Journal of Reproduction and Infertility 7 (3): 75-80, 2016
ISSN 2079-2166

DOI: 10.5829/idosi.jri.2016.7.3.104100

Stages of Gestation in Mixed Breed Sows: Haematological and Serum Biochemical Parameters

[1]O.O. Ajala, [2]J.O. Abiola, [1]A. Akinjiola, [1]T.O. Ojomo and [3]E.S. Samuel

[1]Department of Veterinary Surgery and Reproduction,
Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
[2]Department of Veterinary Medicine,
Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria
[3]Department of Veterinary Physiology, Biochemistry and Pharmacology,
Faculty of Veterinary Medicine, University of Ibadan, Ibadan, Nigeria

Abstract: The haematological and serum biochemical parameters of mixed breed sows during stages of gestation were investigated. Fifteen sexually matured mixed breed sows (*Suis domestica*) allotted into five groups (A to E) of 3 sows each were used. Group A: Non-pregnant, Group B: First trimester (0 - 38 days), Group C: Second trimester (39 – 78 days), Group D: Third trimester (79 – 115 days) and Group E: After parturition (1-7 days). Blood samples were collected at each stage. The packed cell volume (PCV%), haemoglobin concentration (HBg/dL), red blood cell (RBC$\times 10^6$/µL), mean corpuscular volume (MCVfL), mean corpuscular haemoglobin (MCHpg), mean corpuscular haemoglobin concentration (MCHCg/dL),platelet count($\times 10^5$/µL), total and differential white blood cell (WBC$\times 10^3$/µL) count, total protein (TPg/dL), albumin(g/dL), globulin (g/dL), alanine aminotransferase (ALTu/L), alkaline phosphatase (ALPu/L) and aspartate aminotransferase (ASTu/L) were determined. The PCV and RBC values for Group E was significantly reduced ($P<0.05$) as compared with Groups A, C and D. Group E values for HB was also significantly reduced ($P<0.05$) as compared with Groups C and D. The MCHC values followed similar trend, moreover, there was a significant increase ($P<0.05$) in MCV and MCH values in Group E as compared with Group C. The total and differential WBC values for Group C was significantly reduced ($P<0.05$). This reduction was majorly seen when compared with Groups D and E. However, the platelets, total WBC and neutrophils count values for Group C was significantly reduced ($P<0.05$) as compared to Group A, B and E respectively. Group B showed significant reduction ($P<0.05$) in eosinophils values as compared with Groups C, D and E. There was no significant difference ($P>0.05$) in total protein, albumin, globulin and liver enzymes; AST, ALT and ALP values for all the groups except that there was a significant reduction ($P<0.05$) in albumin values of Group E as compared to Group B. Conclusively, parturition causes reduction in erythrocytes parameters in sows. Therefore, erythrocytosis in bred sows can be used in complementing the diagnosis of pregnancy after non-return to estrus when monitored.

.

Key words: Sows · Gestation · Haematology · Serum biochemistry

INTRODUCTION

The distribution of animal production and increase animal population are globally not even, especially in Asia, America and Europe. Consequently therefore, in Africa, animal production and population especially in pig rearing has recently grown more rapidly, reflecting increased adoption of pig husbandry in a continent where "livestock" has traditionally been taken to mean "ruminants" [1]. It has been reported that Nigeria, in western part of Africa has the highest pig population in Africa [2]. Pigs rearing in Nigeria thrive well under a wide range of ecological condition [3], moreover, productivity of breeding stock is largely dependent on its growth rate, reproductive and feed conversion efficiency that are largely of genetic origin and amenable to routine day-to-day manipulation [4, 5].

Corresponding Author: A. Akinjiola, Department of Veterinary Surgery and Reproduction, University of Ibadan, Nigeria. Tel: +2348077673573, E-mail: akinjil@gmail.com.

Domestication of pigs provided man with a more uniform supply of meat called pork [6, 7] and by-products such as pigskin and bristle; used in the manufacture of light leather and brushes especially in Asian countries [8]. The pig's output; yield of meat/tonne of live weight of breeding pigs especially sows per year is about six times that of cattle [9] and pigs can be raised for their entire lifetime in an enclosures without having to suffer the consequences of overgrazing [9].

The importance of metabolic profile in sow husbandry has been well considered[10] and the examination of blood for their constituents has also been used to monitor and evaluate health and nutritional status of animals [11- 15]. The changes in these parameters have also been studied in cattle [16], sheep [17] and red sokoto goats [18]. Blood parameters in pigs have been reported to vary depending on sex, age, geographical location and experimental procedures [19-22]. Nutrition, breed and crossbreeding, pregnancy and oestrus, housing, starvation, environmental factors, stress and transportation are also known to affect haematological and serum biochemical parameters [23, 24].

Realistic evaluation of the management practice, nutrition and diagnosis of health condition could be of importance for comparison and clinical evaluation in pregnancy detection. However, there is paucity of information on the effects of pregnancy on the haematology and serum biochemistry of sows during gestation. Moreover, the information and data collected during this study are attempted to serve as a base for reference intervals and also provide a relationship with other values in other species of animals for correlation and comparison eventually, adding to the available resource of knowledge in swine production and veterinary medicine.

MATERIALS AND METHODS

Experimental Animal: Fifteen sexually matured mixed breed sow (2years of age) were used for this study. The animals were obtained from the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria and the animals were handled according to the care and use of animal in the University of Ibadan. The animals were mated and cared for on the farm during the period of the study.

Experimental Protocol: The fifteen sexually matured mixed breed sows (*Suis domestica*) were allotted into five groups (A to E) of 3 sows each. Group A: Non-pregnant, Group B: First trimester (0 - 38 days), Group C: Second trimester (39 – 78 days), Group D: Third trimester (79 – 115 days) and Group E: After parturition (1-7 days). The animals were housed at the farrowing units of the Teaching and Research Farm, University of Ibadan under a stable room condition of 25±2ºC, 12hours daylight and 12hours dark. Feeding of the animals was done regularly and water given *ad libitum*.

Blood samples were collected for the procedures in the early hours of the day via the vena cava: located at an angle formed between the trachea and the forelimb when extended outwards with physical restraining using the snout and slip-knots. A sterile 5ml syringe was used in the collection of blood into plain universal bottles and bottles containing Ethylene Diamine Tetra-Acetic Acid (EDTA).

The serum obtained was used for biochemical analysis of total protein (TP), albumin, globulin, described by Weichselbaum [25], alanine aminotransferase (ALT), alkaline phosphatase (ALP) and aspartate aminotransferase (AST) using standard laboratory kits (Randox, UK)described by Reitman and Frankel [26].while the blood samples collected into the EDTA containers were used for the analysis of packed cell volume (PCV), haemoglobin concentration (HB), red blood cell (RBC) count and total and differential leucocytes (WBC) count; lymphocytes (Lym), Neutrophils (Neu), Monocytes (Mon) and Eosinophils (Eos), by the microhaematocrit, cyanomethaemoglobin and haemocytometer methods respectively [20, 27].

Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were calculated from the PCV, RBC and the HB values already obtained.

$$\text{MCV (fL)} = \frac{\text{PCV (\%)}}{\text{RBC (}\times 106/\mu\text{L)}} \times 100$$

$$\text{MCH (pg)} = \frac{\text{Hb (g/dl)}}{\text{RBC (}\times 106/\mu\text{L)}} \times 100$$

$$\text{MCHC (g/dl)} = \frac{\text{Hb (g/dl)}}{\text{PCV (\%)}} \times 100$$

Statistical Analysis: The data from the sample collected were statistically analysed using analysis of variance (ANOVA) and Student t-test. Graphpad prism version 4.0 was used. Differences were considered significant at $P<0.05$.

RESULTS

Haematological Parameters in Mixed Breed Sows: The PCV and RBC values for Group E was significantly reduced (P<0.05) as compared with Groups A, C and D. Group E values for HB was also significantly reduced (P<0.05) as compared with Groups C and D (Table 1). The MCHC values followed similar trend, moreover, there was a significant increase (P<0.05) in MCV and MCH values in Group E as compared with Group C.

The total and differential WBC values for Group C was significantly reduced (P<0.05). This reduction was majorly seen when compared with Groups D and E. However, the platelets, total WBC and neutrophils count values for Group C was significantly reduced (P<0.05) as compared to Group A, B and E respectively. Group B showed significantly reduction (P<0.05) in eosinophils values as compared with Groups C, D and E (Table 2).

Serum Protein Parameters in Mixed Breed Sows: The results for the serum biochemical analytes are shown in table 3 and it showed that there was no significant difference (P>0.05) in total protein, albumin, globulin and liver enzymes; AST, ALT and ALP values for all the groups except that there was a significant reduction(P<0.05) in albumin values of Group E as compared to Group B.

Table 1: Erythrocytes parameters of mixed breed sows at different stages of gestation

Parameters	Pre-Gestation	1st Trimester	2nd Trimester	3rd Trimester	Post- gestation
PCV (%)	38.7 ± 0.67[a]	36.7 ± 4.18	42.0 ± 2.08[b]	39.0 ± 0.58[c]	35.3± 0.33[abc]
HB (g/dL)	12.0 ± 0.33	12.2 ± 1.62	13.9 ± 0.67[a]	12.7 ± 0.06[b]	11.5 ± 0.13[ab]
RBC (×10^6/µL)	6.4 ± 0.11[a]	6.0 ± 0.75	7.2 ± 0.27[b]	6.6 ± 0.04[c]	5.4 ± 0.13[abc]
MCV (fL)	60.9 ± 0.09[a]	61.3 ± 0.73	58.0 ± 0.98[b]	61.9 ± 2.14	62.1 ± 0.45[ab]
MCHC (g/dL)	32.0 ± 0.74	33.0 ± 0.61	33.8 ± 0.15[a]	32.9 ± 0.67	32.4 ± 0.18[a]
MCH (pg)	19.4 ± 0.49	20.3 ± 0.27	19.5 ± 0.23[a]	20.4 ± 0.67	20.3 ± 0.17[a]

Values are expressed as mean±SEM.

[a-c]Values with the same superscript within rows are significantly different (P<0.05).N=3.

Table 2: Leucocytes and thrombocytes parameters of mixed breed sows at different stages of gestation

Parameters	Pre- Gestation	1st trimester	2nd Trimester	3rd Trimester	Post- gestation
WBC (×10^3/µL)	10.1 ± 4.55	16.0 ± 1.45[a]	7.8 ± 1.67[abc]	15.90 ± 20[b]	16.8 ± 1.28[c]
Lym (×10^3/µL)	6.94 ± 3.50	11.90 ± 1.79	5.91 ± 1.39[a]	10.40 ± 0.58[a]	9.21 ± 1.48
Neu (×10^3/µL)	2.87 ± 1.09	3.36 ± 0.42	2.67 ± 0.27[a]	3.30 ± 0.51	4.31 ± 0.31[a]
Mon (×10^3/µL)	0.12 ± 0.06	0.16 ± 0.09	0.16 ± 0.01[a]	0.26 ± 0.02[a]	0.24 ± 0.04
Eos (×10^3/µL)	0.24 ± 0.15	0.56 ± 0.10[abc]	0.19 ± 0.03[a]	0.15 ± 0.02[b]	0.24 ± 0.04[c]
Plat (×10^5/µL)	2.06 ± 0.06[a]	2.05 ± 0.42	1.20 ± 0.06[abc]	2.82 ± 0.42[b]	2.34 ± 0.10[c]

Values are expressed as mean±SEM.

[a-c]Values with the same superscript within rows are significantly different (P<0.05). N=3.

Table 3: Serum biochemical parameters of mixed breed sows at different stages of gestation

Parameters	Pre- Gestation	1st Trimester	2nd Trimester	3rd Trimester	Post- gestation
Total Protein (g/dL)	7.97 ± 0.42	8.23 ± 0.27	7.70 ± 0.40	7.27 ± 0.33	7.57 ± 0.03
Albumin (g/dL)	4.70 ± 0.32	4.90 ± 0.21[a]	4.37 ± 0.35	4.03 ± 0.32	4.27 ± 0.07[a]
Globulin (g/dL)	3.27 ± 0.15	3.33 ± 0.07	3.33 ± 0.07	3.23 ± 0.03	3.30 ± 0.06
Albumin/Globulin	1.44 ± 0.08	1.47 ± 0.04	1.31 ± 0.08	1.25 ± 0.09	1.29 ± 0.04
AST (u/L)	18.0 ± 1.15	20.3 ± 1.86	20.0 ± 1.15	19.7 ± 0.88	19.3 ± 2.40
ALT (u/L)	31.7 ± 3.18	31.3 ± 1.33	32.0 ± 3.61	32.0 ± 2.65	31.7 ± 1.20
ALP (u/L)	64.0 ± 11.7	65.0 ± 1.14	71.3 ± 11.7	65.0 ± 9.54	63.7 ± 9.56

Values are expressed as mean±SEM.

[a]Values with the same superscript within rows are significantly different (P<0.05).). N=3

DISCUSSIONS

The haematological and biochemical changes at different stage of gestation are of importance in monitoring the physiology and health status of the sow and also that of the developing foetus. The haematological parameters in this study were within the reference range for pigs [28]. However, increase in PCV, HB and RBC values were more pronounced in th2e second and third trimester in this study and are likely due to the increased foetal development that occurs during this period. Thus, this produces a greater oxygen demand in which the endocrine system stimulates the release of erythropoietin; the primary regulator of erythropoiesis in the mammalian foetus and the adult as described by Zanjani *et al.*, [29]. Hytten [30], indicated that the response in red cell mass rises proportionately to the need to carry the extra oxygen taken up in pregnancy and the bone marrow becomes increasingly active and produces extra red blood cells to go with the excess fluid volume [31].

The decreased in PCV, HB and RBC values at the third trimester could probably be due to the mobilization of maternal haemoglobin into foetal circulation and also the dilution of blood which occurs as a consequence of increased plasma volume during this period [32]. Ozegbe [33], reported that the reduction in the erythrocyte count and haemoglobin values in pregnant animals may be related to the physiological anaemia occurring due to hemodilution. Zvorc *et al.* [34], also reported a significant decrease in RBC, PCV and HB values during the third trimester and the post-gestational period; occurring 2 weeks before parturition and till end of lactation. This reduction in PCV, HB and RBC values occurring during the third trimester of gestation, represents the main cause of "pregnant physiological anaemia" a clinical condition described in various species [35].

Anaemia may also develop as a result of the expansion of the vascular space faster than the expansion of the total-body erythrocyte mass. This hemodilution contributes to the anaemia of the neonate and to the mild anaemia that develops during pregnancy in most domestic animals, the horse being an exception [36, 37]. The increased mean MCV and HB and MCHC value decreased at the third trimester may suggest an increase in the number of immature erythrocytes, which would be in accordance with findings in pregnant rats, rabbits and women [35]. The total and differential WBC values observed were within the reference range for pigs[28]. However, the slight increase in the values for these parameters at the first trimester is probable due to response of the immune system to pregnancy recognising it as a foreign body.

The Total protein, albumin and globulin values in this study were fairly stable and comparable [28]. However, a continuous decrease in albumin values from the first trimester to third trimester and the significant reduction in its value for Group E when compared with Group B is in agreement with earlier reports [38, 39, 40]. This decline is probably due to the increased foetal growth, in which amino acids from the maternal circulation are utilized for protein synthesis in the foetal muscles and increased expansion of extracellular fluid. Theodore *et al.* [41], indicated that a decrease in albumin can be seen in pregnancy and increased globulin can also be seen in third trimester of pregnancy, which was observed in this study.

AST, ALT and ALP values did not differ significantly, but were within the reference range for pigs [28]. Tran [40], indicated an exception of ALP values increasing during pregnancy, being of placenta origin, which was observed in this study during the second trimester. AST gradually increased from the second trimester to the post-gestation period. The production of AST is not specific to the liver as the muscle is another source, but liver damage can be suspected in such cases of increased AST levels.

CONCLUSION

Blood parameters are good indicators of pregnancy, in which the body adjusts its physiological and homeostatic mechanisms to ensure the foetus grows properly and receives adequate nutrition. Conclusively, parturition causes reduction in erythrocytes parameters and there was no alteration in the serum biochemical parameters of the sows during and after gestation. Therefore, erythrocytosis in bred sows can be used in complementing the diagnosis of pregnancy after non-return to estrus when monitored.

REFERENCES

1. FAO, 2012. Pig and animal production: Food and Agriculture Organization (FAO) Animal Production and Health Division. Retrieved October 28, 2013 from http://www.fao.org/ag/againfo/themes/en/pigs/production.html.

2. Adebambo, O., 1982. Evaluation of genetic potential of the Nigeria indigenous Pig. 2nd world conference on genetics applied to livestock. Madrid, Spain.
3. Balogun, T.F. and D.B. Olumeyan, 1988. The position of swine in Nigeria's livestock industry. Samaru Journal of Education, 2: 8-15.
4. Adebambo, A.O., 1981. Comparison of the indigenous and exotic pure and crossbreed sows in Southern Nigeria: Relationship dam and litter performance. Nig. J. Anim. Prod., 8: 67-74.
5. Adebambo, A.O., 1983. Comparative growth and carcass performance of progenies sired by purebred; Large White and Hampshire boars and their crosses with the Nigerian local breeds. Nig J. Anim. Prod., 10: 124-129.
6. Chandy, K.T., 2004. Pig introduction: Breeds and Characteristics. Retrieved March 22, 2013 from http://www.inseda.org/additional material/CD-Agriculture and Environment Education/24-Animal Husbandry – Pigs (PGS)/Pig Introduction-190.doc.
7. Ayalew, W., G. Danbaro, M. Dom, S. Amben, F. Besari, C. Moran and K. Nidup, 2011. Genetic and cultural significance of indigenous pigs in Papua New Guinea and their phenotypic characteristics. Animal Genetic Resources, doi: 10.1017/S2078633611000026. 48: 37-46.
8. Young, M., 2005. Efficiency of pork production: a USA, Canada and Ireland comparison. Allen D. Leman Swine Conference, pp: 124.
9. Mpofu, I. and S.M.M. Makuza, 2003. Pig production science and technology, 1st ed., Upfront Publishing, UK.
10. Radostits, O.M., C.C. Gay, D.C. Blood and K.W. Hinchcliff, 2000. Diseases caused by nutritional deficiencies. In: Veterinary Medicine. 9th ed. London, New York, Philadelphia, San.
11. Hawkey, C.N. and A. Dennett, 1989. A colour atlas of comparative veterinary haematology. Wolfe Medical Publication, England. pp: 192.
12. Banasor, U.U., B.M. Anene, A.B. Chime, T.O. Nnaji, J.I. Eze and A.G. Ezekwe, 2003. Haematology of normal and trypanosome infected Muturu cattle in south-eastern Nigeria. Nig J Anim Prod., 30(2): 236-241.
13. Adenkola, A.Y. and L.A. Durotoye, 2004. Haematological study during pre-partum and postpartum periods in brown savannah does in Zaria. Proceedings of 38th Annual Conference, Agricultural Association of Nigeria. pp: 538-540.
14. Gupta, A.R., R.C. Putra, M. Saini and D. Swarup, 2007. Haematology and serum biochemistry of Chital (Axis axis) and barking deer (*Muntiacus muntjak*) reared in semi-captivity. Vet. Res. Comm., 31: 801-808.
15. Adenkola, A.Y., J.O. Ayo, A.K.B. Sackey and A.B. Adelaiye, 2009. Haematological and serum biochemical changes in pigs administered with ascorbic acid and transported by road for four hours during the harmattan season. Journal of Cell and Animal Biology, 3(2): 21-28.
16. Ghergariu, S., G.J. Rowlands, N. Popand and A. Moldova, 1984. A comparative study of metabolic profiles obtained in dairy herds in Romania. British Veterinary Journal, 140: 600-608.
17. Kaushish, S.K. and K.L. Arora, 1977. Studies on reproduction in Sheep. Blood and plasma contents before and after parturition in Neli sheep. Haryna Veterinarian, 16(2): 74-77.
18. Tambuwal, F.M., B.M. Agaie and A. Bangana, 2002. Haematological and biochemical values of apparently healthy Red Sokoto Goats. Proceeding of 27th Annual Conference, Nigerian Society of Animal Production (NSAP), March, 17-21, FUTA, Akure, Nigeria. pp: 50-53.
19. Egbunike, G.N. and M.O. Akusu, 1983. Breed and sex influences on porcine haematological picture under hot humid climatic conditions. Vet Res. Commun., 6(2): 103-109.
20. Jain, N.C., 1993. Essentials of veterinary hematology (Jain, N. B., Ed.). Lea &Febiger. Philadelphia.
21. Radostits, O.M., D.C. Blood and C.C. Gay, 1994. Veterinary Medicine: A textbook of diseases of Cattle, Sheep, Pigs, Goats and Horses. W.B Saunders Company. London.
22. Aladi, N.O., N.J. Okeudo, I.C. Okoli and E.C. Akanno, 2008. Reproductive and haematological characteristics of the Nigerian indigenous and Large White pigs in a humid tropical environment. Asian J Anim Vet Advances, 3(1): 17-23.
23. Ogunsanmi, A.O., P.A. Akpavieso and V.O. Anosa, 1994. Serumbiochemical changes in WAD Sheep experimentally infected with Trypanosomabrucei. Tropical Veterinarian. 47(2): 195.
24. Balikci, E., A. Yildiz and F. Gurdogan, 2007. Blood metabolite concentrations during pregnancy and post-partum in Akkaraman ewes. Small Rum. Res. 67: 247-251.

25. Weichselbaum, T.E., 1946. An accurate and rapidmethod for the determination of proteins in smallamount of blood serum and plasma. American Journal of Clinical Pathology. 16 Tech. Sect. 10: 40-49
26. Reitman, S. and S. Frankel, 1957. Glutamic – pyruvatetransaminase assay by colorimetric method. AmercanJournal of Clinical Pathology, 28: 56.
27. Schalm, O.W., N.C. Jain and E.J. Carrol, 1975. Veterinary haematology. 3rd ed. Philadelphia, Lea and Febiger. pp: 807.
28. Duncan, J.R. and K.W. Prasse, 1986. Veterinary Laboratory Medicine, 2nd ed., Iowa State University Press.
29. Zanjani, E.D., L.I. Mann, H. Burlington, A.S. Gordon and L.S. Wasserman, 1974. Evidence for a physiologic role of erythropoietin in fetal erythropoiesis. Blood., 44: 285-290.
30. Hytten, F., 1985. Blood volume changes in normal pregnancy. http://www.ncbi.nlm.nih.gov/pubmed/4075604.
31. Guyton 2006. Textbook of Medical Physiology, 11th ed. Chapter 82: Pregnancy and Lactation. pp: 1035.
32. Singh, R., S.P.S. Singha, R. Singh and M.S. Setia, 1991. Distribution of trace elements in blood, plasma and erythrocytes during different stages of gestation in buffalo (Bubalusbubalis). Buffalo J., 1: 77-85.
33. Ozegbe, P.C., 2001. Influence of pregnancy on some erythrocyte biochemical profiles inthe rabbits. Afr J Biomed Res., 4: 135-137.
34. Zvorc, Z., V. Mrljak, V. Susic and J. PopmpeGotal, 2006. Haematological and biochemical parameters during pregnancy and lactation in sows. Vet. Archiv., 76: 245-253.
35. Kim, J.C., 2002. Haematological changes during normal pregnancy in New Zealand white rabbits: a longitudinal study. Comparative Clinical Pathology, 11: 98-106.
36. Allard, R.L., A.D. Carlos and E.C. Faltin, 1989. Caninehematologic changes during gestation and lactation. Compan Anim Pract. 19: 3-6.
37. Harvey, J.W., R.L. Asquith and M. G.Pate, 1994. Haematological findings inpregnant, postparturientand nursing mares. Comp. Haematol Int. 4: 25-29.
38. Antunovic, Z., D. Sencic, M. Sperada and B. Liker, 2002. Influence of the season and the reproductive status of ewes on blood parameters. Small Ruminant Research. 45: 39-44.
39. Hytten, F.E. and I. Leitch, 1971. In: The physiology of human pregnancy. Blackwell Scientific Publications, Oxford. pp: 52.
40. Tran, H.A., 2005. Biochemical tests in pregnancy. Australian Prescriber. Vol. 28.
41. Theodore, X., M.D. O'connell, J. Timothy, M.D. Horita and M.D. Barsam Kasravi, 2005. Understanding and interpreting serum protein electrophoresis. Kaiser Permanente Woodland Hills Family Medicine Residency Program, Woodland Hills, California Am Fam Physician, 71(1): 105-112.