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Hematology, Reproductive Hormonal Level and Conception Rate in Synchronized Indigenous Cows during Artificial Insemination Scheme in Kwara State, Nigeria

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ABSTRACT: Genetic improvement of indigenous cattle breeds through artificial insemination (AI) with exotic semen will aid production system intensification and solve herders-crop farmers' conflict in Nigeria. Successful AI, however, depends on efficient estrous synchronization preparing the animal's hormonal balance required for fertilization. Hence, the objective of this paper was to assess the hematology, reproductive hormonal level and conception rate in synchronized 33 White Fulani and 18 Gudali indigenous cows during artificial insemination (AI) scheme in Kwara State, Nigeria using standard methods. Successful conception was called using transrectal palpation and threshhold of progesterone post-insemination. Data obtained show that there was significant ($p < 0.05$) breed effect on neutrophils and lymphocytes (indicating better stress tolerance in Gudali than White Fulani) and farm location difference in white blood cells, neutrophils, monocytes, hemoglobin, and packed cell volume prior to synchronization. However, all hematological values were subsequently found within reference values for cow post-synchronization. Post-synchronized elevated LH, reduced FSH and progesterone, plus subsequent progesterone surge 16 weeks post-insemination as well as mean conception rate of 82.75% are indicative of reproductive success. Consequently, Fixed Time AI with 3 consecutive injection of 2ml chloprostenol was recommended for estrous synchronization in artificial insemination in Nigerian indigenous cattle.

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Improving genetic profile of indigenous cattle breeds in Nigeria will ensure production efficiency

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(Chasama *et al.*, 2023; Miller, 2010) and increase access to animal protein among the growing human population. The imperativeness of improving the meat potential of indigenous breed of cattle is hinged on the need to incentivize the adoption of modern husbandry practices by pastoralist. This approach aims at introgression of exotic genes into the population of local cattle herds through artificial insemination (AI). This will result in more efficient utilization of feed resources, faster rate of growth and quicker returns on investment. It is expected that the cumulative effect of a more efficient cattle herd will ultimately result in ranching of cattle and discouraging the nomadic traditional husbandry practice that has been indicted in the cattle herders - crop farmers' conflict.

Artificial insemination is a reproductive technology used in farm animal improvement by manually collecting semen from proven sire with high genetic merit, cryopreserved and inseminated into the reproductive tract of the female (Webb, 2003; Temesgen *et al.*, 2021). Prior to insemination, the females' estrous must be synchronized to ensure reproductive success (Xu, 2011). The procedure involves injection or insertion of synthetic reproductive hormones which suppress ovulation for some time then upon withdrawal initiate estrous or heat in the female. In cattle breeding, there are factors that could results in poor conception rate in serviced dam. These could include but not limited to disease infection or poor reproductive health profile, hormonal imbalance due to stress, poor nutritional regime, quality of semen and other management stress (Jemal and Lemma, 2015).

The hematological profile of farm animals has often been used to assess their health (Olaogun and Jeremiah, 2018; Roland *et al.*, 2014). The blood constituents are indicators of the nutritional status, physiological (Etim *et al*., 2013) and metabolic efficiency of the breeding farm animals, while the threshold of reproductive hormones indicates the fertility status of the animal and effectiveness of the adopted estrous synchronization protocol.

Reproductive hormones induce heat (estrous) in cows. Hormone analogues are administered to cows to artificially stimulate ovulation and fertilization takes place in the uterus if spermatozoa are available. Naturally, ovulation occurs every 21 days, but in cattle, reproduction could be manipulated to get all the animals to ovulate at the same time. This is termed estrous synchronization.

The naturally occurring reproductive hormones are Gonadotropin Releasing Hormone (GnRH), Follicle Stimulating Hormone (FSH), Luteinizing Hormone (LH), Estrogens, Progesterone and Prostaglandins (PGs). Progesterone is produced from the corpus luteum. It maintains pregnancy, stimulates growth of uterus during pregnancy, prepare the uterus for zygote implantation and causes the closure of cervical rings thickening of cervical mucus among other functions. Prostaglandins (PGs) are hormones like chemicals naturally occurring in all mammals and secreted not by glands but by cells scattered throughout the body. They act in reproduction as luteotropic hormones and causes strong contraction of the smooth muscles of the reproductive tract. The most common PGs involved in reproduction is PGF2α which is secreted naturally in females by the endometrium, myometrium and graafian follicles. It regresses the corpus luteum and shorten the estrus cycle length. Its analogue Chloprostenol is commonly used in estrus synchronization. Hence, the objective of this paper was to assess the hematology, reproductive hormonal level and conception rate in synchronized 33 White Fulani and 18 Gudali indigenous cows during artificial insemination (AI) scheme in Kwara State, Nigeria.

MATERIALS AND METHODS

Study Area: The study was done in four cattle ranches at the outskirt of Ilorin metropolis, Kwara State North Central Nigeria with latitude 8.9669° N, and longitude 4.3874° E (Fig. 1). The farms were selected purposively in an artificial insemination (AI) scheme due to their adoption of semi-intensive management sytem of cattle rearing and readiness to adopt AI technology.

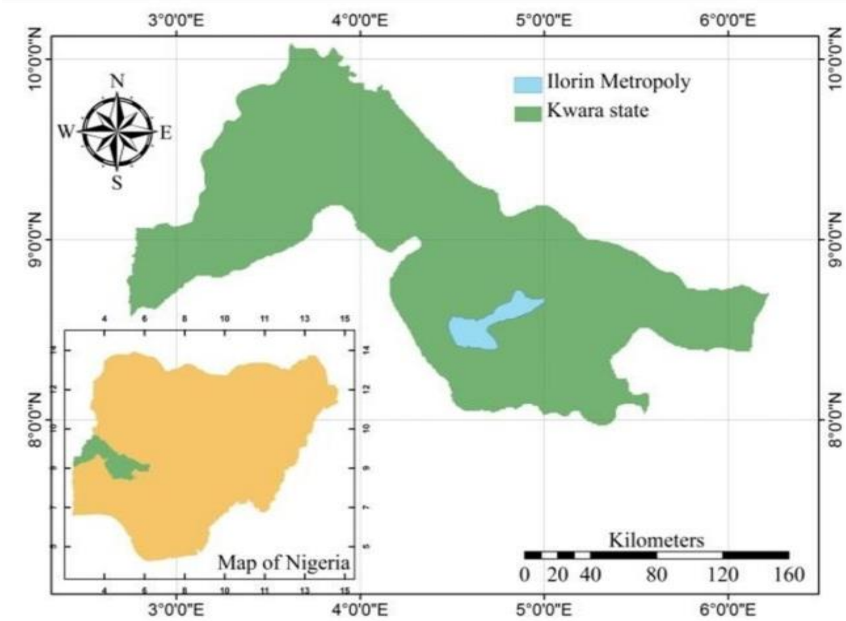

Fig. 1: map of Kwara State showing the study area: (source: Olalekan *et al*., 2018)

Cows Selection: Fifty-one cows including 33 white Fulani and 18 Gudali cows that were in their second to fourth parity were selected for the study. Farm A, B, C had 13 cows each while Farm D had 12 cows. Before the experiment, the animals underwent medical examination including hemiparasite screening and were treated as such. Their body weight was also estimated from girth measurement using the Brainsley weight estimate chart (Brainsley Highlands® Australia, http://www.bairnsley.com).

Estrous Synchronization and Artificial Insemination Process: Two mililiters of Synchromate®, (Bremer Pharma GMBH, Germany), a synthetic prostaglandin analogue containing active ingredient chloprostenol were injected intramuscullarly into each cow for 3 consecutive times to synchronize their estrus (Table 1). They were subsequently inseminated after 72 hours of last Synchromate® injection with exotic semen purchased from National Veterinary Research Institute (NVRI), Jos, Nigeria.

Table 1: presentation of the protocol for estrus synchronization of indigenous cows in a timed artificial insemination scheme in some farm locations in Kwara State

Sn.	Day	Activities
1	0	1st Intramuscular injection Synchromate®
2	11	2nd Intramuscular injection Synchromate®
3	17	3rd Intramuscular injection Synchromate®
4	20	Fixed Timed Artificial Insemination after 72 hours

Sample Collection Before and After Estrous Synchronization: The reproductive hormonal profile and hematological parameters were determined before they were synchonized (baseline) and after synchronization. Blood were drawn through jugular venupuncture using 10 ml syringe and 18 gauge needle. The blood samples were collected in heparinized and plain sample bottles. To estimate conception rate, transrectal palpation was carried out and blood was again sampled after 16 weeks post insemination to assay progesterone (hormone responsible for maintaining pregnancy).

Sample Laboratory Analysis: Blood samples were transported in ice packs to the chemical pathology laboratory at the Faculty of Veterinary Medicine, University of Ilorin for analyses. Centrifugation of blood was done at 2000 revolution per minutes for 10 minutes to separate the serum and plasma of the blood samples stored in the plain and heparinized bottles, respectively (Solomon *et al.*, 2021). The full blood count (FBC) was determined using Avian blood autoanalyser while the reproductive hormonal assay including Estrogen, Follicle Stimulating Hormone (FSH), Leutenizing Hormone (LH) and Progesterone were quantified using enzyme linked immunoabsorbent assay (ELISA) commercial kit and adhering strictly to the manufacturer's instruction. (Accubind ELISA Microwells, Monobind Inc. Lake Forest, USA).

Statistical Data Analysis: The data were collected and stored in Microsoft Excel. Statistical analyses were done with Statistical Product and Service Solutions (SPSS) version 25 (IBM, USA) using a 2 – way analysis of variance (ANOVA) in a 2 x 4 factorial designed experiment. This was done to test the effect of breed of cattle (White Fulani and Gudali) and 4 different farm locations on the measured parameters in the cows.

RESULTS AND DISCUSSIONS

Determination of the hematological responses of White Fulani and Gudali cows before and after estrous synchronization: The baseline data on the variations in leucocytic (white blood cells and their differentials) and erythrocytic (full blood count) parameters in the two breeds of cattle in four farm locations prior to estrous synchronization in an artificial insemination scheme (Table 3) indicates that most of the parameters were within the normal reference range for cattle (Table 2). There was however significant difference ($p < 0.05$) in the values of white blood cells (WBC), neutrophils, monocytes, hemoglobin, and packed cell volume (PCV) between cattle on Farm locations A, B, C and D. Farm C had the highest significant values ($p < 0.05$) for WBC, neutrophils, and monocytes while Farm B had significantly highest value ($p < 0.05$) for lymphocytes and monocytes. These increased values could be due to the fact that the animals were subjected to stress primarily as a result of poor management and handling of the animals.

Table 2: hematological and serum biochemical analysis reference range in cow

Hematology Parameters	Units	Values
Packed Cell Volume (PCV)	%	24 - 46
Hemoglobin (Hgb)	g/dL	8 - 15
Red Blood Cell (RBC)	$x10^{12}/L$	5.0 – 10.0
Mean Corpuscular Volume (MCV)	fl	40 -60
Mean Corpuscular Hemoglobin (MCH)	pg	11 - 17
Mean Corpuscular Hemoglobin Concentration (MCHC)	g/dl	30 - 36
White Blood Cell (WBC)	$x10^{9}/L$	4.0 - 12
Neutrophils	%	15 - 33
Lymphocytes	%	45 - 75
Monocytes	%	0 - 8
Eosinophils	%	0 - 20
Basophils	%	0 - 2
Serum Biochemical Parameters		
Creatinine	μmol/L	44 - 194
Uric Acid	mmol/L	NA
Urea	mmol/L	3.6 – 8.9
Sodium (Na^{+})	mmol/L	136 - 144
Potassium (K^{+})	mmol/L	3.6 – 4.9
Chloride (Cl^{-})	mmol/L	99 - 107
Bicarbonate (HCO_3)	mmol/L	20 - 30
Gamma – glutamyl Transferase (GGT)	U/L	6 – 17.4
Aspartate Aminotransferase (AST)	U/L	60 - 125
Alanine Transaminase (ALT)	U/L	NA
Alkaline Phosphatase (ALP)	U/L	24 - 74
Total Protein	g/L	67 - 75
Albumin	g/L	25 - 38
Glucose	mmol/L	2.2 – 5.6

Source: MSD Veterinary Manual https://www.msdvetmanual.com

This agrees with the findings of Dhabhar *et al*. (2012) that acute stress induces early increased mobilization of leucocytes. Cattle in Farms A and D had significantly highest values ($p < 0.05$) of hemoglobin and PCV. This is an indication of good blood profile adequate for transport of metabolic products in the body. There was also significant breed difference ($p < 0.05$) between the White Fulani and Gudali in neutrophils and lymphocytes values. White Fulani had higher neutrophils count and lower lymphocyte count ($p < 0.05$) compared with Gudali. The higher values of neutrophils and lower lymphocyte counts observed in White Fulani may indicate that they were more susceptible to stress compared with the Gudali breed of cattle. This was similar to the findings of Abwage and Antia (2022) where the neutrophils count in White Fulani was significantly ($P < 0.05$) higher than that of Muturu and N'Dama breeds. There was significant ($p < 0.05$) interaction between the effect of the farm location and the breed of cattle on the neutrophils counts. This is indicated by a progressively steady increase in neutrophils value among Gudali cattle across the farms. It was also observed that the White Fulani cattle had a slightly reduced neutrophil counts compared with Gudali on Farm D contrary to what was observed on Farm B and C where White Fulani had higher neutrophil counts (Fig. 2). The physiological response of the cows, based on the blood profile, improved after the synchronization process (Table 4). All the values of the blood parameters were within the reference range (Table 2). The WBC count was normalized as there was no significant difference ($p > 0.05$) observed between the breeds as well as between cattle on the various farm locations. The hemoglobin count and PCV were also not significantly different ($p > 0.05$) between the farm locations and breeds of cattle. The values were also adequate for normal physiological activities of healthy cattle. Although there were significant ($p < 0.05$) elevation of neutrophils, monocytes, and eosinophils values in cattle on farm C, they were still within the normal reference range.

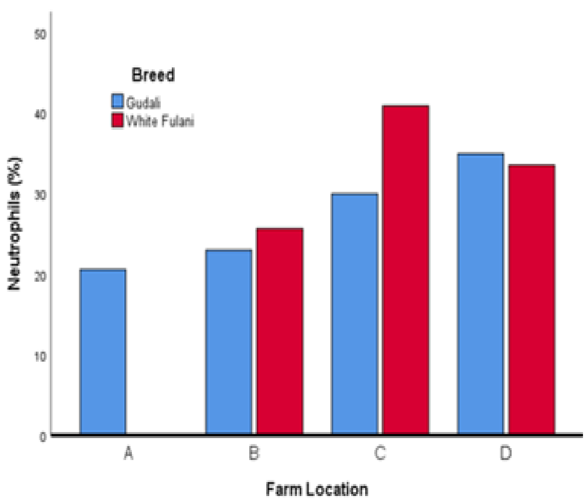

Fig 2: interaction effect of breed and farm location on the neutrophils of indigenous cows prior to estrous synchronization in an artificial insemination scheme in Kwara State, Nigeria. *Note: Farm A has only Gudali herd.*

Body weight estimate from girth measurements and determination of the conception rate of White Fulani and Gudali cows: There was no significant breed difference in body weight between the White Fulani and Gudali cows (Table 5). However, cows on farm D with estimated body weight of 457 kg were significantly ($p < 0.05$) bigger than the cows on the other farms.

The conception rate (Table 5) estimated from the assay of serum progesterone levels revealed that majority of the cows had elevated values at 16 weeks after the insemination (Fig. 6). Elevation of serum progesterone could be associated with maintenance of pregnancy and could be a correct biomarker of conception in cattle (Thirapatsukun *et al.,* 1978; Engida *et al.*, 2022). In addition to the estimation of conception from elevated progesterone values, human progesterone ELISA kit was also used to test urine in cows (Engida *et al*., 2022) and transrectal palpation was done to ascertain gestation. The mean conception rate (Table 5) in the current study was 82.75% which was higher than 54.28%, 51.03% and 58.97% observed by Tadesse *et al.* (2022) in local breeds, cows inseminated once and overall (irrespective of associated factors like breed or season of artificial insemination) respectively. It was also higher than 26.88% obtained by Alemneh *et al.* (2015) following synchronization of local breed with PGF2α and subsequent insemination with imported Holstein semen. The value was also higher than the values obtained in most African cattle breeds; Tswana Tuli zebus (37%) (Mgongo *et al.*, 2009); Bunaji (White Fulani) and Bokoloji (Sokoto Gudali) (46.5%) (Mai *et al.*, 2014) and White Fulani, Red Bororo, Sokoto Gudali, Adamawa Gudali and Muturu (mean conception rate of 25%) (Kubkomawa *et al.*, 2017). However, the conception rate in this study is consistent with the values of 83% reported in Sokoto Gudali inseminated 72 hours after double Estrumate® treatments (Olufisayo *et al.*, 2018).

Table 3: effect of breed and farm location on leucocytic and erythrocytic status of indigenous cows prior to estrous synchronization in an artificial insemination scheme in Kwara State

	Factors:						
	Farm Locations				**Breeds**		**Interactions**
Parameters	A	B	C	D	White Fulani	Gudali	FL x Breed
WBC	$7.95^{b} \pm 0.17$	$7.75^{b} \pm 0.17$	$8.72^{a} \pm 0.15$	$6.63^{c} \pm 0.18$	7.84 ± 0.18	7.89 ± 0.21	ns
NEUT	$25.40^{c} \pm 1.32$	$20.58^{d} \pm 0.69$	$38.17^{a} \pm 1.47$	$33.75^{b} \pm 0.62$	$33.36^{a} \pm 1.43$	$23.24^{b} \pm 1.25$	*
LYMPH	$70.90^{b} \pm 0.95$	$77.75^{a} \pm 0.79$	$59.25^{d} \pm 1.78$	$64.75^{c} \pm 1.13$	$63.76^{b} \pm 1.38$	$75.12^{a} \pm 1.25$	ns
MONO	$0.90^{b} \pm 0.10$	$1.58^{a} \pm 0.15$	$1.50^{a} \pm 0.14$	$0.13^{c} \pm 0.13$	0.92 ± 0.14	1.41 ± 0.15	ns
EOSIN	1.20 ± 0.13	1.58 ± 0.15	1.17 ± 0.21	1.25 ± 0.16	1.12 ± 0.11	1.59 ± 0.12	ns
RBC	4.62 ± 0.22	4.13 ± 0.36	4.13 ± 0.27	4.51 ± 0.13	4.40 ± 0.15	4.19 ± 0.26	ns
HB	$9.36^{a} \pm 0.11$	$8.35^{b} \pm 0.12$	$8.35^{b} \pm 0.12$	$9.13^{a} \pm 0.14$	8.89 ± 0.13	8.51 ± 0.12	ns
PCV	$28.10^{a} \pm 0.57$	$25.17^{b} \pm 0.49$	$25.17^{b} \pm 0.49$	$27.50^{a} \pm 0.27$	26.80 ± 0.42	25.59 ± 0.44	ns
MCV	60.78 ± 0.32	61.08 ± 0.68	61.08 ± 0.34	61.51 ± 0.55	60.98 ± 0.25	61.26 ± 0.49	ns
MCH	20.21 ± 0.11	20.31 ± 0.24	20.26 ± 0.13	20.38 ± 0.13	20.23 ± 0.08	20.37 ± 0.17	ns
MCHC	33.31 ± 0.03	33.18 ± 0.07	33.24 ± 0.06	33.31 ± 0.07	33.3 ± 0.03	33.19 ± 0.05	ns

*Means are presented as ± SEM (Standard Error of Mean). Values with superscript ^{abc} within the same factor and within the same row are significantly different ($p < 0.05$). WBC = White blood cells ($x\ 10^9/L$); NEUT = Neutrophils (%); LYMPH = Lymphocytes (%); MONO = Monocytes (%) and EOSIN = Eosin (%); RBC = Red blood cells ($x\ 10^{12/}L$); HB = Hemoglobin (g/dL); PCV = Parked cell volume (%); MCV = Mean Corpuscular Volume (fl); MCH = Mean Corpuscular Hemoglobin (pg) and MCHC = Mean Corpuscular Hemoglobin Concentration (g/dl); * Significant, ns = not significant*

Table 4: effect of breed and farm location on leucocytic and erythrocytic status of indigenous cows post estrous synchronization in an artificial insemination scheme in Kwara State

	Factors:						
Parameters	**Farm Location**				**Breeds**		**Interaction**
	A	**B**	**C**	**D**	**White Fulani**	**Gudali**	**FL x Breeds**
WBC	8.56 ± 0.54	8.02 ± 0.72	8.04 ± 0.64	6.53 ± 0.67	8.08 ± 0.42	7.89 ± 0.52	ns
NEUT	$37.92^{a} \pm 1.87$	$42.25^{a} \pm 1.04$	$44.25^{a} \pm 1.95$	$30.67^{b} \pm 2.12$	38.48 ± 1.56	42.05 ± 0.99	ns
LYMPH	$56.92^{b} \pm 2.67$	$50.17^{b} \pm 1.21$	$51.58^{b} \pm 1.77$	$68.50^{a} \pm 1.78$	57.59 ± 1.91	51.63 ± 1.12	ns
MONO	$0.08^{b} \pm 0.08$	$0.42^{b} \pm 0.26$	$1.67^{a} \pm 0.33$	$0.33^{b} \pm 0.33$	0.67 ± 0.20	0.84 ± 0.27	ns
EOSIN	$0.23^{b} \pm 0.17$	$0.17^{b} \pm 0.17$	$2.45^{a} \pm 0.71$	$0.33^{b} \pm 0.33$	1.07 ± 0.37	0.67 ± 0.24	ns
RBC	4.51 ± 0.14	4.53 ± 0.22	4.51 ± 0.30	4.42 ± 0.20	4.49 ± 0.14	4.61 ± 0.17	ns
HB	9.14 ± 0.28	9.20 ± 0.38	9.05 ± 0.60	8.88 ± 0.34	9.07 ± 0.27	9.26 ± 0.31	ns
PCV	27.46 ± 0.84	27.67 ± 1.17	27.17 ± 1.83	26.67 ± 1.05	27.22 ± 0.83	27.42 ± 0.92	ns
MCV	60.91 ± 0.33	61.33 ± 1.32	60.43 ± 0.50	60.47 ± 0.50	60.72 ± 0.25	60.89 ± 0.85	ns
MCH	20.22 ± 0.11	20.48 ± 0.43	20.00 ± 0.10	20.15 ± 0.18	20.15 ± 0.07	20.47 ± 0.30	ns
MCHC	33.13 ± 0.14	33.36 ± 0.08	33.33 ± 0.04	33.31 ± 0.06	33.24 ± 0.07	33.32 ± 0.05	ns

*Means are presented as ± SEM (Standard Error of Mean). Values with superscript ^{abc} within the same factor and within the same row are significantly different ($p < 0.05$). WBC = White blood cells ($x\ 10^9/L$); NEUT = Neutrophils (%); LYMPH = Lymphocytes (%); MONO = Monocytes (%) and EOSIN = Eosin (%); RBC = Red blood cells ($x\ 10^{12/}L$); HB = Hemoglobin (g/dL); PCV = Parked cell volume (%); MCV = Mean Corpuscular Volume (fl); MCH = Mean Corpuscular Hemoglobin (pg) and MCHC = Mean Corpuscular Hemoglobin Concentration (g/dl); * Significant, ns = not significant*

Higher conception rate of 95% was also reported in White Fulani x Friesian breeds (Nafarnda *et al.*, 2005) and 85 to 90% reported in Bunaji x Friesian dairy cow (Alphonsus *et al.*, 2014). In a Fixed Timed AI (FTAI) estrous synchronization protocol, detection of estrous would not be required prior to insemination as all cows injected with synchronizing agent would be inseminated with semen at a predetermined time, hence, pregnancy rate is expected to be higher than 67% achieved when 70% conception rate was recorded in a population of cows where 95% were detected with estrous after synchronization (Smith *et al*., 2013). Such pregnancy rate in AI or natural beef cattle breeding was considered excellent.

Table 5: estimates of b*ody weight (kg) and conception rate (%) of indigenous breeds of cows inseminated with exotic semen in four farm locations in Kwara State*

Factors:		Body weight Estimate (kg)	Conception Rate (%)
Farm Location	A	338.38[b] ± 2.83	85
	B	377.83[b] ± 4.37	83
	C	344.33[b] ± 1.32	75.5
	D	457.00[a] ± 32.62	87.5
Breeds	White Fulani	372.75 ± 13.56	78.6
	Gudali	383.74 ± 9.14	81.3
Farm Location x Breed Interaction		ns	ns

Values with superscript [abc] within the same factor and within the same column are significantly different ($p < 0.05$). Assessment of conception was done by transrectal palpation and assaying serum progesterone at 16 weeks post Fixed Timed Artificial Insemination

Reproduction hormones level in White Fulani and Gudali cows before and after estrous synchronization: Evaluation of reproductive hormone concentration could provide insight into physiological and welfare status of farm animals and act as indicators of reproductive performance and success (Evans *et al.*, 2022). The response of estrogen (E2) to estrous synchronization using Synchromate® (Fig. 3) revealed that there was variation in the response of animals in different farm locations under different management practices and between the two breeds of cattle enrolled for insemination. While estrogen hormone surged in response to Synchromate® in farms B and C significantly ($p < 0.05$), there was no estrogen response in farm A. However, at farm D, the reverse was the case as estrogen was significantly reduced ($p < 0.05$) by the administration of Synchromate®. This observation could be possibly due to presence of undetected pregnant cows in early stages of pregnancy on these farms. There was no significant increase in the threshold of estrogen in white Fulani, but in Gudali, estrogen was significantly ($p < 0.05$) increased.

Across the various farm locations and breeds, there was significant increase ($p < 0.05$) in the threshold of luteinizing hormone (LH). There was however a greater response of LH to Synchromate® observed at farm D compared to the other farm locations as well as in White Fulani compared to Gudali (Fig. 4). There was a significant ($p < 0.05$) reduction in the threshold of follicle stimulating hormone (FSH) in response to Synchromate® in all the farm locations except at farm D. Also, Gudali had a reduction in FSH while it remains constant in white Fulani (Fig. 5). Across the farm locations, Progesterone level was reduced consequent upon the administration of Synchromate®. The same trend was observed in the two breeds (Fig. 6). After 16 weeks post insemination, the progesterone level had increased significantly ($p < 0.05$) indicating that progesterone threshold was at pregnancy maintenance (gestation) levels across all the farm locations and among the breeds. The variable results obtained following hormonal treatments with Synchromate in this study is consistent with observation made by Kesler *et al.* (1996) that results from cattle synchronized with Synchromate® have been variable. The variation has been attributed to nutritional status of each cow, management difference of each farm, ovarian changes, endocrine events, and uterine infection. The surge in the level of LH was expected as the animal already had elevated estrogen in their body. High estrogen concentration from the Graafian follicle stimulates an increase in the release of gonadotropin-releasing hormone (GnRH) pulses from the hypothalamus and, in turn, LH secretion from the pituitary toward the onset of estrus in animal. This surge of LH in blood stream makes the mature follicle to rupture to release the ovum and the cellular tissue left behind becomes luteinized and form a new corpus luteum (Shahid *et al.*, 2019). LH is responsible for ovulation (Asnake *et al.*, 2018), thus its concentration is expected to rise upon the administration of Synchromate®. FSH specifically stimulates follicular waves and follicles on the ovary to grow and prepare for ovulation. As the follicles increase in size, they begin to release estrogen and level of progesterone become low (Hafez and Jainudeen 2016). After the release of the ova, the FSH begins to decline owing to the negative feedback of progesterone surge. Thus, the decline in the level of FSH in this study might be in order as ova must have been released. The threshold of progesterone in the current study 16 weeks post insemination was within the gestation range of 20 – 50ng/ml as described by Evans *et al. (*2022). During the luteal phase of estrus cycle, the remnants of the newly ruptured ovarian follicle develop into the corpus luteum which begin to produce progesterone needed to support and maintain a potential pregnancy if the egg is fertilized (Liuel, 2017).

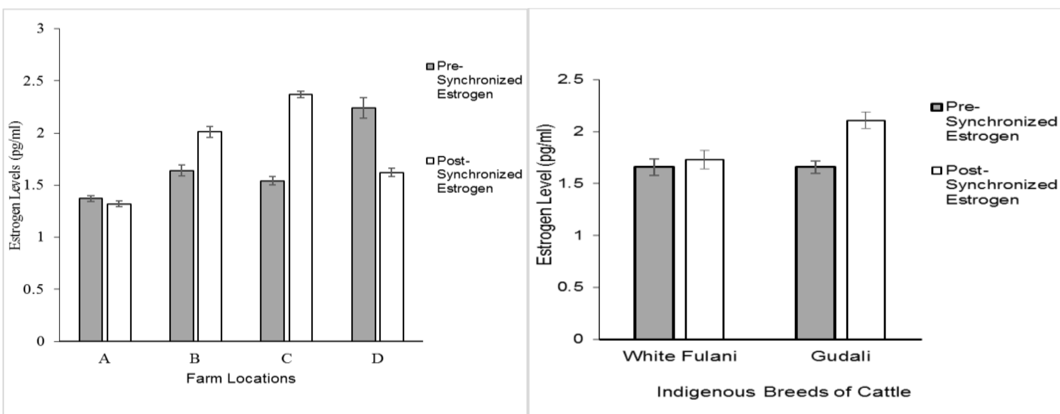

Fig. 3: estrogen hormone response to estrous synchronization with synchromate® in two indigenous cattle breeds in a timed – artificial insemination scheme in some farm locations in Kwara State

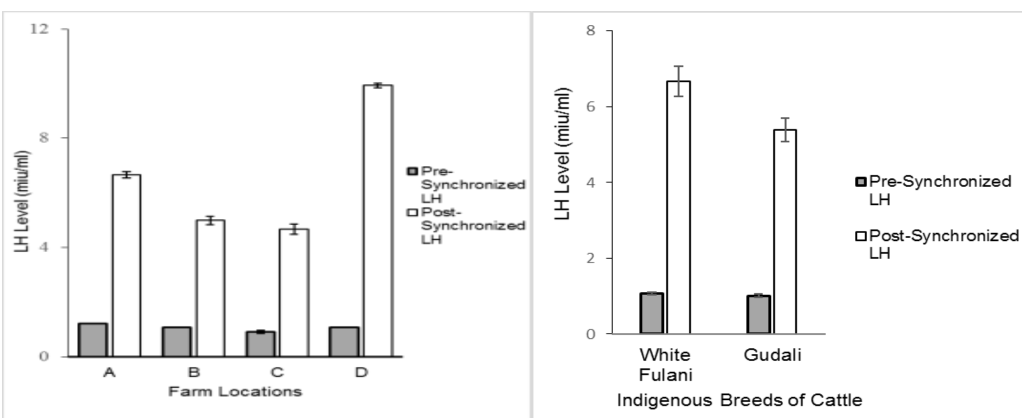

Fig. 4: luteinizing hormone (LH) response to estrous synchronization with synchromate® in two indigenous cattle breeds in a timed – artificial insemination scheme in some farm locations in Kwara State

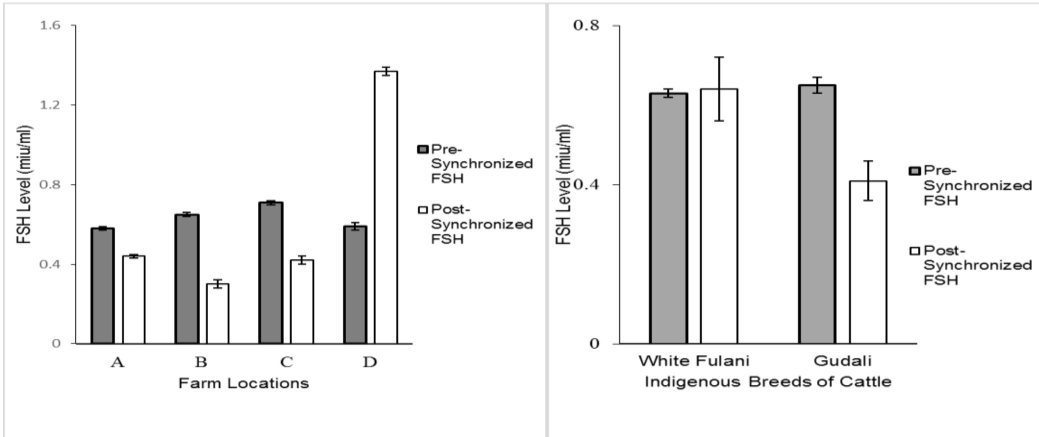

Fig. 5: follicle stimulating hormone (FSH) response to estrous synchronization with synchromate® in two indigenous cattle breeds in a timed – artificial insemination scheme in some farm locations in Kwara State

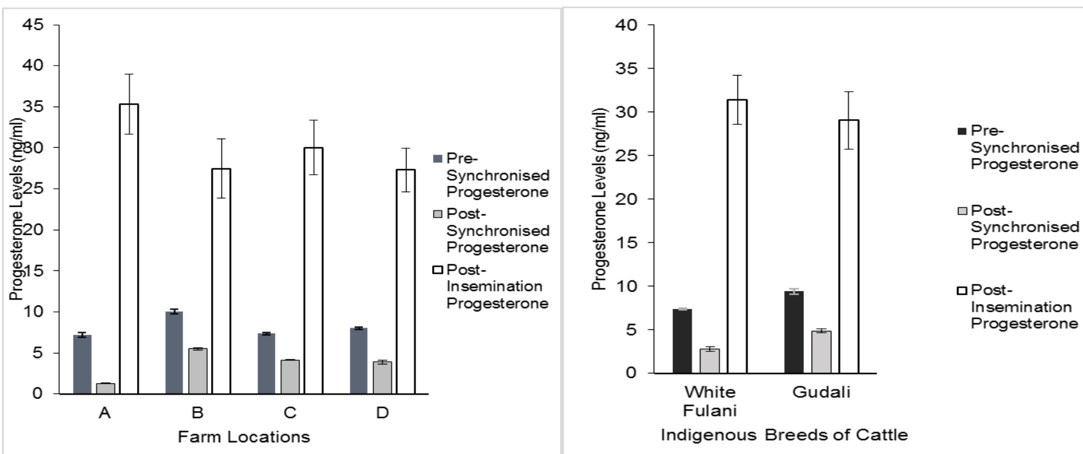

Fig. 6: progesterone hormone response to estrous synchronization with synchromate® in two indigenous cattle breeds in a timed – artificial insemination scheme in some farm locations in Kwara State

Conclusions: It can be concluded that the hematological and biochemical parameters evaluated were within the normal reference range indicating substantial healthy cows. Also, the assayed reproductive hormones and high conception rate were indicative of reproductive success consequent upon estrous synchronization protocol used in this study. Routine health evaluation of cows and use of chloprostenol, intramuscularly injected, as synchronizing agent during artificial insemination in herd improvement of indigenous cattle breeds in Nigeria are thus recommended. Further study to evaluate the hybrid offspring of artificially inseminated indigenous cows with exotic semen is suggested.

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Data Availability: Data are available upon request from the corresponding author.

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