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Haematology and Serum Biochemical Profiles of Indigenous Tenyi-vo Pigs of Nagaland

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Abstract

The purpose of this study was aimed to establish a baseline reference value about haematology and serum biochemical profiles of Tenyi-vo pig. The blood samples were collected from six numbers (n=6) of apparently healthy pigs belonging to age group of 3 months. The overall value (Mean ± SEM) for packed cell volume, haemoglobin concentration, total erythrocyte count, mean corpuscular volume, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration, total leukocyte count, lymphocytes, neutrophils, platelets and red cell distribution width were recorded as 32.98±1.07%, 10.03±0.74 g/dL, 6.06±0.26 x 106/μL, 52.36±1.66 fL, 19.15±0.88 pg, 36.68±1.00 g/dL, 27.88±5.28 x 103/μL, 21.53±1.60 %, 72.95±2.10 %, 481.5±35.74 x 103/μL and 15.03±0.31 % respectively. Similarly, the overall value (Mean ± SEM) in respect of glucose, calcium, total protein, albumin, globulin, blood urea nitrogen, bilirubin, triglyceride, cholesterol, alanine amino transferase and alkaline phophatase were recorded as 90.00±9.58 mg/dL, 11.13±0.36 mg/dL, 9.13±0.27 g/dL, 2.38±0.29 g/dL, 6.65±0.52 g/dL, 21.36±1.31 mg/dL, 0.07±0.01 mg/dL, 16.78±1.68 mg/dL, 65.66±2.87 mg/dL, 47.08±7.03 U/L and 62.4±6.89 U/L respectively. From the experiment, it can be inferred that the overall recorded haematological and biochemical values can be used as baseline data for assessment of productive performance, metabolic, health status, disease diagnostic, treatment and other purposes of Tenyi-vo pigs.

Keywords: Biochemical, Indigenous, Haematology, Pigs, Serum, Tenyi-vo

Introduction

Piggery plays a vital role in improving socioeconomic status and livelihood of the tribal population of Nagaland due to faster economic return because of high fecundity, better feed conversion efficiency, early maturity and short gestation interval (Patr *et al*., 2014). Almost, every household of Nagaland rears around 2- 3 numbers of pigs in their backyard as a source of food and efficient way to generate an extra income. Unfortunately, state is yet to attain self-sufficiency in term of pork production. The tribal people of Nagaland and marginal farmers of India have a preference of local indigenous pigs over other crossbreed and exotic breeds of pigs (Borkotoky *et al*., 2014), because of well adaptability to its own ecological niche, diseases resistance and can be reared with minimal inputs, in a backyard farming with kitchen waste, garbage crop residues, seasonally available plants (Kumaresan *et al.,* 2007), good quality bristles (Mohana *et al.,* 2014), indigenous local breed gains early sexual maturity and meat quality is preferred by all over crossbred and exotic pigs (Karunakaran *et al.,* 2009). Tenyi-vo is a recognized indigenous pig breed of Nagaland (Accession No.: INDIA_PIG_1400_TENYI-VO_09004), and is reared mainly for pork production. Because of the high demand of indigenous local pig meat among tribal population, it necessitates to promote rearing of Tenyi-vo pigs with scientific input, better health care management to improve socio-economic and livelihood of the peoples of Nagaland.

A baseline information of haematology and serum biochemical profile is an index for the assessment of physiological and pathological status (Hawkey and Dennett, 1989), metabolic status (Otto *et al*., 1992), stress either may be due to nutritional, environmental or physical (Mayengbam and Tolenkhomba, 2015), and adaptability to a given geographical location of animals (Sejian *et al.,* 2014). It also provides base line information for clinical interpretation of metabolic and infectious diseases as well as helps in prediction of animals' productive performance (Chemshirova, 2000; K Kumar *et al.,* 2017). However, haematology and serum biochemical profiles vary according to physiological status, environmental factors, genetic, breed, sex, age and geographical location (De *et al.,* 2013; Mayengbam *et al.,* 2014; Mayengbam and Tolenkhomba, 2015; K Kumar *et al.,* 2017; Yu *et al.,* 2019). The normal physiological value of a breed within species in one geographical location cannot be taken as a reference value in another locality. Therefore, strength of a base line data in relation to haematology and serum biochemical profiles of domestic livestock species have been given due importance (Opara *et al.,* 2006). Since, no literature is available on haematology and serum biochemical profiles of Tenyi-vo pigs. Therefore, the present study was conducted for establishing a baseline data about haematology and serum biochemical profiles of Tenyi-vo pigs reared in its native home tracts Nagaland.

Materials and Methods

Location of Works

The experiment was conducted in College of Veterinary Sciences and Animal Husbandry, Central Agricultural University (I), Jalukie, Peren District, Nagaland, India which is situated at an altitude of 800-2500 meters above the sea level, latitude and longitude position being 25º 57 N and 93º72 E, respectively. The temperature of Jalukie, Peren District ranged between 18ºC to 35ºC during the experiment.

Selection, Blood Sampling and Processing

The indigenous local Tenyi-vo pigs were maintained in College Livestock Farm Complex by maintaining standard managemental procedures. A total of six (n=6) numbers of apparently healthy pigs in the age group of 3 months were selected for the experiment. Blood samples (3ml) were collected from anterior vena cava by direct puncture with a sterile needle at 8.00 A.M. in the morning before feeding and watering the pigs. Immediately after collection, one ml of blood was transferred to EDTA vacutainer tubes for estimation of haematological parameters. The remaining two ml of blood were transferred in a sterile serum separator vacutainer tube and allowed to clot. The clotted blood in vacutainer tube was transported to the laboratory for further processing. The vacutainer tubes were centrifuged at 3000 rpm for 10 minutes at room temperature. The serum samples were collected and aliquots were prepared and kept at -20°C until analysis of selected biochemical parameters.

Quantification of Haematological and Serum Biochemical Parameters

The haematological parameters estimated in this study were Packed Cell Volume (PCV), haemoglobin (Hb), Total

Erythrocyte Count (TEC), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), platelets, Total Leukocyte Count (TLC), neutrophils, lymphocytes and Red Cell Distribution Width (RDW) and these haematological parameters were estimated using an automated Blood cell counter (Model No: MS4Se), Melet Schloesing Laboratories, France.

Likewise, the serum biochemical parameters estimated in this study were glucose, calcium, total protein, albumin, globulin, blood urea nitrogen (BUN), bilirubin, triglyceride, cholesterol, ALT, and ALP. These serum biochemical parameters were estimated utilizing an automated biochemical analyzer (Erba-EM-200). The data obtained from the experiment were analyzed statistically using a Graph Pad prism 5. All data were expressed as Mean ± SEM and compared with normal physiological value for pigs depicted in Merck's Veterinary Manual.

Results and Discussion

The mean haematology values of Tenyi-vo pig are presented in Table 1. The haematology values obtained from the present experiment were within the normal physiological range as depicted for pigs in Merck's Veterinary Manual except TLC, lymphocytes and neutrophils count.

Table 1: Mean hematological values of indigenous Tenyi-vo pigs of Nagaland

Parameters	Merck's Veterinary Manual	Tenyi-vo Pigs			Similar to the present study	Lower than the present study	Higher than the present study
		Minimum value	Maximum value	Mean ± SEM (n=6)			
PCV (%)(Unit)	36-43	32	35.4	32.98±1.07	-	De *et al.*, 2013; Ventrella *et al.*, 2017	Brockus *et al.*, 2005; Clark SG *et al.*, 2009; Eze *et al.*, 2010, Mayengbam *et al.*, 2014; Etim *et al.*, 2014; Mayengbam and Tolenkhomba, 2015; Nath *et al.*, 2017a; Parkunan *et al.*, 2019;
Haemoglobin (g/dL)	10-16	8.2	12.7	10.03±0.74	Eze *et al.*, 2010; Etim *et al*., 2014	De *et al.*, 2013;Ventrella *et al.*, 2017	Clark SG *et al.*, 2009; Mayengbam *et al.*, 2014; Mayengbam and Tolenkhomba, 2015; Nath *et al.*, 2017a; Parkunan *et al.*, 2019
TEC($x10^6$/µl)	05-08	5.01	6.74	6.06±0.26	Ventrella *et al.*, 2017	Brockus *et al.*, 2005; Clark SG *et al.*, 2009; De *et al.*, 2013	Eze *et al.*, 2010; Mayengbam *et al.*, 2014; Mayengbam and Tolenkhomba, 2015; Nath *et al*., 2017a
MCV (fl)	50-68	48.1	59.5	52.36±1.66	Etim *et al*., 2014	Eze et al., 2010; De *et al.*, 2013; Ventrella *et al.*, 2017	Brockus *et al.*, 2005; Clark S G *et al.*, 2009; Mayengbam *et al.*, 2014; Mayengbam and Tolenkhomba, 2015; Nath *et al.*, 2017a
MCH (pg)	17-21	17.2	23	19.15±0.88	Etim *et al.*, 2014; Clark S G *et al.*, 2009; Mayengbam et al., 2014; Mayengbam and Tolenkhomba, 2015	Eze *et al.*, 2010; De *et al.*, 2013; Ventrella *et al*., 2017	Brockus *et al*., 2005 Nath *et al.*, 2017a
MCHC (g/dL)	30-34	32.2	38.8	36.68±1.00	Etim *et al*., 2014	Brockus *et al.*, 2005; Eze *et al.*, 2010; Clark S G *et al*., 2009; De *et al.*, 2013; Mayengbam *et al.*, 2014; Mayengbam and Tolenkhomba, 2015	Nath *et al.*, 2017a
Platelets (x 10^3/µl)	200-500	372	595	481.5±35.74	-	Brockus *et al*., 2005; De *et al.*, 2013	Nath *et al*., 2017a
TLC (x 10^3/µl)	Nov-22	11	40.43	27.88±5.28	-	Brockus *et al.*, 2005; De *et al.*, 2013; Mayengbam *et al.*, 2014; Nath *et al.*, 2017; Ventrella *et al.*, 2017	Eze *et al.*, 2010
Lymphocytes (%)	39-62	16.6	27.2	21.53±1.60	Etim *et al*., 2014		De *et al.*, 2013; Mayengbam *et al.*, 2014; Nath *et al.*, 2017a; Ventrella *et al.*, 2017
Neutrophils (%)	28-47	65.1	80	72.95±2.10	-	De *et al.*, 2013; Mayengbam *et al.*, 2014; Nath *et al.*, 2017a; Ventrella *et al.*, 2017	
RDW		14	15.3	15.03±0.31			Yeom *et al.*, 2012; Ventrella *et al.*, 2017

Also, the haematology values were compared with earlier reports of indigenous and exotic breed of pigs. PCV, Hb, TEC, MCV, lymphocytes values of Tenyi-vo pigs were lower than the value recorded for Zovawk pigs of Mizoram

and Doom pigs of Assam (Mayengbam *et al.*, 2014; Mayengbam and Tolenkhomba, 2015; Nath *et al.*, 2017a) and exotic pig breed such as Yorkshire and Mangalitza (Kotosová *et al.*, 2014) respectively. However, the values recorded in respect of TEC, PCV, MCV, MCHC and Hb were higher than Nicobari and Andaman desi pigs (De *et al.*, 2013). This might be due to environmental factors, age, sex, breed and geographical location (De *et al.*, 2013; Mayengbam *et al.*, 2014; Mayengbam and Tolenkhomba, 2015). But TLC values of Tenyi-vo pigs were higher as compared to the earlier reports (Brockus *et al.*, 2005; De *et al.*, 2013; Kotosová *et al.*, 2014; Mayengbam *et al.*, 2014; Nath *et al.*, 2017a; Ventrella *et al.*, 2017). The mean serum biochemical values of Tenyi-vo pig are presented in Table 2.

Table 2: Mean serum biochemical values of indigenous Tenyi-vo pigs of Nagaland

Parameters (Unit)	Merck's Veterinary Manual	Tenyi-vo Pigs			Similar to the present study	Lower than the present study	Higher than the present study
		Minimum Value	Maximum value	Mean ± SEM (n=6)			
Glucose (mg/dL)	85-150	66.2	125.7	90.00±9.58	-	-	Kaneko *et al.*, 1997; Brockus *et al.*, 2005; Cooper CA *et al.*, 2014; K. Kumar *et al.*, 2017;Yu *et al.*, 2019; Ventrella et al., 2017
Calcium (mg/dL)	7.1-11.6	9.7	12.2	11.13±0.36	Yeom *et al.*, 2012; Cooper CA *et al.*, 2014	Mayengbam *et al.*, 2012; K Kumar *et al.*, 2017	Nath *et al.*, 2017b
Total Protein (g/dL)	7.9-8.9	8.04	9.83	9.13±0.27	-	Friendship *et al.*, 1984; Yeom *et al.*, 2012; Cooper CA *et al.*, 2014; K. Kumar et al., 2017; Ventrella et al., 2017; Yu et al., 2019	-
Albumin (g/dL)	1.9-3.9	1.14	3.15	2.38±0.29	-	-	Friendship *et al.*, 1984;Cooper CA *et al.*, 2014; K. Kumar *et al.*, 2017; Ventrella *et al.*, 2017
Globulin (g/dL)	5.3-6.4	5.3	8.7	6.65±0.52	-	Yeom *et al.*, 2012; Cooper CA *et al.*, 2014	-
BUN (mg/dL)	Oct-30	15.6	25.2	21.36±1.31	-	Yeom *et al.*, 2012; Cooper CA *et al.*, 2014; K. Kumar *et al.*, 2017	-
Bilirubin (mg/dL)	0-10	0.02	0.13	0.07±0.01	-	-	-
Triglyceride (mg/dL)		12	23.4	16.78±1.68	-	-	Yu *et al.*, 2019
Cholesterol (mg/dL)	36-54	53	74	65.66±2.87	Yu *et al.*, 2019	Yeom *et al.*, 2012 (Free cholesterol)	
ALT (U/L)	31-58	20.6	67.5	47.08±7.03	-	Friendship *et al.*, 1984;Mayengbam and Tolenkhomba, 2015; Ventrella *et al.*, 2017;Yu et al., 2019	Klem T B *et al.*, 2010; K. Kumar *et al.*, 2017
ALP (U/L)	118-395	35	85	62.4±6.89	-	Mayengbam and Tolenkhomba, 2015	Yeom *et al.*, 2012;Friendship et al., 1984; Klem T B et al., 2010; Cooper CA et al., 2014; K. Kumar et al., 2017; Ventrella et al., 2017

The results found from the present experiment were within the physiological range as depicted for pigs in Merck's Veterinary Manual except globulin and ALP. The serum biochemical values recorded in the present experiment were also compared with earlier reports of indigenous and exotic breed of pigs. The mean serum glucose concentration (90.00±9.58 mg/dL) was comparatively lower than earlier reports of pigs (Cooper CA *et al.*, 2014; K. Kumar *et al.*, 2017; Yu *et al.*, 2019). This might be attributed to prolong feeding interval between evening and morning feeds. The value recorded from the experiment in respect of serum globulin (6.65±0.52 g/dL) of the Tenyi-vo pigs was comparatively higher than previously reported literatures (Yeom *et al.*, 2012; Cooper CA *et al.*, 2014). The elevated globulin concentration with high TLC and neutrophils counts revealed ill health of Tenyi-vo pigs,

although the pigs didn't showed any clinical signs and symptoms. Therefore, from the present experiment, it can be revealed that serum biochemical profiles of indigenous local Tenyi-vo pigs of Nagaland has little variations compared to other indigenous and either exotic breed of pigs. However, a large sample size of Tenyi-vo pigs will be helpful to strengthen the present data to establish a reference interval for haematology and serum biochemical parameters of Tenyi-vo pigs.

Indigenous pigs are important genetic resources for India because of its well adaptability to its own native home tract, minimal occurrence of disease compared to crossbreed and either exotic breed of pigs. A few literatures are available on baseline information of haematology and serum biochemical parameters for indigenous local breed of pigs of India. The haematology profile provides baseline information which can give important clue to assess productive performance, managemental practices, health status, diagnosis of metabolic diseases, feeding management (Otto *et al*., 1992; Radostits *et al.*, 2006; Mir *et al.*, 2008). The serum biochemical profiles are essential indicators of weight gain, metabolic disorders, other physiological and environmental causes (Swenson, 1970; K Kumar *et al.*, 2017). So, deviation from a normal reference value will help in prediction of physiological status of the animal (Kaneko *et al*., 1997), thus help in diagnosis of diseases, infections and metabolic disorders. Therefore, establishment of a reference value on haematological and serum biochemical parameters are essential for determination of physiological status of the animal (Swenson, 1970). However, there is no literature on haematology and serum biochemical profiles of Tenyi-vo pigs of Nagaland. So, the data recorded in present study may be served as guide on haematological and serum biochemical parameters and can be used for evaluation of health status and disease diagnosis purpose of Tenyi-vo pigs.

Conclusion

The analyzed haematology and serum biochemical profiles were within normal range except TLC, lymphocytes, neutrophils count, ALP and globulin. The variation revealed that Tenyi-vo pigs were in mild infection, although they were apparently healthy. Overall, results found from the experiment in respect of haematology and serum biochemical profiles may be served as a guide on haematology and serum biochemical values of Tenyi-vo pigs and can be utilized for growth assessment, health status, disease diagnosis and ultimately facilitate in managemental strategies with minimum economic losses.

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Conflict of Interests

There is no conflict of interest.

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References

1. Borkotoky, D., Perumal, P. and Singh, R. K. (2014). Morphometric attributes of Naga local pigs. *Veterinary Research*, 2 (1): 08-11.
2. Brockus C W, Mahaffey E A, Bush S E and KruppDespain A W. (2005). Hematologic and serum biochemical reference intervals for Vietnamese potbellied pigs (Sus scrofa). *Comparative Clinical Pathology*, 13: 162–165.
3. Chemshirova, N. (2000). Blood biochemical characteristics and their connection with milk productivity of cattle. *Journal of Animal Science*, 2: 45-47.
4. Clark, S. G. and Coffer, N. (2008). Normal hematology and hematologic disorders in potbellied pigs. *Veterinary Clinical North America Exotic Animal Practice*, 11(3): 569-82.

5. Cooper, C. A., Moraes, L. E., Murray, J. D. and Owens, S. D. (2014). Hematologic and biochemical reference intervals for specific pathogen free 6-week-old Hampshire-Yorkshire crossbred pigs. *Journal of Animal Science Biotechnology*, 5 (1): 5.
6. De, A. K., Kundu, A., Kundu, M. S., Sunder, J. and Jeyakumar, S. (2013). Comparative study on haematological traits of endangered Andaman wild pig and other indigenous pig breeds available at Andaman and Nicobar Islands, India. *Veterinary World*, 6 (10): 794-798.
7. Etim N N, Williams M E, Akpabio U, and Offiong E E A. (2014) Haematological parameters and factors affecting their values. *Agricultural Science*, 2(10; 37-47.
8. Friendship, R. M., Lumsden, J. H., McMillan, I. and Wilson, M. R. (1984). Hematology and biochemistry reference values for Ontario swine. *Canadian Journal of Comparative Medicine*, 48 (4): 390–393.
9. Hawkey, C. N. and Dennett, A. (1989). A colour atlas of comparative veterinary haematology. Wolfe Medical Publication, England, Page 192.
10. K, Kumar, S. V., Balasubramanyam, D., Senthil, N. R., Manju, G. and Gopi, H. (2017). Serum biochemical profile of indigenous pigs in Tamil Nadu. *International Journal of Chemical Studies*, 5 (4): 243-245.
11. Kaneko, J. J., Harvey, J. W. and Bruss, M. L. (1997). Clinical Biochemistry of Domestic Animals, 5th ed., Academic Press, San Diego, London, Boston, New York, Sydney, Tokyo, Toronto.
12. Karunakaran, M., Mandal, M., Rajarajan, K., Karmakar, H. D., Bhatt, B. P., Das, J., Bora, B., Baruah, K. K. and Rajkhowa, C. (2009). Early puberty in local Naga boar of India: Assessment through epididymal spermiogram and in vivo pregnancy. *Animal Reproduction Science*, 111: 112-119.
13. Klem T B, Bleken E, Morberg H, Thoresen S I and Framstad T (2010). Hematologic and biochemical reference intervals for Norwegian crossbreed grower pigs.*Veterinary Clinical Pathology*, 39(2):221-6.
14. Kotosova, J., Poracova, J., Vasko, L., Blascakova, M. M. and Vascova, J. (2014). Haematological Status for Selected Pig Breeds. *American Journal of Animal and Veterinary Sciences*, 9 (4): 239-244.
15. Kumaresan, A., Bujarbaruah, K. M., Pathak, K. A., Chhetri, K., Das, S. K., Das, A. and Ahmed, S. K. (2007). Performance of pigs reared under traditional tribal low input production system and chemical composition of non-conventional tropical plants used as pig feed. *Livestock Science*, 107: 294-298.
16. Mayengbam, P. and Tolenkhomba, T. C. (2015). Seasonal variation of hemato-biochemical parameters in indigenous pig: Zovawk of Mizoram. *Veterinary World*, 7 (7): 505-508.
17. Mayengbam, P., Tolenkhomba, T. C. and Ayub, Ali, M. (2014). Hematological profile of Zovawk- an indigenous pig of Mizoram. *Veterinary World*, 8 (6): 732-737.
18. Mayengbam, P., Tolenkhomba, T. C., Ali, M. A., Saikia, P., Singh, S. N. and Hmar, L. (2012). Electrolyte (Na, K, Cl, Ca, Pi and Mg) profile of Zovawk pigs of Mizoram, India in different age groups. *International Multidisciplinary Research Journal*, 2 (2): 49-51.
19. Mohana, N. H., Debnath, S., Mahapatra, R. K., Nayak, L. K., Baruah, S., Das, A., Banik, S. and Tamuli, M. K. (2014). Tensile properties of hair ûbres obtained from different breeds of pigs. *Biosystems Engineering*, 119**:** 35-43.
20. Nath, R., Barman, A., Sarma, S., Goswami, J., Sarmah, S. and Deka, I. (2017b). Electrolytes and hormones profiles of Doom pigs Assam of different age groups. *International Journal of Chemical Studies*, 5 (2): 149-151.
21. Nath, R., Sarma, S., Barman, A., Laskar, S., Sarmah, S., Borgohain, R., Deori, P., Kachari, J. and Laskar, R. (2017a). Analysis of baseline value and age-related changes in hematology of Doom pigs of Assam. *International Journal of Chemical Studies*, 5 (2): 135-137.
22. Opara, M. N., Ike, K. A. and Okoli, I. C. (2006). Haematology and plasma biochemistry of the wild adult African grass cutter (Thryonomys swinderianus,Temminck). *Journal of American Science*, 2: 17-22.
23. Otto, F., Ibanez, A., Caballero, B. and Bogin, E. (1992). Blood profile of Paraguayan cattle in relation to nutrition, metabolic state, management and race. *Israel Journal of Veterinary Medicine*, 47: 91-99.
24. Patr, M. K., Begum, S. and Deka, B. C. (2014). Problems and prospects of traditional pig farming for tribal livelihood in Nagaland. *Indian Research Journal of Extension Education*, 14 (4): 6-11.
25. Radostits, O. M., Gay, C. C., Hinchciliff, K. W. and Constable, P. D. (2006). Veterinary Medicine. 10th Edn., *Elsevier Science* Ltd., USA.
26. Sejian, V., Singh, A. K., Sahoo, A. and Naqvi, S. M. K. (2014). Effect of mineral mixture and antioxidant supplementation on growth, reproductive performance and adaptive capability of Malpura ewes subjected to heat stress. *Journal of Animal Physiology and Animal Nutrition*, 98: 72–83.
27. Swenson, M. J. (1970). Physiological properties, cellular and chemical constituents of blood. In M. J. Swenson (Ed.), Dukes' physiology of domestic animals, 8th ed., Corn stock Publishing Associates, Cornell University Press, Ithaca, London, Pages 75-83.

28. Ventrella, D., Dondi, F., Barone, F., Serafini, F., Elmi, A., Giunti, M., Romagnoli, N., Forni, M. and Bacci, M. L. (2017). The biomedical piglet: establishing reference intervals for haematology and clinical chemistry parameters of two age groups with and without iron supplementation. *BMC Veterinary Research,* 13: 23.
29. Yeom, S., Cho, S. Y., Park, C. and Lee, W. (2012). Analysis of reference interval and age-related changes in serum biochemistry and hematology in the specific pathogen free miniature pig. *Laboratory Animal Research*, 28 (4): 245-253.
30. Yu, K., Canalias, F., Solà-Oriol, D., Arroyo, L., Pato, R., Saco, Y., Terre, M. and Bassols, A. (2019). Age related serum biochemical reference intervals established for unweaned calves and piglets in the post-weaning period. *Frontiers Veterinary Science*, 6:123.

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