groups. This is at variance with other studies done with pigs of different ages and sexes (Yeom, 2012). We therefore opine that the variations in these findings could be age, gender-related or both.

On week 6 of exposure to sheep RBC, serum albumin concentration in both groups rose higher than the reference values. This suggests that their exposure to the sheep RBC for a period of six weeks might have resulted in inflammatory reaction or paraproteinemia (Villegas and Purchase, 1989).

From the results of the antibody assay, we observed that after the first and booster immunization; the LWL had averagely higher levels of antibody titres than NIP (Figure I). This tends to suggest that when the two breeds are challenged by the same disease agent in the field, that LWL would possibly give a better immediate immunological performance than the NIP. This comparative better immunological performance of LWL could possibly be an advantage of this breed over NIP in disease diagnoses where an introduction of infectious agent can rapidly be detected. On the other hand, the ability of NIP to maintain higher antibody titres after initial and revaccination (Figure I) could also be an advantage it has over its LWL counterparts in situation of disease monitoring through sero-surveillance.

Following booster immunization three weeks later, the antibody response rose to reach a peak in both breeds (Figure I). This observation is reminiscent with an earlier report, that following a second exposure to the same antigen in most animal species, antibody response is usually quicker and higher (Villegas and Purchase, 1989).

Under the conditions of this study, although LWL grew faster and had better immediate immunological performance than the NIP, the NIP had higher feed efficiency and more sustained antibody titres. The NIP also recorded higher values of total protein and globulin throughout the study period. This research could provide important fundamental data for further immunological studies in NIP.

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