SciMedCentral Journal of Veterinary Medicine and Research

Research Article

Effects of Metabolic Profile, Season and Stage of the Sexual Cycle on Follicular Dynamics, Quality and Oocyte Yield In Three Tropical Zebu Cattles

Dorice Kana Azafack[1], Ferdinand Ngoula[1]*, Justin Kouamo[2], Herve Tchoffo[1], and Linda Kaze Kenne[1]

[1]*Animal Physiology and Health Research Unit, Department of Agronomy and Agricultural Sciences, University of Dschang, Cameroon*

[2]*Department of Surgery and Medical Pathology, University of Ngaoundere, Cameroon*

***Corresponding author**

Ngoula Ferdinand, Animal Physiology and Health Research Unit, Department of Agronomy and Agricultural Sciences, University of Dschang, Cameroon, Tel: 237 676656710; Email: fngoula@yahoo.fr

Submitted: 17 February 2020

Accepted: 11 March 2020

Published: 17 March 2020

ISSN: 2379-948X

Keywords

- Metabolic profile
- Sexual cycle
- Follicular dynamics
- Oocyte yield
- Tropical zebu cattles

Abstract

Genetic and environmental factors have been reported to affect ovary characteristics. In the present study, we investigated the effects of metabolic profile on follicular population, oocyte quality and yield in three tropical cattle breeds. Blood and ovaries were collected from 195 zebu cattle (Gudali, Red and White Fulani) aged 3 to 15 years, with body condition score (BCS) of 2.93 ±0.65 (1 to 5) during slaughtering. The phases of sexual cycles were divided into proestrus, estrus, metestrus and diestrus. In each ovary, the follicle were counted and classified according to their diameter in small (<3 mm), medium (3-8 mm) and large (>8 mm) using an electronic caliper. Oocytes were collected by slicing technique and classified in class I, II, III and IV according to their cumulus investment and cytoplasmic distribution in four groups under a light microscope (400X). The metabolic or biochemical parameters were evaluate in the serum using automate and commercially available kits. Results show that from 390 ovaries, 6642 follicles were counted. The mean number of follicles per ovary was 18.45±0.58 and 15.74±0.48 respectively for right and left ovary. Small, medium and large follicles per cow represented 24.15±0.86; 9.30±0.39 and 0.61±0.05 respectively. The average number of follicles obtained per cow (34.06 ± 13.01) increased significantly with BCS (P<0.05). With the exception of total of class III oocytes, the overall number of follicles and oocytes were significant higher during rainy than dry season (P<0.05). Ovaries with corpus luteum presented fewer follicles than ovaries without corpus luteum. The highest number of large follicles was obtained during estrus phase of sexual cycle and the number of class I and II oocyte were obtain in proestrus. The mean oocyte yield per ovary was 8.34±0.28 and 7.02±0.24 respectively for right and left ovary. The quality of oocyte graded I, II, III and IV were 5.94 ±0.19, 3.29±0.16, 2.56 ±0.12 and 3.83±1.14 respectively. The average number of selected oocyte for in vitro embryo production represented 9.23±0.35 per cow and the oocyte index was 0.93. At the end of the research, we can easily see that, dry season negatively affect follicular population, oocyte yield and metabolic parameters. Estrus and proestrus are the best phases of the sexual cycle for the emergence of large follicles and good quality oocytes respectively.

INTRODUCTION

Cattle production plays an important role in Cameroon's national animal systems and represents 10% of total livestock [1]. Reproductive performance is vital to perpetuate existence of cattle. This highly depends on adequate nutrition and proper management system of rearing the livestock, the lack of which associated with pathological factors results in poor productivity, infertility and sometimes sterility [2]. These factors may be classified either into specific diseases affecting the reproductive organs directly or non-specific factors that underscore the reproductive efficiency [3]. Cattle breeds in Cameroon are trypano-tolerent cattle (Namchi, Kapsiki, Kuri and Bakossi) which are very robust [4] and are considered to be highly endangered breeds [5]. Nevertheless, there are principally trypano-susceptible cattle in Cameroon: zebus (Bos indicus) [6]. Despite the rich breed diversity of local cattle; their productivity still remains low due mainly to farming systems commonly extensive without steady animals. Breeding of local cattle is naturally under traditional management systems with very little or no breeding programs.

One of the most important particularities of the extensive breeding systems is exploitation of fodder resources, often heterogeneous in space and variable with time. Thus, seasonal fluctuations of food resources lead livestock to practice a dynamic of storage and mobilization of tangible reservation [7]. Evolution weight of animals enable to identify critical period and factors that limit their productivity [8].That can be studied through Body Score Conditions during different seasons, and /or metabolic profile analysis. To overcome these problems, Assisted Reproductive Technologies (ARTs) such as Artificial Insemination (AI), In Vitro Embryo Production (IVEP), multiple ovulation and embryo transfer (MOET) have been developed. In Cameroon, artificial insemination (AI) of local breeds with exotic semen has contributed to the improvement of cattle genetic potential [9]. However, embryo transfers (IT) and In Vitro Embryo Production (IVEP) of cattle has not been sufficiently tested in Cameroon. In cattle, the IVEP is largely used in the world and has allowed the production of high genetic embryos from oocytes collected from live cows or after slaughter to promote the growth of the specific species [10]. The processes of collection, maturation, fertilization and in vitro culture of oocytes were significantly improved [11] and were also used in the development of laboratory in mass production of embryos in vitro. However, the egg donor intrinsic and extrinsic factors such as follicular size, morphology of cumulus complex, biochemical, hormonal and nutritional aspects have been reported as the cause of results fluctuations in the laboratories [12]. In addition, hormones such as Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH) for in vitro maturation (IVM) medium is important even in the subsequent in vitro fertilization (IVF) and embryonic development [13].

It is in this context that this study was undertaken with the main objective to evaluate factors that affect metabolic and hormonal profile of three cattle breeds in Cameroon (Gudali, White and Red Fulani). This was achieved by the determination of follicular population, oocytes quality and establishment of the relation between the reproductive characteristics of cows, the stage of the estrus cycle and season, the nutritional status of animals, the impact of energy, protein parameters and hormone on the follicular population, quality and oocyte yield.

MATERIALS AND METHODS

Study area

The study was carried out in Bafoussam, west region of Cameroon (Latitude, 5°46’ N and Longitude, 10°40’E) characterized by Sudano Guinean climate. Average annual precipitation 2000 mm of water with a short dry season of 3-4 months (November to February) and long rainy season of 8-9 months (March - October). The samples were collected at the Bafoussam municipal slaughterhouse from November 2017 to October 2018 and analyzed in the Animal Physiology and Health Laboratory of the University of Dschang.

Animal selection

The study was conducted on a total of 195 cyclic local zebus of different breeds: Gudali (64), White (63) and Red Fulani (68). Cows were mainly originated from North West region and were randomly selected. Body Condition Score (BCS) and age of cows were determined as described by Natumyana et al. [14] and Moussa Garba et al. [15] respectively.

Blood collection

Blood sample was collected from the jugular vein of each cow immediately after slaughter in 10 ml dry tubes (reference: Venoject R). After collecting, blood samples were transferred to the laboratory at 5°C and centrifuged at 2700 g for 15min and the sera obtained were stored in aliquots (1.5 ml Eppendorf tubes) at -20°C until assayed.

Ovary collection and handling

After slaughter, the left and right ovaries were excised and placed in separate conical tubes containing physiological normal saline solution (0.9%) supplemented with antibiotics (0.5 mg / ml of penicillin-streptomycin sulfate). Thereafter all collections were transported immediately to the laboratory in a sterile thermos with temperature between 34 to 36°C.

Determination of weight and the size of ovary

In the laboratory, all ovaries were cleared off attached tissue and mesovarium (trimming) and weighed using an electronic scale, Mettler PC 2000. The length, width and thickness of the ovary were measured using digital calipers and the ovaries were thereafter classified into two groups in function of their volume ($V < 2.25 \times 1.75 \times 1.25$ and $V > 2.25 \times 1.75 \times 1.25$) with V= volume, 2.25 = length, 1.75 = width and 1.25 = diameter of ovary as described by Samad and Raza [16].

Determination of follicular population and stage of sexual cycle

The trimmed ovaries were subjected to washings (5-6 times) with warm saline fortified with antibiotics and transferred into the laminar flow. The apparent follicles on each ovary were measured using electronic digital calipers, counted and then classified according to their diameters (Φ) into three categories: small ($\Phi < 3$ mm), medium ($3 \leq \Phi \leq 8$ mm) and large ($\Phi > 8$ mm) as described by Baki et al. [17]. The size and color of corpus luteum present on the ovary were noted and permitted to distinguish four stages of the sexual cycle (proestrus, estrus, metestrus and diestrus) as described by Nguyen-kien and Hanzen [18] and Satrapa et al [19].

Oocytes recovery

Oocytes were retrieved using slicing technique [20] in the separate plastic Petri dishes containing collection medium (physiological normal saline solution 0.9%). The collected oocytes were graded as excellent (I), good (II), fair (III) and poor (IV) quality under the stereo microscope (x 10) according to the homogeneity of the cytoplasm and layers cumulus of cell [21]. The index (overall quality) was calculated using the following formula [(GI x 1 + GII x 2 + GIII x 3 + GIV x 4) / Total number of oocytes recovered] when GI, GII, GII and GIV represented grate I, grate II, grate II and grate IV oocyte as described by Duygu et al. [22]. Index values that trend to one reflected good quality oocytes.

Biochemical analysis

Serum sample was analysed to determine the concentration of total cholesterol, urea, phosphorus, total protein, and albumin. Total globulins were calculated by subtracting albumin from total protein [23]. All biochemical parameters were determined by colometric methods using an Automated chemistry analyzer (Lab Max Plenno, Labtest, Lagoa Santa, Brazil. While the levels of different hormones (FSH, LH and estradiol) in the sera were determined using the commercial kits ELISA (OMEGA Diagnostic Automation Inc).

Statistical analysis

The collected data were analysed using SPSS version 20.00. Analysis of Variance 1 and 2 ways and Duncan's test statistics were used to test the differences between means. The level of significance was recorded at the 5% level of confidence.

RESULTS AND DISCUSSION

Characterization of slaughtered cows

The average BCS of cows were 2.93 ±0.65 on a ladder 1 to 5. The minimum and maximum BCS registered was 2 to 4. The percentages of animals with BCS equal to [3] and age equal to [6-9] were high as well as in Gudali, Red and White Fulani (Table 1).

Follicular population

From 195 pairs of ovaries collected, 6642 follicles were counted on their surface. The mean number of follicles per ovary was 18.45 ± 0.58 and 15.74 ± 0.48 respectively for right and left ovary. Small (Φ < 3mm), medium (3 ≤ Φ ≤ 8 mm) and large (Φ> 8 mm) follicles per cow represented 24.15 ± 0.86; 9.30 ± 0.39 and 0.61 ± 0.05 respectively. The average number of follicles obtained in this study per cow (34.06± 13.01) increased significantly (P < 0.05) with BCS (Table 6). The overall number of follicles was significant (P < 0.05) high during rainy than dry season (Table 2). In additionally, the number of large follicles and god quality oocyte were significantly (P < 0.05) high during estrus stage of sexual cycle (Table 3, 5a and 5b)

Nutritional status of cows

Metabolic dosage in 195 cow's serum used in this study was classified into protein parameters (total protein, albumin, globulin and urea), energy (total cholesterol) and hormones (Follicle Stimulating Hormone, Luteinising Hormone and estriol). It showed that the levels of albumin and cholesterol were significantly higher in Gudali cows with BCS = 3 while the level of urea was significantly higher in thin Gudali (P < 0.05) (Table 4).

Oocyte quality

Of the total of 390 ovaries, 3045 oocyte were obtained. The mean oocyte yield per ovary was 8.34± 0.28 and 7.02 ± 0.24 respectively for right and left ovary. The oocyte quality graded I, II, III and IV (Figure 1) were 5.94 ±0.19, 3.29 ±0.16, 2.56 ±0.12 and 3.83 ± 1.14 respectively. Selected oocyte for IVEP represented 9.23 per cow and the oocyte index was 0.93. It is also shown that, with the exception of total of class III oocyte, the distribution of oocytes was significantly (P < 0.05) high during rainy than dry season. Right ovaries were heavier than left and the total number of follicle and oocyte of right ovary was higher than the sum of the left. In addition, dry season was negatively impacted ovary characteristics (Table 7a and b).

The quality and the number of oocyte were generally most important during rainy season than what reported in dry season (Table 8a and 8b).

From the following results, some correlations have been retains. It follows up highly positive correlations between the BCS and the average ovary weight (r = 0,28** ; P < 0,01), between the total number of follicle and the total number of small follicle (r = 0,99** ; P < 0,01) ; between the rate of total protein and class I oocyte (r = 0,15* ; P < 0,05). Nevertheless, highly negative correlations have been recorded on the one hand between the total number of large and medium follicle (r = -0,19** ; P < 0,01), on the other hand between the total number on large follicle and class III (r = -0,15* ; P < 0,05) (Tables 9-11).

DISCUSSION

Reproductive efficiency as well as Body Condition score may be affected by a season as observed in this study. The lowest BCS of animal obtained in dry season may be due on the one hand to lack of feeds or feeds supply with poor nutriments but no doubt related to bad healthy status associated to most important development of epizootic diseases and some infections in dry season and also on the other hand, to the availability of feeds during the dry season. In fact, Maina et al. [24] has demonstrated the under nutrition of Africa zebu cows. In fact, cow with BCS ≤ 2 have a fewer developing follicles during the luteal phase of the estrous cycle and tend to produce fewer eggs during the follicular phase compared to those with BCS ≥ 3 because the number of follicles that leave the ovarian reserve depends of the individuals BCS [25]. Generally, periods of low nutrition are associated with a decrease in insulin secretion and elevation of nonesterified fatty acids (NEFA) [26] due to enhanced lipolysis and reduced lipogenesis. Nevertheless the lowest BCS of cows was generally less sensitive on younger than older cows. This may be due to age as reported by Ali et al. [27]. In fact, appreciable growth weight of young animals attenuated harmful effects of unfavorable season and then they are more resistant during strong conditions of dry season [28].

Table 1: Distribution of cows as function of breed, BCS and age.

Breed		BCS			AGE (years)	
	[1-2]	[3]	[4-5]	[3-5]	[6-9]	[10-15]
RedFulani (n=68)	17	31	20	14	40	14
Frequency (%)	**24.24**	**45.45**	**30.30**	**18.18**	**60.60**	**21.21**
White Fulani (n= 30)	21	35	7	16	34	13
Frequency (%)	**33.33**	**56.66**	**10**	**25.39**	**53.96**	**20.63**
Gudali(n= 64)	18	34	12	18	32	14
Frequency (%)	**28.12**	**53.12**	**18.75**	**21.9**	**50.00**	**28 .10**

NB: BCS: body condition score.

Table 2: Effects of breed and season on follicular population.

Follicular size	Breed	Season		Average±SD	P-VALUE
		Dry	Rainy		
Small	Gudali (n= 64)	(32)18.22 ± 2.89^{aA}	(32)33.56 ±14.34^{bA}	**25.39± 11.10$^{\alpha}$**	**0.04**
	White Fulani (n=63)	(31) 18.61± 3.1^{aA}	(32) 30.75±13.39^{bA}	**24.50± 11.24$^{\alpha}$**	**0.04**
	Red Fulani (n= 68)	(32) 16.25±2.00^{aA}	(36) 33.60± 13.24^{bA}	**23.48± 13.11$^{\alpha}$**	**0.03**
	Average	**17.34 ± 12.30$^{\alpha}$**	**33.09 ± 8.35$^{\alpha}$**	**24.18± 13.11$^{\alpha}$**	-
	P-value	**0.17**	**0.17**	-	-
Medium	Gudali (n= 64)	(32) 10.06 ± 2.38^{aA}	(32)10.47±4.19^{aA}	10.27±4.99$^{\alpha}$	**0.01**
	White Fulani (n=63)	(31) 7.59± 3.82^{aA}	(32) 8.71±3.29^{aA}	**9.47± 6.16$^{\alpha}$**	**0.85**
	Red Fulani (n= 68)	(32) 8.75±3.66^{aA}	(36) 1.28± 2.00^{aA}	**9.57± 3.26$^{\alpha}$**	**0.39**
	Average	**8.53 ± 4.04$^{\alpha}$**	**9.27 ± 5.41$^{\alpha}$**	**9.65± 3.26$^{\alpha}$**	-
	P-value	**0.24**	**0.24**	-	-
Large	Gudali (n= 64)	(32)0.53 ± 0.12^{aA}	(32) 0.72±0.27^{aA}	**0.63± 0.16$^{\alpha}$**	**0.11**
	White Fulani (n=63)	(31) 0.55 ± 0.17^{aA}	(32)0.81 ± 0.27^{aA}	**0.68 ± 0.18$^{\alpha}$**	**0.68**
	Red Fulani (n= 68)	(32) 0.34± 0.12^{aA}	(36) 0.67± 0.1^{aA}	**0.51± 0.11$^{\alpha}$**	**0.30**
	Average	**0.45 ± 0.11$^{\alpha}$**	**0.75 ± 0.35$^{\alpha}$**	**0.58± 0.21$^{\alpha}$**	-
	P-value	**0.44**	**0.17**	-	-
Total follicle	Gudali (n= 64)	(32) 28.81±2.91^{aA}	(32) 37.75 ± 17.29^{bA}	**35.28±013.09$^{\alpha}$**	**0.01**
	White Fulani (n=63)	(31) 27.325±3.10^{aA}	(32) 39.16±14.40^{bAB}	**33.43 ± 12.00$^{\alpha}$**	**0.04**
	Red Fulani (n= 68)	(32)26.68 ±2.02^{aA}	(36) 43.11 ± 12.32^{bB}	**34.47 ±13.86$^{\alpha}$**	**0.03**
	Average	**34.22 ± 11.24$^{\alpha}$**	**33.32 ±10.65$^{\alpha}$**	**34.37 ±11.36$^{\alpha}$**	-
	P-value	**0.44**	**0.01**	-	-

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 3: Variations of numbers of follicles as function of breed and sexual cycle.

Parameters	BREED	Sexual cycle				Average±SD	P-VALUE
		Proestrus	Estrus	Metestrus	Diestrus		
Small	Gudali (n= 64)	(19)27.47 ± 12.99^{bA}	(10)26.10 ±6.01^{bB}	(10) 25,20±15,36^{abA}	(25) 21.96± 9.55^{aA}	**24.39± 11.10$^{\alpha\beta}$**	**0.02**
	White Fulani (n=63)	(19) 23.31± 13.12^{aA}	(7) 22.28±9.67^{aAB}	(13)24,07±13,96^{aA}	(24) 20.45± 9.20^{aAB}	**22.50± 11.24$^{\alpha}$**	**0.17**
	Red Fulani (n= 68)	(21) 25.33±11.25^{aA}	(5) 20.60± 11.14^{aA}	(20) 22,30± 8,95^{aA}	(22) 29.63±17.28^{aB}	**25.48± 13.11$^{\beta}$**	**0.30**
	average	**25.34 ± 12.30$^{\alpha}$**	**23.09 ± 8.35$^{\alpha}$**	**23,58 ± 12,00$^{\alpha}$**	**23.43 ± 12.81$^{\alpha}$**	**24.18± 13.11$^{\alpha\beta}$**	-
	P-value	**0.17**	**0.01**	**0,23**	**0.03**	-	-
Medium	Gudali (n= 64)	(19) 9.68 ± 2.18^{aA}	(10)10.10±5.08^{abB}	(10) 9,70± 7,08^{aA}	(25) 11.00±5.70^{bA}	**10.26± 4.99$^{\alpha}$**	**0.01**
	White Fulani (n=63)	(19) 6.57± 3.84^{aA}	(7) 10.00±7.09^{aAB}	(13) 8,07± 4,97^{aA}	(24) 8.87± 5.41^{aA}	**8.14± 5.11$^{\alpha}$**	**0.85**
	Red Fulani (n= 68)	(21) 9.23±4.96^{aA}	(5) 6.60± 3.78^{aA}	(20) 10,60± 6,43^{aA}	(22) 9.31± 7.37^{aA}	**9.47± 6.16$^{\alpha}$**	**0.39**
	average	**8.53 ± 4.04$^{\alpha}$**	**9.27 ± 5.41$^{\alpha}$**	**9,53 ± 6,14$^{\alpha}$**	**9.77 ± 6.21$^{\alpha}$**	**9.57± 3.26$^{\alpha}$**	-
	P-value	**0.40**	**0.02**	**0,05**	**0.69**	-	-
Large	Gudali (n= 64)	(19)0.32 ± 0.16^{aA}	(10)1.00±0.47^{aA}	(10)0.60 ± 0.27^{aA}	(25)0.72± 0.38^{aA}	**0.63± 0.16$^{\alpha}$**	**0.11**
	White Fulani (n=63)	(19) 0.42 ± 0.27^{aA}	(7)0.72 ± 0.37^{aA}	(13)0.77 ± 0.22^{aA}	(24)0,83 ± 0.46^{aA}	**0,68 ± 0.18$^{\alpha}$**	**0.68**
	Red Fulani (n= 68)	(21) 0.23± 0,18^{aA}	(5) 1.20± 0.30^{aA}	(20)0.46 ± 0,21^{aA}	(22)0.68 ± 0.32^{aA}	**0.51± 0.11$^{\alpha}$**	**0.30**
	average	**0.32 ± 0.11$^{\alpha}$**	**0.95 ± 0.35$^{\alpha}$**	**0.58 ± 0,23$^{\alpha}$**	**0.275 ± 0.26$^{\alpha}$**	**0.58± 0.21$^{\alpha}$**	-
	P-value	**0.44**	**0.17**	**0.22**	**0.41**	-	-
Total follicles	Gudali (n= 64)	(19) 33.47±12.41^{aA}	(10) 37.20 ± 8.99^{abB}	(10) 34.50± 17.79^{aA}	(25) 39.68±13.59^{bB}	**33.28±013.09$^{\alpha}$**	**0.11**
	White Fulani (n=63)	(19) 34.315±13.00^{aA}	(7) 35.00±12.93^{aAB}	(13) 33.92± 12.51^{aA}	(24)31.16± 10.99^{aA}	**33.43 ± 12.00$^{\alpha}$**	**0.68**
	Red Fulani (n= 68)	(21)34.81 ±1 0.39^{aA}	(5)33,40 ± 10.62^{aA}	(20)33.35 ± 10.88^{aA}	(22)32.64±18.63^{aAB}	**35.47 ±13.86$^{\alpha}$**	**0.30**
	average	**34.22 ± 11.24$^{\alpha}$**	**33.32 ±10.65$^{\alpha}$**	**32.79 ± 12.13$^{\alpha}$**	**34.32 ± 14.21$^{\alpha}$**	**34.37 ±11.36$^{\alpha}$**	-
	P-value	**0.44**	**0.01**	**0.20**	**0.04**	-	-

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 4: Effects of breed and body condition score on the biochemical parameters.

Parameters	Breed	BCS			Average	P-value
		[1-2] n=49	**[3] n=50**	**[10-15] n=19**	± SD	
Total proteins	Gudali(n=63)	11.08±3.08^{aA}	10.11±1.58^{aA}	11.38±3.64^{aA}	**10.63±2.57**$^{\alpha}$	**0,21**
(g / dl)	White Fulani (n=64)	10.24±1.64^{aA}	11.10±2.50^{aA}	10.71±1.79^{aA}	**10.83±2.28**$^{\alpha}$	**0.32**
	Red Fulani (n=68)	10.10±1.38^{aA}	10.22±2.11^{aA}	9.58±1.67^{aA}	**10.09±1.85**$^{\alpha}$	**0,58**
	Average ± SD	**10.43±2.03**$^{\alpha}$	**10.50±2.17**$^{\alpha}$	**10.63±2.82**$^{\alpha}$	**10.52±0.49**$^{\alpha}$	**-**
	p-value	**0,41**	**0,09**	**0,25**	-	**-**
	Gudali (n=63)	2.02±0.5^{aA}	2.91±0.28^{bB}	2.63±0.50^{aA}	**2.77±0.41**$^{\alpha}$	**0,01**
	White Fulani (n=64)	2.82±0.39^{aA}	2.82±0.38^{aB}	2.86±0.32^{aA}	**2.83±0.38**$^{\alpha}$	**0,77**
	Red Fulani (n=68)	2.63±0.49^{aA}	2.54±0.50^{aA}	2.67±0.49^{aA}	**2.59±0.49**$^{\alpha}$	**0,68**
Albumin	Average± SD	**2.69±0.46**$^{\alpha}$	**2.76±0.43**$^{\alpha}$	**2.69±0.47**$^{\alpha}$	**2.72 ±0.08**$^{\alpha}$	**-**
(g / dl)	p-value	**0,37**	**0,00**	**0,55**	**-**	-
Globulin	Gudali (n=63)	7.54±1.50^{aA}	7.26±1.50^{aA}	8.00±2.92^{aA}	**7.50±2.24**$^{\alpha}$	**0,45**
(g/dl)	White Fulani (n=64)	7.47±1.4^{aA}	8.05±2.55^{aA}	7.43±1.27^{aA}	**7.83±2.18**$^{\alpha}$	**0,58**
	Red Fulani (n=68)	7.84±2.47^{aA}	7.35±2.00^{aA}	7.25±3.33^{aA}	**7.47±2.37**$^{\alpha}$	**0,72**
	Average± SD	**7.63±1.89**$^{\alpha}$	**7.57±2.09**$^{\alpha}$	**7.63±2.77**$^{\alpha}$	**7.65 ±0.46**$^{\alpha}$	**-**
	p-value	**0,82**	**0,19**	**0,77**	-	**-**
Urea	Gudali (n=68)	36.84±9.96^{bA}	35.80±10.19^{abA}	35.56±9.00^{aA}	**35,17 ±10,92**$^{\alpha}$	**0,70**
(mg/dl)	White Fulani (n=64)	36.29±9.73^{aA}	33.36±7.47^{aA}	31.71±3.98^{aA}	**33.97±7.90**$^{\alpha}$	**0,32**
	Red Fulani (n=68)	33.00±12.43^{aA}	34.86±9.09^{aA}	28.67±12.02^{aA}	**34.32±10.37**$^{\alpha}$	**0.71**
	Average± SD	**35.63±10.49**$^{\alpha}$	**34.63±9.09**$^{\alpha}$	**32.43±9.75**$^{\alpha}$	**3434.82± 1.9**$^{\alpha}$	**-**
	p-value	**0,53**	**0,50**	**0,17**	**-**	**-**
Total cholesterol (mg/dl)	Gudali (n=6)	131.62±53.74^{aA}	146.31±54.10^{bA}	146.19±60.7^{abA}	**143.30±55.16**$^{\beta}$	**0,70**
	White Fulani (n=64)	136.94±48.94^{aA}	129.64±56.76^{aA}	144.19±61.83^{aA}	**133.24±54.66**$^{\alpha}$	**0,70**
	Red Fulani (n=68)	140.74±58.06^{bA}	127.68±52.17^{aA}	115.33±50.2^{aA}	**129.15±53.44**$^{\alpha}$	**0,42**
	Average	**137.00±52.89**$^{\alpha}$	**134.24±54.56**$^{\alpha}$	**135.23±57.70**$^{\alpha}$	**148.02± 9.18**$^{\alpha}$	**-**
	p-value	**0,89**	**0,28**	**0,34**	**-**	**-**
Phosphorus (mg/dl)	Gudali(n=63)	14.15±3.10^{aA}	14 ?94±2.72^{aA}	15.25±3.37^{aA}	**14,32 ±0,5**$^{\alpha}$	**0,59**
	White Fulani (n=64)	14.29±2.77^{aA}	14.82±2.40^{aA}	14.43±3.10^{aA}	**14,00 ±0,43**$^{\alpha}$	**0,76**
	Red Fulani (n=68)	14.32±2.60^{aA}	14.68±2.92^{aA}	14.92±2.61^{aA}	**14.62±2.75**$^{\alpha}$	**0,82**
	Average	**14.27±2.74**$^{\alpha}$	**14.81±2.66**$^{\alpha}$	**14.97±3.00**$^{\alpha}$	**14.50± 0.50**$^{\alpha}$	**-**
	p-value	**0,74**	**0,9**	**0,83**	**-**	**-**

A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05); a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05); α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 5a: Variations of oocyte quality as function of breed and sexual cycle.

Oocyte quality	Breed	Stade du cycle sexuel				Averazge ±SD	P-value
		Proestrus	Estrus	Metestrus	Diestrus		
	Gudali n=64	(19)6.56 ± 1.66^{aA}	(10)7.20±1.81^{aA}	(10)6.50±1,36^{aA}	(25)7,04± 2,23^{aA}	**6.36± 1.90**$^{\alpha}$	**0.24**
	White Fulani n=63	(19)6.95± 2.19^{aA}	(7)6.86±3.02^{aA}	(13)7.54±2,16^{aA}	(24)6,45± 2,20^{aA}	**6.56± 2.23**$^{\alpha}$	**0.17**
Classe I	Red Fulani n=68	(21)7.19±1.65^{aA}	5)6.20± 1.40^{aA}	(20)7.45± 2,55^{aA}	(22)7,41±2,48^{aA}	**7.28± 2.25**$^{\alpha}$	**0 .30**
	Average	**6.92 ± 1.93**$^{\alpha}$	**6.89 ± 2.15**$^{\alpha}$	**7.26 ± 2,20**$^{\beta}$	**6,94 ± 2,31**$^{\alpha}$	**6.66± 2.33**$^{\alpha}$	_
	P-valu e	**0.17**	**0.17**	**0.11**	**0,37**	_	_
Classe II	Gudali n=64	(19)4.48 ± 1.80^{aA}	(10)4.00±2.48^{aA}	0)4.90± 1.18^{aB}	(25)4,60± 2,27^{aA}	**4.36± 1.99**$^{\alpha}$	**0.11**
	White Fulani n=63	(19)4.89± 1.54^{bA}	(7)4.44±1.26^{bA}	(13)2.84± 1.52^{aA}	(24)3,25± 1,39^{abA}	**3.05± 1.14**$^{\alpha}$	**0.03**
	Red Fulani n=68	(21)4.33±1.99^{aA}	(5)4.80± 1.30^{aA}	(20)4.00± 2.12^{aAB}	22)5,14± 1,35^{aA}	**4.79± 1.92**$^{\alpha}$	**0.39**
	Average	**4.58 ± 1.04**$^{\alpha}$	**4.37 ± 2.21**$^{\alpha}$	**4.90 ± 2.34**$^{\beta}$	**4.54 ± 2.01**$^{\alpha}$	**3.65± 1.24**$^{\alpha}$	_
	p-value	**0.24**	**0,24**	**0.04**	**0.69**	_	_
Classe III	Gudali n=64	(19)3.68 ± 1.16^{aA}	(10)2.80±1.54^{aA}	(10)3.10 ± 0.73^{aA}	(25)3.88± 1.38^{aA}	**3.53± 1.46**$^{\alpha}$	**0.11**
	White Fulani n=63	(19) 2.89 ± 1.56^{aA}	(7)3.14 ± 1.21^{aA}	(13)2.85 ± 1.57^{aA}	(24)3.25 ± 1.32^{aA}	**3.05 ± 1.48**$^{\alpha}$	**0.68**
	Red Fulani n=68	(21)3.24± 0.98^{aA}	(5)2.20± 1.34^{aA}	(20)2.95± 1.31^{aA}	(22)3.95 ± 1.62^{aA}	**3.31± 1.31**$^{\alpha}$	**0.30**
	Average	**3.27 ± 1.41**$^{\alpha}$	**2.77 ± 1.25**$^{\alpha}$	**2.90 ± 2.03**$^{\alpha}$	**3.69 ± 1.46**$^{\alpha}$	**3.29± 1.21**$^{\alpha}$	_
	p-value	**0.44**	**0.17**	**0.02**	**0.41**	_	_
Classe IV	Gudali n=64	(19)4.57±2.21^{aA}	(10)3.90 ± 1.69^{aA}	(10)4.80± 1.75^{aA}	(25)4.32±1.55^{aA}	**4.41± 1.89**$^{\alpha}$	**0.11**
	White Fulani n=63	(19) 4.58 ± 1.54^{aA}	(7)5.42 ± 3.97^{aA}	(13)3.92 ± 2.17^{aA}	(24)4.42 ± 2.42^{aA}	**4.48 ± 1.28**$^{\alpha}$	**0.68**
	Red Fulani n=68	(21)**4.76 ± 1.74**$^{\alpha}$	(5)4.80 ± 0.62^{aA}	(20)4.60 ± 1.87^{aA}	(24)4.42 ± 2.42^{aA}	**4.60 ±1.82**$^{\alpha}$	**0.30**
	Average	**4.64 ± 1.84**$^{\alpha}$	**4.59 ±2.55**$^{\alpha}$	**4.49 ± 1.93**$^{\alpha}$	(22)4.41 ± 1.65^{aA}	**4.50 ±1.22**$^{\alpha}$	_
	p-value	**0.44**	**0.17**	**0.02**	**0.41**	_	_

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 5b: Variations of oocyte quality as function of breed and sexual cycle.

Oocyte quality	Sexual Cycle					AVERAGE ±SD	P-value
	Breed	**Proestrus**	**Estrus**	**Metestrus**	**Diestrus**		
	Gudali (n= 64)	19)17.27±4.04^{bA}	(10)14.70±6.49^{aA}	(10)15.90± 2.79^{abA}	(25)17.49±4.48^{bA}	**17.69± 4.49$^{\alpha}$**	**0.01**
	White Fulani (n=63)	(21)17.36±6.50^{aA}	(7)17.43±6.73^{aB}	(13)15.69± 5.11^{aA}	(24)15.50± 5.89^{aA}	**16.32± 5.90$^{\alpha}$**	**0.68**
Total class	**Red Fulani (n= 68)**	(21)16.61 ±4.61^{aA}	(5)16.60 ± 4.72^{aAB}	(20)17.35 ± 5.78^{aA}	(22)18.64± 4.73^{aA}	**16.50 ±5.06$^{\alpha}$**	**0.3**
	Averge	17.01 ±5.05^{aA}	**16.00 ±4.55$^{\alpha}$**	**16.51 ± 4.23$^{\alpha}$**	**17.12 ± 5.22$^{\alpha}$**	**16.52± 5.27$^{\alpha}$**	_
	P-value	**0.44**	**0.03**	**0.02**	**0.41**	_	_
	Gudali (n= 64)	(19)11.05±2.76^{aA}	(10)11.20± 3.90^{aA}	(10)10.50± 2.41^{aA}	(25)11.40±2.49^{aA}	**16.69± 2.07$^{\alpha}$**	**0.11**
	White Fulani (n=63)	(19)11.89±4.14^{aA}	(7)11.29±4.30^{aA}	(13)12.00± 3.15^{aA}	(24)10.33± 3.59^{aA}	**11.23± 3.50$^{\alpha}$**	**0.68**
Class 1 and 2	**Red Fulani (n= 68)**	(21)11.52 ±3.51^{aA}	(5)11.00 ± 1.73^{aA}	(20)12.35 ± 4.55^{aA}	(22)12.55± 3.63^{aA}	**12.60±3.85$^{\alpha}$**	**0.3**
	Averge	**11.49 ± 3.44$^{\alpha}$**	**11.18 ±3.45$^{\alpha}$**	**11.89 ± 3.73$^{\alpha}$**	**11.38 ± 3.31$^{\alpha}$**	**13.68±3.25$^{\alpha}$**	_
	P-value	**0.44**	**0.17**	**0.22**	**0.41**	_	_
	Gudali (n= 64)	(19)8.26±3.07^{aA}	(10)6.70 ± 2.49^{aA}	(10)7.90± 1.61^{aA}	(25)8.20±2.21^{aA}	**7.94± 2.43$^{\alpha}$**	**0.11**
	White Fulani (n=63)	(19)7.47±5.20^{aA}	(7)8.57±4.83^{aA}	(13)6.77± 1.95^{aA}	(24)7.66± 3.00^{aA}	**7.52 ± 2.90$^{\alpha}$**	**0.68**
Class 3 and 4	**Red Fulani (n= 68)**	(21)8.00 ±2.09^{aA}	(5)7.00 ± 2.22^{aA}	(20)7.55 ± 2.25^{aA}	(22)8.36 ± 2.53^{aA}	**7.91 ±2.28$^{\alpha}$**	**0.3**
	Averge	**7.92 ± 2.54$^{\alpha}$**	**7.36 ±3.35$^{\alpha}$**	**7.40 ± 2.53$^{\alpha}$**	**8.07 ± 2.55$^{\alpha}$**	**7.81 ±2.38$^{\alpha}$**	_
	P-value	**0.44**	**0.1**	**0.22**	**0.41**	_	_

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 6: Effects of breed and BCS on follicular population.

Follicular size	Breed	BCS			Average ±SD	P-value
		[1-2] n=49	[3] n=111	[4-5] n=35		
	Gudali (n=64)	(13)19.44±7.50^{aA}	(35)23.57±12.09^{Aa}	(16)22.85±8.39^{aA}	22.39±9.38$^{\alpha}$	**0.46**
	White Fulani (n=63)	(17)24.23±9.90^{abA}	(39)26.35±15.3b^{AB}	(7)21.57±10.99^{aA}	23.92±10.99$^{\alpha}$	**0.64**
Total of small follicle	Red Fulani (n=68)	(19)21.58±8.55^{aA}	(37)28.00±17.44^{Bb}	(12)25.46±11.72^{abA}	25.49±13.12$^{\beta}$	**0.42**
	Average	20.60±7.88$^{\alpha}$	26.06±15.31$^{\beta}$	24.43±11.26$^{\alpha}$	**23.71±11.89$^{\alpha}$**	**-**
	P-value	0.43	0.25	0.36	**-**	
	Gudali(n=64)	10.54±1.33^{aA}	9.97±0.94^{aAB}	10.69±0.95^{aA}	10.27±3.62$^{\alpha}$	**0.78**
	White Fulani (n=63)	7.54±4.60^{aA}	8.94±4.90^{aA}	9.57±3.45^{aA}	8.14±5.11$^{\alpha}$	**0.47**
Total medium follicle	Red Fulani (n=68)	7.79±4.54^{aA}	10.41±6.66^{bB}	9.25 6.67^{abA}	9.47±6.16$^{\alpha}$	**0.32**
	Average	**8.91±5.43$^{\alpha}$**	**9.26±5.76$^{\alpha}$**	**9.97±4.83$^{\alpha}$**	**9.32 ± 0.21$^{\alpha}$**	**-**
	p-value	**0.98**	**0.34**	**0.31**	-	**-**

Total of large follicle	Gudali (n=64)	0.54±0.10^{aA}	0.77±0.59^{aA}	0.69±0.19^{aA}	**0.63 ±0.08^{α}**	**0.52**
	White Fulani (n=63)	0.65±0.20^{aA}	0.69±0.12^{aA}	0.71±0.21^{aA}	**0.68 ±0.18^{α}**	**0.76**
	Red Fulani (n=68)	0.41±0.25^{aA}	0.74±0.34^{aA}	0.50±0.38^{aA}	**0.51 ±0.28^{α}**	**0.20**
	Average	**0.54±0.28^{α}**	**0.71±0.23^{α}**	**0.62±0.41^{α}**	**0.61 ± 0.19^{α}**	-
	p-value	**0.12**	**0.36**	**0.21**	-	-
Total follicle	Gudali (n=64)	30.81±8.58^{aA}	34.09±15.20^{bA}	34.15±11.95^{bA}	**33.28±13.10^{α}**	**0.69**
	White Fulani (n=63)	32.46±10.84^{abA}	35.94±14.57^{bAB}	31.86±12.26^{aA}	**33.33±12.00^{α}**	**0.58**
	Red Fulani (n=68)	31.33±9.57^{aA}	36.27±13.60^{bB}	36.53±16.61^{bA}	**35.47±13.87^{α}**	**0.52**
	Average	**31.20±9.42^{α}**	**34.24±13.23^{α}**	**35.69±14.52^{α}**	**33.97±0.92^{α}**	-
	p-value	**0.10**	**0.14**	**0.06**	-	-

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

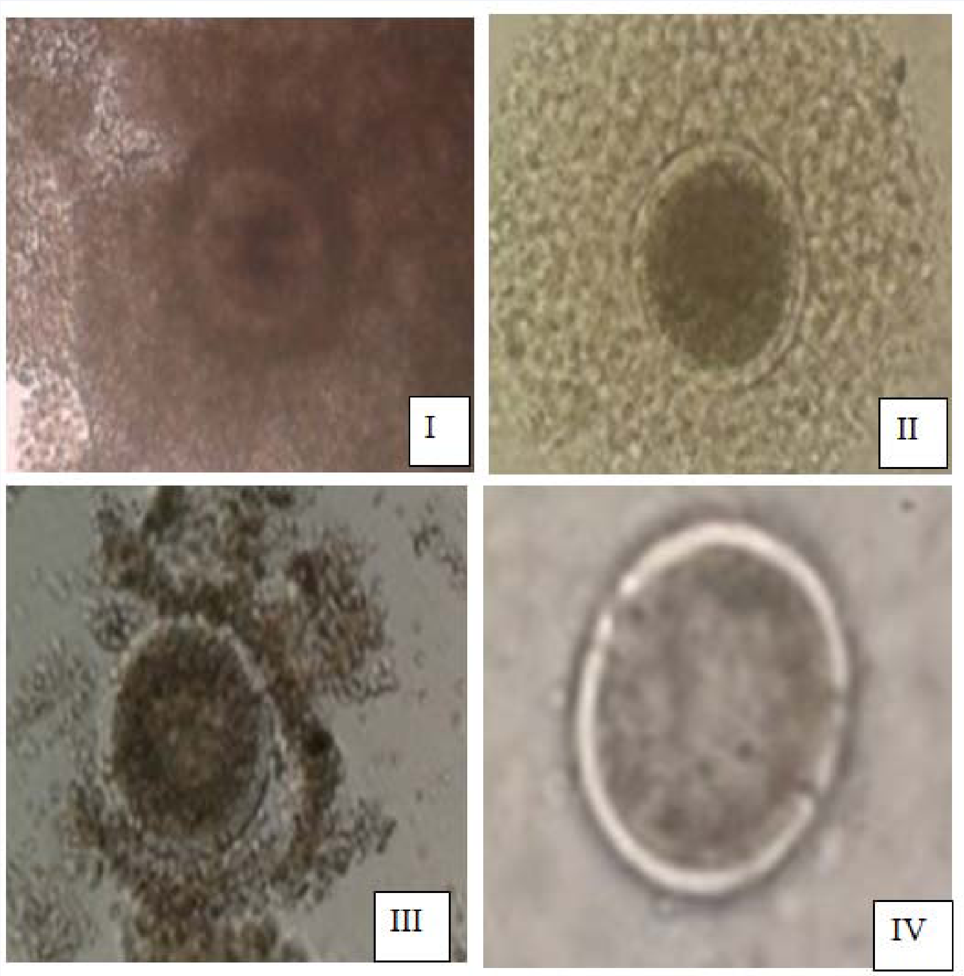

Figure 1 Oocytes (I) Grade I, (II) Grade II, (III) Grade III and (IV) Grade IV (400X).

Table 7a: Effets de la race et de la note d'état corporelsur la qualitéovocytaire.

Oocyte quality	Breed	BCS			Average ±SD	P-value
		[1-2] n=49	[3] n=111	[4-5] n=35		
	Gudali(n=64)	(13)6.54±2.025^{aA}	(35)6.91±2.215^{aA}	(16)6.94±1.482^{aAB}	6.84±1.99$^{\alpha}$	**0.63**
	White Fulani(n=63)	(17) 7.29±2.41^{bA}	(39)6.95±1.98ab	(7 5.29±3.30^{aA}	6.86±2.30$^{\alpha}$	**0.04**
Class I	Red Fulani (n=68)	(19)7.21±1.87^{abA}	(37)7.11±2.40^{aA}	(12)7.83±2.44^{bB}	7.26±2.25$^{\beta}$	**0.52**
	Average	7.06±2.09$^{\alpha}$	6.99±2.18$^{\alpha}$	6.91±2.38$^{\alpha}$	**6.91±2.59$^{\alpha}$**	
	P-valu e	0.48	0.35	0.03		
Class II	Gudali(n=64)	3.85±2.230^{aA}	4.51±2.00^{aA}	4.50±1.71^{aAB}	4.38±1.97$^{\alpha}$	**0.56**
	White Fulani (n=63)	4.18±2.00^{aA}	4.59±2.35^{aA}	3.86±2.03^{aA}	4.40±2.21$^{\alpha}$	**0.67**
	Red Fulani (n=68)	4.79±2.09^{aA}	4.65±1.87^{aA}	5.25±1.91^{aB}	4.79±1.92$^{\alpha}$	**0.39**
	Average	**4.32±2.09$^{\alpha}$**	**4.58±2.07$^{\alpha}$**	**4.62±1.86$^{\alpha}$**	**4.52±1.31$^{\alpha}$**	-
	p-value	**0.48**	**0.32**	**0.21**	-	-
Class III	Gudali(n=64)	3.46±1.66^{aA}	3.54±1.44^{aA}	3.56±1.36^{aA}	3.53±1.447$^{\alpha}$	**0.72**
	White Fulani (n=63)	2.47±0.94^{aA}	3.28±1.55^{aA}	3.14±1.57^{aA}	3.05 ±1.44$^{\alpha}$	**0.56**
	Red Fulani (n=68)	3.42±1.64^{aA}	3.16±1.09^{aA}	3.58±3.58^{aA}	3.31 ±1.38$^{\alpha}$	**0.40**
	Average	**3.10±1.48$^{\alpha}$**	**3.32±1.37$^{\alpha}$**	**3.48±1.52$^{\alpha}$**	**3.31±1.35$^{\alpha}$**	-
	p-value	**0.32**	**0.41**	**0.32**	-	-
Class IV	Gudali(n=64)	5.77±2.08^{bB}	4.11±1.67^{ab}	3.94±1.56a^{aA}	4.41±1.84$^{\alpha}$	**0.04**
	White Fulani (n=63)	4.00±1.93^{aA}	4.69±2.55^{aA}	4.43±1.61^{aA}	4.48±2.30$^{\alpha}$	**0.13**
	Red Fulani (n=68)	4.53±1.34^{aA}	4.51±1.83^{aA}	5.00±1.80^{aA}	4.60± 1.69$^{\alpha}$	**0.52**
	Average	4.67±1.87$^{\alpha}$	4.45±2.07$^{\alpha}$	4.40±1.68$^{\alpha}$	**4.52±0.92$^{\alpha}$**	-
	p-value	**0.01**	**0.24**	**0.35**	-	-

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 7b: Effects of breed and BCS on oocyte quality.

Oocyte quality	Breed	BCS			Average±SD	P-value
		[1-2] n=49	[3] n=111	[4-5] n=35		
Total class	Gudali(n=64)	16.92±5.83^{aA}	16.69±4.43^{aA}	16.50±3.79^{aAB}	16.69±4.53$^{\alpha}$	**0.69**
	White Fulani (n=63)	14.82±.53^{aA}	17.15±6.04^{bA}	15.29±6.34^{abA}	16.32±5.94$^{\alpha}$	**0.53**
	R Red Fulani (n=68)	17.53±4.76^{abA}	16.97±4.96^{aA}	19.08±5.85^{bB}	17.50± 5.05$^{\beta}$	**0.52**
	Average	**16.42±5.35$^{\alpha}$**	**16.94±5.17$^{\alpha}$**	**17.14±5.17$^{\beta}$**	**16.77±4.9$^{\alpha}$**	-
	p-value	**0.21**	**0.34**	**0.74**	-	-
Class I and II	Gudali (n=64)	10.38±2.93^{aA}	11.43±3.13^{aA}	11.44±2.47^{aAB}	11.22±2.93$^{\alpha}$	**0.52**
	White Fulani (n=63)	11.47±3.20^{aA}	11.54±3.71^{aA}	9.14±5.04^{aA}	11.25±3.75$^{\alpha}$	**0.58**
	Red Fulani (n=68)	12.00±3.46^{aA}	11.76±3.85^{aA}	13.08±4.05^{aB}	12.06± 3.76$^{\alpha}$	**0.42**
	Average	**11.38±3.23$^{\alpha}$**	**11.57±3.56$^{\alpha}$**	**11.54±3.81$^{\alpha}$**	**11.47±3.92$^{\alpha}$**	-
	p-value	**0.56**	**0.22**	**0.65**	-	-
Class III and IV	Gudali (n=64)	9.23±2.94^{bB}	7.66±2.22^{abA}	7.50±2.42^{aA}	8.14±2.48$^{\alpha}$	**0.04**
	White Fulani (n=63)	6.47±2.15^{aA}	7.97±3.16^{aA}	7.57±2.82^{aA}	7.52±2.92$^{\alpha}$	**0.28**
	Red Fulani (n=68)	7.95±1.77^{aAB}	7.68±2.29^{aA}	8.58±2.93^{aA}	7.91± 2.284$^{\alpha}$	**0.52**
	Average	**7.77±2.46$^{\alpha}$**	**7.77±2.59$^{\alpha}$**	**7.88±2.65$^{\alpha}$**	**7.84±2.92$^{\alpha}$**	-
	p-value	**0.50**	**0.27**	**0.53**	-	-

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 8a: Effects of breed and season on oocyte quality.

Oocyte quality	Breed	Season: Dry	Season: Rainy	Average±SD±SD±SD	P-VALUE
Class 1	**Gudali (n= 64)**	(32) 6.72 ± 1.59^{aA}	(32) 6.97± 2.34^{aA}	**6.84± 1.9**$^{\alpha}$	**0.40**
	White Fulani (n=63)	(31) 5.81± 1.89^{aA}	(32) 7.88± 2.28^{aAB}	**6.56± 2,23**$^{\alpha}$	**0.17**
	Red Fulani (n= 68)	(32) 6.19±1.63^{aA}	(36) 8.22±2.38^{aB}	**7.27± 2.25**$^{\alpha}$	**0.30**
	Average	**6.22 ± 1.93**$^{\alpha}$	**6.94 ± 2.31**$^{\alpha}$	**6.66± 2.33**$^{\alpha}$	_
	P-value	**0.17**	**0.03**	_	_
Class 2	**Gudali (n= 64)**	(32) 4.75 ± 1.29^{aA}	(32) 4.00± 1.74^{aA}	**4.38± 1.97**$^{\alpha}$	**0.01**
	White Fulani (n=63)	(31) 3.55± 1.52^{aA}	(32) 5.22± 2.49^{bA}	**3.05± 1.14**$^{\alpha}$	**0.03**
	Red Fulani (n= 68)	(32) 3.94±1.55^{aA}	(36) 5.56± 1.90^{aA}	**4.79± 1.92**$^{\alpha}$	**0.39**
	Average	**4.38 ± 1.04**$^{\alpha}$	**4.74 ± 2.01**$^{\alpha}$	**3.65± 1.24**$^{\alpha}$	_
	P-value	**0.24**	**0.69**	-	_
Class 3	**Gudali (n= 64)**	(32) 3.72± 1.46^{aA}	(32)3.34± 1.43^{aA}	**3.53± 1.46**$^{\alpha}$	**0.11**
	White Fulani (n=63)	(31) 2.71 ± 1.26^{aA}	(32)3.38 ± 1.52^{aA}	**3.05 ± 1.48**$^{\alpha}$	**0.68**
	Red Fulani (n= 68)	(32) 3.06± 0.88^{aA}	(36)3.53 ± 1.66^{aA}	**3.31± 1.31**$^{\alpha}$	**0.30**
	Average	**3.27 ± 1.41**$^{\alpha}$	**3.69 ± 1.46**$^{\alpha}$	**3.29± 1.21**$^{\alpha}$	_
	P-value	**0.40**	**0.11**	_	_
Class 4	**Gudali (n= 64)**	(32) 4.56±1.95^{aA}	(32) 4.25±1.76^{aA}	**4.41± 1.89**$^{\alpha}$	**0.11**
	White Fulani (n=63)	(31) 3.32 ± 1.24^{aA}	(32)5.59 ± 2.52^{aA}	**4.48 ± 1.28**$^{\alpha}$	**0.80**
	Red Fulani (n= 68)	(32) **4.03 ± 1.54**^{aA}	(36)5.11 ± 1.65^{aA}	**4.60 ±1.82**$^{\alpha}$	**0.30**
	Average	**4.24 ± 1.84**$^{\alpha}$	**4.78± 1.81**$^{\alpha}$	**4.50 ±1.22**$^{\alpha}$	_
	P-value	**0.44**	**0.45**	_	_

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 8b: Effects of breed and season on oocyte quality.

Oocyte quality	Breed	Season: Dry	Season: Rainy	Average± SD	P-VALUE
Total class	**Gudali (n= 64)**	(32) 15.59±3.25^{aA}	(32) 17.78±4.21^{aA}	**16.69± 4.49**$^{\alpha}$	**0.21**
	White Fulani (n=63)	(31) 13.13±3.70^{aA}	(32)19.41± 6.08^{bA}	**16.32 ± 5.90**$^{\alpha}$	**0.04**
	Red Fulani (n= 68)	(32) 14.97 ±4.00^{aA}	(36)19.74 ± 4.83^{aA}	**17.50 ±5.06**$^{\alpha}$	**0.30**
	Average	**14.01 ±5.05**$^{\alpha}$	**17.12 ± 5.22**$^{\alpha}$	**16.52 ± 5.27**$^{\alpha}$	_
	P-value	**0.34**	**0.41**	_	_
Class 1 and 2	**Gudali (n= 64)**	(32) 11.47±2.94^{aA}	(32) 10.94±2.42^{aA}	**16.69± 2.07**$^{\alpha}$	**0.11**
	White Fulani (n=63)	(31) 9.35±2.34^{aA}	(32)13.09± 3.96^{aA}	**11.23 ± 3.50**$^{\alpha}$	**0.68**
	Red Fulani (n= 68)	(32) 10.12 ±2.61^{aA}	(36)13.78 ± 2.83^{aA}	**12.60 ±3.85**$^{\alpha}$	**0.30**
	Average	**10.69 ± 3.44**$^{\alpha}$	**11.38 ± 3.31**$^{\alpha}$	**13.68 ±3.25**$^{\alpha}$	_
	P-value	**0.14**	**0.21**	_	_
Class 3 and 4	**Gudali (n= 64)**	(32) 7.59±2.44^{aA}	(32) 8.28±2.50^{aA}	**7.94± 2.43**$^{\alpha}$	**0.11**
	White Fulani (n=63)	(31) 6.03±1.60^{aA}	(32) 8.97± 3.10^{aA}	**7.52 ± 2.90**$^{\alpha}$	**0.68**
	Red Fulani (n= 68)	(32)7.09 ±1.89^{aA}	(36)8.64 ± 2.43^{aA}	**7.91 ±2.28**$^{\alpha}$	**0.30**
	Average	**7.92 ± 2.54**$^{\alpha}$	**8.07 ± 2.55**$^{\alpha}$	**7.81 ±2.38**$^{\alpha}$	_
	P-value	**0.44**	**0.41**	_	_

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 9: Effects of breed and body condition score on the ovary weight.

Ovarylocalization	Breed	BCS: **[1-2] n=49**	BCS: **[3] n=111**	BCS: **[4-5] n=35**	Average ± SD	P-value
Average weight of right ovary (g)	Gudali(n=64)	4.15 ±1.06^{abB}	4.37 ± 1.14^{bA}	3.56 ±0.89^{aA}	**4.13 ±1.10**$^{\beta}$	**0.05**
	White Fulani (n=63)	3.29 ±1.21^{aA}	4.03 ±1.34^{abA}	4.57 ±1.39^{bA}	**3.89 ±1.35**$^{\alpha}$	**0.06**
	Red Fulani (n=68)	2.84 ±0.76^{aA}	4.03 ±1.36^{bA}	3.83 ±1.11^{abA}	**3.66 ±1.27**$^{\alpha}$	**0.03**
	Average ± SD	**3.35 ±1.12**$^{\alpha}$	**4.14 ±1.29**$^{\beta}$	**3.86 ±1.11**$^{\alpha}$	**3.78 ± 0.21**$^{\alpha}$	-
	p-value	**0.00**	**0.42**	**0.13**	-	-

Average weight of left ovary (g)	Gudali (n=64)	3.15 ±0.98^{aB}	3.34 ±1.18^{aA}	3.31 ±1.70^{aA}	**3.30 ±1.1$^{\alpha}$**	**0.87**
	White Fulani (n=63)	2.82 ±0.80^{aA}	3.03 ±1.11^{aA}	4.00 ±1.52^{bB}	**3.08 ±1.12$^{\alpha}$**	**0.05**
	Red Fulani (n=68)	2.63 ±0.83^{aA}	3.00 ±1.08^{aA}	3.08 ±0.79^{aA}	**2.92 ±0.97$^{\alpha}$**	**0.32**
	Average± SD	**2.8 ±0.87$^{\alpha}$**	**3.12 ±1.12$^{\alpha}$**	**3.37 ±1.11$^{\alpha}$**	**3.1 ± 0.19$^{\alpha}$**	-
	p-value	**0.25**	**0.36**	**0.21**	-	-
Average weight of ovary (g)	Gudali (n=64)	3.77 ± 1.01^{aA}	3.86 ±0.95^{bA}	3.70 ±0.75^{aA}	**3.75 ±0.92$^{\alpha}$**	**0.44**
	White Fulani (n=63)	3.06 ±0.65^{aA}	3.41 ± 0.96^{aA}	4.29 ±0.73^{aA}	**3.41 ±0.92$^{\alpha}$**	**0.01**
	Red Fulani (n=68)	2.58 ±0.60^{aA}	3.54 ±1.04^{aA}	3.50 ±0.79^{aA}	**3.26 ± 0.98$^{\alpha}$**	**0.01**
	Average	**3.06 ±0.85$^{\alpha}$**	**3.59 ±1.00$^{\alpha}$**	**3.66 ±0.80$^{\alpha}$**	**3.47 ± 0.14$^{\alpha}$**	-
	p-value	**0.06**	**0.14**	**0.06**	-	-

a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05). A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 10: Effects of breed and age on the ovary weight.

Ovarylocalization	Breed	AGE			Average± SD	P-value
		[3-5] n=49	**[6-9] n=111**	**[10-15] n=35**		
Average weight of right ovary (g)	Gudali(n=64)	3.75±1.19^{aA}	4.39±1.15^{aA}	3.82±0.80^{aA}	**4.13 ±1.10$^{\alpha}$**	**0.09**
	White Fulani (n=63)	3.38±1.36^{aA}	4.09±1.30^{aA}	4.00±1.41^{aA}	**3.89 ±1.35$^{\alpha}$**	**0.21**
	Red Fulani (n=68)	3.25±1.18^{aA}	3.94±1.43^{aA}	3.44±0.41^{aA}	**3.66 ±1.27$^{\alpha}$**	**0.14**
	Average ± SD	**3.42±1.22$^{\alpha}$**	**4.14±1.30$^{\alpha}$**	**3.74±1.03$^{\alpha}$**	**3.78 ± 0.21$^{\alpha}$**	-
	p-value	**0.61**	**0.34**	**0.31**	-	-
Average weight of left ovary (g)	Gudali (n=64)	3.36±1.28^{aA}	3.42±1.13^{aA}	3.00±1.93^{aA}	**3.30 ±1.1$^{\alpha}$**	**0.43**
	White Fulani (n=63)	3.25±0.57^{aA}	3.09±1.28^{aA}	2.86±1.23^{aA}	**3.08 ±1.12$^{\alpha}$**	**0.6**
	Red Fulani (n=68)	2.63 ±0.88^{aA}	3.14±1.12^{aA}	2.69±0.45^{aA}	**2.92 ±0.97$^{\alpha}$**	**0.12**
	Average± SD	**3.05±0.95$^{\alpha}$**	**3.22±1.17$^{\alpha}$**	**2.88±0.9$^{\alpha}$**	**3.1 ± 0.19$^{\alpha}$**	-
	p-value	**0.07**	**0.36**	**0.21**	-	-
Average weight of ovary (g)	Gudali (n=64)	3.64±1.36^{aA}	3.97±0.84^{aA}	3.35±0.60^{aA}	**3.75 ±0.92$^{\alpha}$**	**0.06**
	White Fulani (n=63)	3.13±0.71^{aA}	3.58±0.93^{aA}	3.36±1,8^{aA}	**3.41 ±0.92$^{\alpha}$**	**0.27**
	Red Fulani (n=68)	2.88±0.95^{aA}	3.58±1.07^{aA}	2.94±0.44^{aA}	**3.26 ± 0.98$^{\alpha}$**	**0.01**
	Average± SD	**3.16±1.02$^{\alpha}$**	**3.71±0.96$^{\alpha}$**	**3.21±0.77$^{\alpha}$**	**3.36±0.92$^{\alpha}$**	-
	p-value	**0.16**	**0.14**	**0.06**	-	-

A, B, C: on the same column, values affected with the same letter do not differ significantly (P > 0.05); a, b, c : on the same line, values affected with the same letter do not differ significantly (P > 0.05); α, β : on the same column, values affected with the same letter do not differ significantly (P > 0.05).; α, β : on the same line, values affected with the same letter do not differ significantly (P > 0.05).

Table 11: Relations between different parameters study in animals.

	BCS	**AOW**	**TSF**	**TMF**	**TLF**	**TF**	**TClIO**	**TClIIO**	**TClIIIO**	**TClIVO**	**Prot**	**Al**	**Gl**
AOW	0,28**												
TLF				-0,19**									
TF			0,99**	0,39**									
TClIO			0,32**	0,17*		0,36**							
TClIIO			0,17*		-0,1	0,15*	0,36**						
TClIIIO					-0,15*	0,14*	0,16*	0,22**					
TClIVO			0,23**			0,21**							
TClO			0,25**		-0,14*	0,24**	0,37**	0,87**	0,49**	0,47**			
Prot							0,15*						
Al		-0,20 **					0,15*						
Gl											0,16**		
Ch											0,28**	0,22**	0,20**

P						0,14*					-0,23**	0,20**	-0,2**
Oest										0,17*	0,29**		
LH											0,16*	0,14*	
FSH									0,22**			0,19**	
K	0,14*												
C		-0,14*											

BCS = bdy condition ; AOW = average ovary weight ; TSF = total small follicle ; TMF = total medium follicle ; TLF = total large follicle ; TF = total follicule ; TClI O= total class I oocyte ; TClII O= total class II oocyte ; TClIII O= total class III oocyte ; TClIV O = total class IV oocyte; TCl O= total class oocyte ; Prot = protein ; Al = albumin ; Gl = globulin ; Ch = cholesterol ; P = phosphorous ; Oest = oestriol ; LH = lutéinic hormone ; FSH = follicle stimulating hormon ; K = potassium ; Ca = calcium.

The average number of follicles obtained in this study per cow increased with BCS, also in rainy season inside different breeds; confirmed the fact that energizing supply has a major impact on dynamic of follicular growth [29]. The higher number of follicles and oocyte accounted on the ovary in the rainy season was reported by Diskin et al. [30] and Fassi et al. [31] who indicated that ovarian activity is most important during rainy season. This may be attributed to availability and quality of pasture in rainy season which enhance chance of feeds. Thus, they confirmed that the nutritional status of the animal had an influence on the ovarian function in zebu cows, likewise the season of the year [32]. The metabolic and hormonal changes between the rainy and dry season affect follicular dynamics and oocyte development. This may be due to heat stress which altered endocrine patterns and reduced follicular development. In fact, heat stress induces the production of heat-shock proteins which may serve as protection against thermal stress [33]. Then, these proteins could constitute the lack of proteins used in follicular growth and oocytes development. In addition, heat temperature increases the number of small follicles as well as observed in this study and oocytes are in bad quality [34]. The higher degeneration of oocytes in dry season reflects their lower developmental competence compared with oocytes recovered in rainy season. Thus, during oogenesis and folliculogenesis, several dynamic processes that are regulated by endocrine, paracrine and autocrine signals have been shown to be linked with energetic status and the quality of oocyte depends on the nutritional condition under which the follicle began its development [35]. Moreover, oocyte growth and maturation are believed to be particularly sensitive to changes in nutritional, chemical and endocrine environments.

Significantly higher follicles were observed in this study during estrus stage of sexual cycle. This result is in accordance with the findings of Kouamo et al. [36] using zebu cows in Adamawa region of Cameroon. In fact, in estrus stage, the follicles are large in size and only one becomes dominat (12-13 mm) while the others are atresia [37]. This might explain the reason which more large follicles were counted in this stage. Mutha and Uma [38] reported that the oocyte yield and the quality of cultivable oocytes are higher when the cows are in the follicular (proestrus and estrus) than the luteal (metestrus and diestrus) stage. Thus follicular stage is the best period of the sexual cycle for the emergence of quality oocytes.

The right ovary was heavier than the left suggesting that right ovary is more active than the left. The same observations were reported by Kouamo et al. [36]. Indeed, the finding of Drion et al. [39] showed that there exist in cattle a great follicular activity on right ovary and consequently ovulations are more regular at this level. In addition, a density of blood vessels which facilitates blood supply are must important on right ovary than left.

The not significantly higher level of protein, but significantly higher level of urea and phosphorus obtained in Gudali cow in this study could be attributed to moderate BCS observed with this breed. Indeed, protein provides amino acids that are necessary for maintenance of vital functions as growth, reproduction and lactation, while serum urea is an indicator of the balance between nitrogen and energy intake. Whereas phosphorus deficiency act especially at the ovarian level by anoestrus, irregular estrus, and decreasing of ovarian activity [40]. This substantiated the previous results of follicles and oocyte yield obtained with this breed.

Low concentrations of hormones obtained in this study during dry season are attributed to the bad and lack of feeding due to the characteristics of strong season. This agrees with earlier findings of Ali et al. [27]. Indeed, periods of low nutrition are generally associated with a decrease in insulin growth factor (IGF) secretion and elevation of nonesterified fatty acid (NEFA) [26]; and then may cause the lengthening of the sex cycle durations in zebus. It has been proven that, insulin may serve as a nutrition signal influencing LH release [41]. On the other hand, it has been reported that, energy balance, specific hormones and metabolites remain precise indicator [42]. In addition, nutrition related metabolic and hormonal changes may affect both follicular growth and oocyte quality yield [43]. In fact, cows with negative energy balance may have direct consequences on the hypothalamic- pituitary axis by reducing the secretion of pituitary gonadotropins especially FSH and LH which are responsible for follicular development and oocyte mature [29]. Inversely, high plasma levels of IGF-1 resulting from improved nutrition, increases the sensitivity of granulosa cells to FSH stimulation [44]. Indeed, basal folliculogenesis is essentially controlled by growth hormones such as Insulin Growth Factor-1 (IGF-1) and the lack of which could be resulting poor follicular yield and oocyte quality of cows.

CONCLUSION

This study indicated that season temperature had a detrimental effect on the follicular population, oocyte yield and metabolic parameters. Moreover for the IVEP, females' oocyte donors should have acceptable BCS and oocyte should be collected during proestrus and estrus stage of sexual cycle of cows.

ACKNOWLEDGEMENT

The authors gratefully acknowledge to the head of the zootechnical center of Bafoussam, the butchers of the Bafoussam municipal slaughterhouse for making available animals for the research facilities of contribution

ETHICAL APPROVAL

Experimental protocols used in this study were approved by the ethic comity of the Department of Animal science, FASA, University of Dschang - Cameroon and strictly conformed with the internationally accepted standard ethical guidelines for laboratory animal use and care as described in the European Community guidelines; EEC Directive 86/609/EEC, of the 24th November 1986.

REFERENCES

1. MINEPIA (Ministry of Livestock, Fisheries and Animal Husbandry). Directing diagram for the development of the dies of the breeding in Cameroon. 2009; 2: 82.
2. Zemjanis R. Veterinian and Animal production in Nigeria. 11th Ann. Conf. Nigerian Vet. Med. Assoc. 1974; 25-31.
3. Asdell SA. Infertility and sterility. Churchill London. 1968; 184-242.
4. Donelson JE. Antigenic variation and the African trypanosome genome. Acta Trop. 2003; 85: 391-404.
5. Lhoste P. Cattle genetic resources of West Africa. In Hickman, CG, ed. Cattle genetic resources, Amsterdam, 183 P. Doctoral thesis 1991; Nat. Vet. School of Aifort. Creteil, France.
6. Sartori R, Barros CM. Reproductive cycle in bos indicus cattle. Anim Reprod Sci. 2011; 124: 244-250.
7. Chilliard Y, Bocquier F. Directed effects of photoperiod on lipid metabolism, leptin synthesis and milk secretion in adult sheep. In: Cronjé P.B. Ed., Ruminant physiology: digestion, metabolism growth and reproduction, Wallingford, UK, CAB International, 2000; 205-223.
8. Vall E, Bayala I. Body condition note of the Sdanese zebus; Animal production in West Africa. Bobo-Dioulasso, Burkina Faso, Cirdes. 2004; 8 (Fiche n °12); 20: 496 - 500.
9. Messine O, Mbah D, Saint-Martin G. Synchronization of the estrus of Gudali females in the CRZ of wakwa (Cameroon). In: Reproduction and Genetic improvement of the ruminants: Contributions of new Technologies. New African Editions of Senegal, Scientific current events (AUF). 1993; 13-21.
10. Blanco MR, Demyda S, Moreno, Millan, M. and Genero, E. Developmental competence of in vivo and in vitro matured oocytes: A review. Biotechnol Mol Biol Rev. 2011; 6: 155-165.
11. Nandi S, Girish Kumar V, Chauhan MS. In vitro production of bovine embryos: we need to stop or proceed -a review. Agric. Rev. 2006; 27: 122-129.
12. Adamiak SJ, Powell K, Rooke JA, Webb R, Sinclair KD. Body composition, dietary carbohydrates and fatty acids determine post-fertilization development of bovine oocytes in vitro. Reprod. 2008; 131: 247-258.
13. Wang S, Liu Y, Holyoak GR, Evans RC, Bunch TD. A protocol for in vitro maturation and fertilization of sheep oocytes. Small Rumin. Res. 1998; 29: 83-88.
14. Natumanya R, Owiny D, Kugonza R. The potential of Ankole cattle abattoir ovaries for in vitro embryo production. J. Anim. Biomed. Sci. 2008; 3: 1819-4214.
15. Moussa Garba MH, Marichatou M, Issa ML, Abdoul Aziz C, Hanzen. Genital tractus of zebus cows (Bos indicus) in Niger. J Trop Livest Sci. 2013; 66: 137-142.
16. Samad HA, Raza A. Factor's affecting recovery of buffalo follicular oocytes. Pakinstan Vet J. 1999; 19: 2.
17. Baki Acar D, Birdane MK, Dogan N, Gurler H. Effect of stage of estrus cycle on follicular population oocyte yield and quality, and biochemical composition of serum and follicular fluid in anatolian water buffalo. Anim Reprod Sci. 2013; 137: 8-14.
18. Hanzen C. In vitro embryo production. 2009; 21: 3.
19. Satrapa RA, Nabhan T, Silva CF, Simoens RAL, Razza EM, et al. Influence of sire breed (Bos indicus versus Bos taurus) and interval from slaughter to oocyte aspiration on heat stress tolerance of in vitro-produced bovine embryos. Theriogenol. 2010; 76: 1162-1166.
20. Wang ZG, Yu SD, Xu ZR. Effects of collection methods on recovery efficiency, maturation rate and subsequent embryonic developmental competence of oocytes in Holstein cow. Asian-Australasian J. Anim. sci. 2007; 20: 496-500.
21. Alves BG, Alves AK, Lucio AC, Martins CM, Silva TH, Santos RM. Ovarian activity and oocyte quality associated with the biochemical profil of serum and follicular fluid from girolando dairy cows postpartum. Anim Reprod Sci. 2014; 146: 117-125.
22. Duygu BA, Muhammed KB, Dogan N, Hander G. Effect of the stage of estrus cycle on follicular population oocyte yield and quality, and biochemical composition of serum and follicular fluid in Anatolian water buffalo. Anim Reprod Sci. 2013; 137: 8-14.
23. Kouamo J, Leye A, Ouedraogo GA, Sawadogo GJ, Bernard P. Influence of energy, protein and mineral parameters on the success of the bovine artificial insemination in traditional dreeding in the area of this in Senegal. Vet Med Rev 2011; 162: 425-431.
24. Maina VA, Muktar A, Sabo YG. Effects of Body Condition Score on ovarian activity of Bos indicus (Zebu) Cow. Asian J Sci Res. 2008; 1: 421-428.
25. Drion PV, Beckers JF, Ectors FJ, Hanzen C, Houstain JY, Lonergan P. Regulation of the follicular and luteal growth. Vet point. 1996; 28.
26. Gill RD, Hart IC. Insulin and glucagon binding to hepatocytes in relation to circulating hormone and metabo- lites in goats maintained on different diets. Horm. Met. Res. 1981; 13: 603.
27. Ali Brahim, Patrice Grimaud, Chantal Kaboré-Zoungrana. Factors of variation in body weight and body conditionof Arab zebu in the Sudanian zone of Tchad. Nat Sci. 2010; 7: 143-153.
28. Leperre Ph, Dwinger RH, Rawlings P, Janneh L, Zurcher G, Faye J, Maxwell J. Study of the zootehnical parameters in a traditionalvillage environment in the Gambia. Vet. Vet. J. Trop Countries. 1992; 45: 55-62.
29. Chaudhari SUR, Paul-bokko B. Reproductive status, pregnancy wastage and incidence of gross genital abnormalities in cows slaughtered at Maiduguri Abattoir, Nigeria. Pakistan Vet J. 2000; 20: 203-205.
30. Diskin MG, Mackey DR, Roche JF, Screenan JM. Effects of nutrition and metabolic status on circulating hormones and ovarian follicle development in cattle. Anim Reprod Sci. 2003; 78: 345-370.
31. Fassi Fihri A, Lakhdissi HL, Derqaoui Kh, Hajji M, Naciri A. Goumari. Genetic and non-genetic effects on the number of ovarian follicles and oocyte yield and quality in the bovine local (Oulmes Zaer), exotic breeds and their crosses in Morocco. African J. Biotechnol. 2005; 4: 9-13.
32. Ali S, Ahmad N, Akhtar N, Zia-ur R, Sarwar M. Effect of season and age on the ovarian size and activity of one-humped camel (Camelus dromedarius). Asian-Australasian J Anim Sci. 2007; 20: 1361-136.
33. Ealy AD, Hansen PJ. Ontogeny of thermotolerance during murine embryonic development. Biol. Reprod. 1992; 46.

34. Barati F, Niasari-Naslaji A, Bolourchi M, Sarhaddi F, Razavi K, Naghzali E, et al. Superovulatory response of Sistani cattle to three different doses of FSH during winter and summer. Theriogenology. 2006; 66: 1149-1155.

35. Monniaux D, Caraty A, Clement F, Dalbiès-Tran R, Dupont J, Fabre S, et al. Ovarien follicular development and ovulation in mammals. Inra Anim prod. 2009; 22: 59-76.

36. Kouamo J, Nono Fambo SM, Zoli AP. Effect of the stage of sexual cycle, harvesting technique and season on follicular dynamics and oocyte quality of Zebus catte under udano -sahelian climate. Int J Vet Biosci. 2017; 1: 1-7.

37. Fieni F, Tainturuer D, Bruyas JF, Battut I. Echographic examination of the cow. National days of the GTV. 1998; 411-415.

38. Mutha Rao M, Uma Mahesh Y. Efficacy of different harvesting techniques on oocyte retrieval from buffalo ovaries. Buffalo Bulletin. 2012; 31.

39. Drion P, Beckers J, Derkenne F, Hanzen C. Follicular development in the cow. Hormonal mechanisms during the cycle and postpartum. Ann Vet Med. 2000; 144: 385 - 404.

40. Kile JP, Alexander BM, Moss GE, Hallford DM, Nett TM. Gonadotropin-releasing hormone overrides the negative effects of reduced dietary energy on gonadotropin synthesis and secretion in ewes. Endocrinol. 1991; 128: 843-849.

41. Atheton D. The effect of mineral nutrition on bovine fertility with particular reference to embryo transfer. 10ème Reunion A.E.T.E-Lyon. 1994; Sept 9-10.

42. Zarco L. Effects of the energy balance on reproduction in the high production vacuum cleaner. Mechanisms, importance and prevention. Memories of the V course. Int Bov Reprod. 1993; 147-176.

43. Dominguez MM. Effects of body condition, reproductive status and breed on follicular population and oocyte quality in cows. Theriogenol. 1995; 43: 1405-1418.

44. O'callaghan D, Boland MP. Nutritional effects on ovulation, embryo development and the establishment of pregnancy in ruminants. Anim Reprod Sci. 1999; 15, 53-60.

Cite this article

Azafack DK, Ngoula F, Kouamo J, Tchoffo H, Kenne LK (2020) Effects of Metabolic Profile, Season and Stage of the Sexual Cycle on Follicular Dynamics, Quality and Oocyte Yield In Three Tropical Zebu Cattles. J Vet Med Res 7(2): 1185.