Open Access Library Journal
2026, Volume 13, e15299
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Effects of Breed, Age and Body Condition Score on the Biochemical and Hormonal Parameters of Three Cattle Breeds from Chad (Arab, Kouri and Toupouri)

Hachim Souleyman[1,2], Dorice Kana Azafack[2*], Issa Ousman[1], Attamar Attahir[1], Ferdinand Ngoula[2]

[1]National Institute of Science and Technology of Abeche, Abeche, Chad
[2]Animal Physiology and Health Research Unit, Department of Zootechnic, Faculty of Agronomy and Agricultural Sciences, University of Dschang, Dschang, Cameroon
Email: *kanadorice@yahoo.fr.

How to cite this paper: Souleyman, H., Azafack, D.K., Ousman, I., Attahir, A. and Ngoula, F. (2026) Effects of Breed, Age and Body Condition Score on the Biochemical and Hormonal Parameters of Three Cattle Breeds from Chad (Arab, Kouri and Toupouri). *Open Access Library Journal*, **13**: e15299.
https://doi.org/10.4236/oalib.1115299

Received: April 4, 2026
Accepted: June 9, 2026
Published: June 12, 2026

Abstract

Background: This study was conducted to evaluate the biochemical and hormonal parameters of three cattle breeds in Chad (Arabian, Kouri, and Toupouri cows) in order to enhance the productivity of the cattle sub-sector in Chad while conserving local genetic resources. **Methods:** A total of 166 cycling cows and 40 pregnant cows were used. Breed identification was based on phenotypic characteristics. The age of each animal was determined by simultaneous analysis of dentition and horns. Body condition score (BCS) was determined before slaughter. The blood samples were collected during slaughter and centrifuged. The resulting serum was then analyzed to determine serum urea concentrations, total cholesterol, phosphorus, and total protein colorimetrically using a Lab Max Plenno automated chemical analyzer with commercial reagents. Hormone levels (FSH, LH, P4, and estradiol) were obtained using the ELISA method. Calcium, phosphorus, and urea levels were obtained using complexometry and flame photometry techniques. **Results:** Results revealed that the number of pregnant cows observed during the study period was 18.93%. Cows with low (BCS = 1 - 2) and medium (BCS = 3) BCS represented more than half of the cows of the study. Protein and cholesterol levels were in general higher in Kouri and Toupouri cows compared to Arabian. Phosphorus levels were high in young cows. Regardless of the breed, hormone levels were generally higher in young cows (3 - 5 and 6 - 9 years); although some older cows were an exception. Among the different BCS groups, lean Arabian cows (BCS = 1 - 2) and cows with average body reserves (BCS = 3) had significantly higher calcium levels.

Conclusions: This study indicates that young animals (3 - 5 years) with average BCS of 3 could be the best choice to use when doing selection of the local cattle to enhance reproduction.

Subject Areas

Animal Behavior

Keywords

BCS, Breed, Biochemical, Hormonal, Parameters

1. Introduction

The cattle sector plays a significant role in national livestock production in the majority of African countries [1]. With over 20 million head of cattle [2], the cattle breeds raised in Chad are mostly zebu (Arabian, M'bororo, Fulani), Toupouri, Kouri and Taurine. However, productivity remains low despite the diversity of breeds. The major factors that are responsible for this low productivity have been identified as genetic, zootechnical, health and reproductive problems which remain a poorly planned, traditional method using unknown genetic material [3] [4].

Although local breeds possess good qualities that must be exploited in order to boost their productivity of these breeds, they are raised using traditional methods with few genetic improvement programs. It is with the aim of finding solutions to this problem that the Chadian government has therefore committed to improving livestock feed and proposing a new development strategy aimed at optimizing overall animal and plant productivity using available local resources. Elements of this strategy include adapting livestock farming systems to available feed resources [5].

Achieving good productivity performances and reproduction in cattle farming requires careful management of feed [6]. So, abnormalities related to the balance, quantity, or distribution of the ration must be avoided, particularly at the end of gestation and the beginning of lactation. This complexity explains the use of tools such as biochemical testing to detect and correct any nutritional imbalances early on [7]. The determination of blood constituent concentrations through biochemical analyses is a technique that is increasingly being developed today and allows for monitoring of feed intake levels [8]. To date, few studies have been conducted on the production potential of local breeds in Chad.

It is in this context that this work was initiated with the general objective to evaluate the effects of breed, age and body condition score (BCS) on the biochemical and hormonal parameters of three cattle breeds from Chad (Arabian, Kouri and Toupouri). This was achieved by mastering the knowledge of biochemical and hormonal profiles in relation with breed, BCS, age and physiological status in or-

der to optimize the productivity of local Chadian breeds using available resources.

2. Materials and Methods

2.1. Study Site

The study was conducted from mid-August 2024 to the end of July 2025 at the slaughterhouse and laboratory of the Livestock Research Institute for Development, located in the Chari Baguirmi region, within the peri-urban area of N'Djamena, Chad (13˚49′59″N and 20˚50′05″E). The average annual rainfall in this area ranges from 226.10 to 711.20 mm, with an average humidity of 74% and wind speed reaching 18 km/h.

2.2. Animals

This study was conducted on a total of 166 cycling cows, divided among three breeds: Arabian (n = 59), Kouri (n = 57), and Toupouri (n = 50), and 40 pregnant cows grouped into: Arabian (n = 11), Kouri (n = 15), and Toupouri (n = 14). Our study was carried out over two seasons: a dry season (October to June) and a rainy season (July to September).

2.3. Breed Identification, Age Determination, and BCS

Breed identification was based on phenotypic characteristics as described by Lhoste [9]. Identification was based on the following elements: presence or absence of a hump, horn presentation, animal profile, and coat color. Based on these elements, three breed types were identified and studied: the Arabian zebu, the Kouri taurine, and the Toupouri zebu. The age of each animal was determined by simultaneous analysis of its dentition and horn rings. The following formula was used: age (years) = N + 2, where N represents the number of horn grooves and 2 is a constant [10]. BCS was determined before slaughter according to the scale proposed by a previous study [11].

2.4. Blood Analysis

Blood was collected during slaughter in 10 ml tubes labeled as anticoagulant-free. The ovaries were removed separately by incision of the broad ligament and introduced individually into tubes containing an isotonic medium of 0.9% NaCl and penicillin-streptomycin (0.5 mg/ml). The samples (ovaries and blood) were then placed in an insulated container at a temperature between 30 and 32˚C, and then transported immediately to the laboratory before 2 hours after slaughter. At the laboratory, the blood was centrifuged at 2100 g for 30 min. The collected sera were aliquoted and then frozen at −20˚C until analysis. The resulting serum was then analyzed to determine serum urea and phosphorus concentrations, total cholesterol, and total protein colorimetrically using a Lab Max Plenno automated chemical analyzer (Lab test, Lagoa Santa, Brazil) with commercial reagents. Hormone levels (FSH, LH, and estradiol) were obtained by ELISA following the protocol of the commercial kit (OMEGA Diagnostic Automation Inc.). Calcium lev-

els were obtained using the complexometric technique as described by Lamathe [12].

2.5. Physiological Status

The physiological status of the cows was determined post-slaughter by examination of the uterus. For pregnant cows, the uterus was incised and the fetus was removed to estimate its approximate gestational age using the formula: Y = X (X + 2), where X represents the number of months of gestation, Y represents the crown-rump length (cm), and 2 is a constant [13].

2.6. Statistical Analyses

All data were entered into Excel®. Two-way analysis of variance (ANOVA) and the t-test were used to assess the effect of cow characteristics, biochemical parameters, and hormones on breed, age, and BCS. Differences between means were tested using Duncan's test. For non-normal data, the Krustal-Wallis test was used to compare different means. The results are expressed as weighted means with standard errors (χ^2 ± SEM) at the 5% significance level. The data were analyzed using SPSS version 20.00.

3. Results

3.1. Characterization of Cows According to Breed, Age, Body Condition Score, and Physiological Status

This study revealed that, cows with average and low body condition scores (BCS [3] and [1] [2]) represented more than half of the animals in the study (70.86 %); and the majority were between 3 and 5 years old. The rate of pregnant cows observed during our work was 19.41%; then 27.5%, 37.5%, and 35.00% for the Arabian, Kouri, and Toupouri breeds, respectively.

Table 1. Distribution of cows according to breed, age, body condition score (BCS) and physiological status.

Factors	modalities	Breed			Average (%)
		Arab (%)	Kouri (%)	Toupouri (%)	
BCS	[1 - 2]	33.33	37.25	29.41	24.75
	[3]	35.78	40	24.21	46.11
	[4 - 5]	31.66	25	43.33	29.12
Age (years)	[3 - 5]	33.87	34.67	31.45	60.59
	[6 - 9]	33.89	35.59	30.50	29.05
	[10 - 15]	28.57	38.09	33.33	10.34
Physiological status	not pregnant	(n) =59	(n) =57	(n) =50	81.06
	pregnant	(n) =11	(n) =15	(n) =14	18.93

Note: BSC: Body Condition Score, n: number of cows.

Furthermore, the number of pregnant cows observed during the study period shows that, although the proportion of pregnant cows slaughtered was considerable; this number was even higher among Kouri cows (15 cows or 37.5%) compared to the value obtained in the Arab and Toupouri breeds (11 cows or 27.5% and 14 cows or 35.00%) respectively (Table 1).

3.2. Metabolic Profile of Slaughtered Cows in Relation to Breed, Age, and Body Condition Score

3.2.1. Effects of Breed and Age on Biochemical Parameters of Cows

Table 2 which presents the effects of breed and age on the biochemical parameters of cows shows that:

When breed was considered independently of age, older Kouri cows (10 - 15 years old) had significantly higher protein levels ($P < 0.05$). This significant difference ($P < 0.05$) was also found in Toupouri cows aged [6 - 9] and [10 - 15] years, respectively, for protein and total cholesterol levels.

When age was taken into account independently of breed, Kouri cows aged [10 - 15] years had a significantly higher protein level ($P < 0.05$) compared to other age groups.

Table 2. Effects of breed and age on biochemical parameters of cows.

Parameters	Breed	Age (year)			Average	P-value
		[3 - 5] n = 20	[6 - 9] n = 20	[10 - 15] n=18		
Total proteins (g/dl)	Arab n = 18	70.68 ± 3.18^{aA}	75.66 ± 8.25^{aA}	65.67 ± 4.35^{Aa}	$70.67 \pm 3.38^{\alpha}$	0.21
	Kouri n = 22	73.00 ± 2.64^{abA}	68.00 ± 2.66^{aA}	78.33 ± 2.09^{Bb}	$72.64 \pm 2.07^{\alpha}$	0.03
	Toupouri n = 18	63.33 ± 7.86^{aA}	81.33 ± 7.86^{bA}	77.67 ± 2.74^{abAB}	$74.44 \pm 2.79^{\alpha}$	0.02
	Average	$74.80 \pm 2.87^{\alpha}$	$75.20 \pm 2.76^{\alpha}$	$69.41 \pm 2.32^{\alpha}$	$72.52 \pm 0.49^{\alpha}$	—
	p-value	0.41	0.09	0.02	—	—
Total cholesterol (g/l)	Arab n = 18	2.00 ± 0.00^{aA}	2.00 ± 0.00^{aA}	2.33 ± 0.21^{aA}	$2.11 \pm 0.07^{\alpha}$	0.70
	Kouri n = 22	2.00 ± 0.00^{aA}	2.00 ± 0.25^{aA}	2.00 ± 0.00^{aA}	$2.00 \pm 0.93^{\alpha}$	0.70
	Toupouri n = 18	2.01 ± 1.67^{abA}	1.67 ± 2.03^{aA}	2.33 ± 0.21^{bA}	$2.21 \pm 0.14^{\alpha}$	0.04
	Average	$2.033 \pm 0.6^{\alpha}$	$1.9 \pm 0.12^{\alpha}$	$2.22 \pm 0.12^{\alpha}$	$2.13 \pm 0.18^{\alpha}$	—
	p-value	0.89	0.28	0.34	—	—

Note: a, b, c: on the same row, values assigned the same letter do not differ significantly ($P > 0.05$); A, B, C: on the same column, values assigned the same letter do not differ significantly ($P > 0.05$), α, β: In the same column, values assigned the same letter do not differ significantly ($P > 0.05$). α, β: In the same row, values assigned the same letter do not differ significantly ($P > 0.05$).

3.2.2. Effects of Breed and Age on Mineral Content in Cows

The effects of breed and age on mineral content in cows are listed in Table 3. The following results were observed:

When breed was considered independently of age, the oldest Kouri and Arabian cows ([10 - 15]) years old had significantly higher calcium and phosphorus levels, respectively ($P < 0.05$). However, this significant difference ($P < 0.05$) was only observed in middle-aged ([6 - 9] years) Arabian cows for calcium levels.

When age was considered independently of breed, Arab and Kouri cows aged [6 - 9] and [3 - 5] years old respectively recorded significantly higher ($P < 0.05$) calcium and phosphorus levels.

Table 3. Effects of breed and age on mineral elements in cows.

Parameters	Breed	Age (years)			Average	P-value
		[3 - 5] n = 20	[6 - 9] n = 20	[10 - 15] n = 18		
Ca (mg/l)	Arab n = 18	52.33 ± 1.48^{aA}	66.67 ± 4.96^{bB}	56.00 ± 1.89^{abA}	$44.67 \pm 2.29^{\alpha}$	0.01
	Kouri n = 22	52.25 ± 2.11^{abA}	50.00 ± 4.93^{aA}	62.33 ± 3.69^{bA}	$54.18 \pm 2.37^{\alpha}$	0.02
	Toupouri n = 18	53.00 ± 3.52^{aA}	62.00 ± 5.11^{aAB}	59.67 ± 5.54^{aA}	$58.22 \pm 2.76^{\alpha}$	0.68
	Average	$56.75 \pm 2.15^{\alpha}$	$58.46 \pm 4.43^{\alpha}$	$59.56 \pm 2.20^{\alpha}$	$52.32 \pm 0.08^{\alpha}$	__
	p-value	0.37	0.03	0.55	__	__
Phosphorus (mg/l)	Arab n = 18	42.33 ± 1.47^{abA}	39.00 ± 1.87^{aA}	44.67 ± 2.22^{bA}	$41.60 \pm 2.24^{\alpha}$	0.04
	Kouri n = 22	53.00 ± 2.21^{aB}	51.00 ± 4.15^{aA}	51.00 ± 3.83^{aA}	$51.73 \pm 1.91^{\alpha}$	0.58
	Toupouri n = 18	42.33 ± 4.10^{aA}	43.67 ± 6.00^{aA}	50.33 ± 6.02^{aA}	$45.44 \pm 3.08^{\alpha}$	0.72
	Average	$46.60 \pm 1.19^{\alpha}$	$49.30 \pm 2.89^{\alpha}$	$47.78 \pm 2.67^{\alpha}$	$47.34 \pm 1.89^{\alpha}$	__
	p-value	0.02	0.19	0.77	__	__
Urea (mg/l)	Arab n = 18	2.43 ± 0.4^{aA}	3.34 ± 1.21^{aA}	3.10 ± 0.14^{aA}	$2.82 \pm 0.22^{\alpha}$	0.70
	Kouri n = 22	3.24 ± 1.07^{aA}	3.51 ± 0.32^{aA}	3.24 ± 0.90^{aA}	$3.21 \pm 1.18^{\alpha}$	0.32
	Toupouri n = 18	2.93 ± 0.3^{aA}	3.04 ± 1.17^{aA}	3.02 ± 1.04^{aA}	$2.32 \pm 0.13^{\alpha}$	0.71
	Average	$2.86 \pm 1.18^{\alpha}$	$3.29 \pm 1.29^{\alpha}$	$1500 \pm 0.87^{\alpha}$	$2.78 \pm 0.21^{\alpha}$	__
	p-value	0.53	0.50	0.17	__	__

Note: a, b, c: on the same row, values assigned the same letter do not differ significantly ($P > 0.05$); A, B, C: on the same column, values assigned the same letter do not differ significantly ($P > 0.05$), α, β: In the same column, values assigned the same letter do not differ significantly ($P > 0.05$). α, β: In the same row, values assigned the same letter do not differ significantly ($P > 0.05$).

3.2.3. Effects of Breed and Body Condition Score (BCS) on Biochemical Parameters of Cows

The effects of breed and BCS on biochemical parameters of cows are listed in Table 4. It's show that:

Regardless of breed and BCS, total protein levels were significantly higher ($P < 0.05$).

When breed was considered independently of BCS, Toupouri and Kouri cows had significantly higher total protein levels ($P < 0.05$) at BCS values of 3 and 4 - 5, respectively. However, this significant difference ($P < 0.05$) was only observed in Arabian cows with a BCS = 3.

When comparing body condition scores independently of breed, Toupouri and Arabian cows with average and good body reserves, respectively (BCS = 3 and BCS = [4 - 5]), had significantly higher cholesterol levels ($P < 0.05$). Conversely, in Toupouri and Kouri cows with average and good body reserves (BCS = 3 and BCS = [4 - 5]), respectively, protein levels showed a significantly greater difference ($P < 0.05$).

Table 4. Effects of breed and BCS on the biochemical parameters of cows.

Parameters	Breed	BCS			Average	P-value
		[1 - 2] n = 18	[3] n = 18	[4 - 5] n = 22		
Total proteins (g/dl)	Arab n = 18	66.29 ± 3.48^{abA}	80.71 ± 6.35^{bA}	60.75 ± 2.30^{Aa}	$70.67 \pm 3.38^{\alpha}$	0.02
	Kouri n = 22	65.20 ± 2.34^{Aa}	70.86 ± 3.56^{abAB}	77.60 ± 0.98^{Bb}	$72.64 \pm 1.66^{\alpha}$	0.03
	Toupouri n = 18	68.67 ± 2.76^{aA}	92.50 ± 5.48^{bB}	69.75 ± 3.94^{Aab}	$74.44 \pm 3.19^{\alpha}$	0.02
	Average	$66.78 \pm 1.63^{\alpha}$	$79.50 \pm 5.46^{\alpha}$	$71.60 \pm 2.00^{\alpha}$	$72.55 \pm 0.49^{\beta}$	0.04
	p-value	0.41	0.03	0.02	0.2	__
Total cholesterol (g/l)	Arab n = 18	2.14 ± 0.14^{Aa}	2.00 ± 0.00^{aA}	2.25 ± 0.25^{aB}	$2.11 \pm 0.07^{\alpha}$	0.70
	Kouri n = 22	2.20 ± 0.37^{Aa}	1.86 ± 0.15^{aA}	2.00 ± 0.00^{aA}	$2.00 \pm 0.93^{\alpha}$	0.70
	Toupouri n = 18	2.00 ± 0.11^{Aa}	2.50 ± 0.28^{aB}	2.00 ± 0.00^{aA}	$2.11 \pm 0.13^{\alpha}$	0.3
	Average	$2.20 \pm 0.16^{\alpha}$	$2.06 \pm 0.9^{\alpha}$	$2.05 \pm 0.45^{\alpha}$	$2.10 \pm 0.18^{\alpha}$	0.4
	p-value	0.89	0.02	0.03	0.3	__

Note: a, b, c: on the same row, values assigned the same letter do not differ significantly ($P > 0.05$); A, B, C: on the same column, values assigned the same letter do not differ significantly ($P > 0.05$). BCS: Body Condition Score. *α, β*: In the same column, values assigned the same letter do not differ significantly ($P > 0.05$). *α, β*: In the same row, values assigned the same letter do not differ significantly ($P > 0.05$).

3.2.4. Effects of Breed and Age on Hormone Levels in Cows

The effects of breed and age on hormone levels in cows are reported in Table 5. The following results were observed:

Regardless of breed and age, estradiol levels were significantly higher ($P < 0.05$) compared to other hormone levels.

When breed was considered independently of age, LH, progesterone, and estradiol levels were significantly higher ($P < 0.05$) in middle-aged [6 - 9] years Toupouri cows. Furthermore, estradiol levels were significantly higher ($P < 0.05$) in Arabian and Kouri cows aged [6 - 9] and [10 - 15] years, respectively.

When comparing age groups independently of breed, the E2 level was significantly higher ($p < 0.05$) in cows aged [6 - 9] years. Among the different age groups, the oldest cows [10–15] years of the Arabian and Kouri breeds had significantly higher ($P < 0.05$) LH and estradiol levels, respectively, compared to the other age groups. Furthermore, in the [6 - 9] year age group, the LH level was significantly higher only in the Toupouri breed ($P < 0.05$).

Table 5. Effects of breed and age on hormone levels in cows.

	Breed	Age (years)			Average	P-value
		[3 - 5] n = 20	[6 - 9] n = 20	[10 - 15] n = 18		
FSH (pg/ml)	Arab n = 18	1804.25 ± 33.10^{Aa}	1310.40 ± 79.13^{aA}	1348.19 ± 26.17^{aA}	$1255.34 \pm 93.28^{\alpha}$	0.21
	Kouri n = 22	1334.23 ± 12.19^{Aa}	1293.45 ± 78.44^{aA}	1238.49 ± 58.19^{Aa}	$1283.82 \pm 21.19^{\alpha}$	0.3
	Toupouri n = 18	1122.38 ± 15.89^{Aa}	$1456.89 \pm 19,74^{bA}$	1395.19 ± 27.15^{abA}	$1319.14 \pm 56.18^{\alpha}$	0.02
	Moyenne	$1420.28 \pm 23.18^{\alpha}$	$1353.58 \pm 54.24^{\alpha}$	$1327.29 \pm 34.17^{\alpha}$	$1286.10 \pm 58.35^{\alpha}$	0.3
	p-value	0.41	0.4	0.21	0.2	__

Continued

LH (ng/ml)	Arab n = 18	6.33 ± 0.78^{Aa}	7.00 ± 0.00^{aAB}	7.67 ± 0.21^{Ab}	7.00 ± 0.28$^{\alpha}$	0.01
	Kouri n = 22	7.00 ± 0.37^{Aa}	6.25 ± 0,41^{aA}	6.67 ± 0.49^{aAB}	6.64 ± 0.23$^{\alpha}$	0.22
	Toupouri n = 18	6.67 ± 0.22^{abA}	7.33 ± 0.21^{bB}	6.00 ± 0.34^{Aa}	6.67 ± 0.19$^{\alpha}$	0.03
	Average	6.70 ± 0.25$^{\alpha}$	6.80 ± 0.23$^{\alpha}$	6.78 ± 0.25$^{\alpha}$	6.82 ± 0.08$^{\alpha}$	0.4
	p-value	0.37	0.03	0.04	0.2	__
E2 (pg/ml)	Arab n = 18	97.00 ± 2.22^{Aa}	118.67 ± 9.68^{bA}	92.67 ± 9.01^{Aa}	102.78 ± 4.19$^{\alpha}$	0.02
	Kouri n = 22	88.75 ± 3.02^{Aa}	104.00 ± 9.54^{abA}	119.00 ± 9.25^{Bb}	102.55 ± 4.95$^{\alpha}$	0.03
	Toupouri n = 18	93.00 ± 4.66^{Aa}	118.67 ± 4.61^{bA}	113.63 ± 9.81^{abAB}	108.33 ± 4.97$^{\alpha}$	0.01
	Average	92.50 ± 2.02$^{\alpha}$	112.80 ± 5.20$^{\alpha}$	108.33 ± 5.11$^{\beta}$	103.62 ± 4.91$^{\beta}$	0.03
	p-value	0.53	0.50	0.01	0.4	__
P4 (ng/ml)	Arabe n = 18	13.00 ± 1.93^{Aa}	11.33 ± 1.80^{aA}	9.33 ± 0.85^{Aa}	11.22 ± 0.97^{A}	0.70
	Kouri n = 22	11.25 ± 0.41^{Aa}	13.75 ± 1.67^{aA}	13.00 ± 1.89^{Aa}	12.64 ± 0.83$^{\alpha}$	0.70
	Toupouri n = 18	10.67 ± 0.21^{Aa}	17.33 ± 0.55^{bA}	12.67 ± 0.90^{Aa}	13.56 ± 1.64$^{\alpha}$	0.04
	Average	11.60 ± 0.54$^{\alpha}$	14.10 ± 0.99$^{\alpha}$	11.67 ± 0.90$^{\alpha}$	12.43 ± 1.28$^{\alpha}$	0.5
	p-value	0.89	0.28	0.34	0.3	__

Note: a, b, c: on the same row, values assigned the same letter do not differ significantly (P > 0.05); A, B, C: on the same column, values assigned the same letter do not differ significantly (P > 0.05); A, B: on the same row, values assigned the same letter do not differ significantly (P > 0.05), *α*, *β*: In the same column, values assigned the same letter do not differ significantly (P > 0.05). *α*, *β*: In the same row, values assigned the same letter do not differ significantly (P > 0.05).

3.2.5. Effects of Breed and Body Condition Score (BCS) on Mineral Elements in Cows

The effects of breed and BCS on mineral elements in cows are listed in Table 6. The results show that:

Regardless of breed and BCS, calcium and phosphorus levels were significantly higher (P < 0.05).

When comparing breed independently of BCS, the Kouri breed with average BCS = 3 and fat (BCS = [4 - 5]) had a significantly higher calcium level (P < 0.05).

Table 6. Effects of breed and NEC on mineral elements in cows.

Parameters	Breed	BCS			Average	P-value
		[1 - 2] n = 18	[3] n = 18	[4 - 5] n = 22		
Ca (mg/l)	Arab n = 18	54.86 ± 3.53^{Ab}	66.17 ± 2.76^{Ab}	51.25 ± 5.72^{Aa}	58.44 ± 2.51^{A}	0.21
	Kouri n = 22	42.60 ± 5.60^{aA}	57.29 ± 1.33b^{Ba}	57.80 ± 3.39^{Ba}	54.18 ± 2.37^{A}	0.02
	Toupouri n = 18	50.33 ± 2.14^{aAB}	58.50 ± 0.81^{Aa}	64.00 ± 5.74^{Aa}	58.22 ± 2.76^{A}	0.68
	Average	49.94 ± 2.85^{A}	61.00 ± 1.53^{A}	58.86 ± 2.72^{A}	56.32 ± 0.08^{B}	0.03
	p-value	0.03	0.03	0.55	0.4	__
Phosphorous (mg/l)	Arab n = 18	40.57 ± 2.17^{Aa}	49.71 ± 4.67^{Aa}	43.00 ± 3.24^{Aa}	44.67 ± 2.22^{A}	0.6
	Kouri n = 22	53.20 ± 5.31^{Aa}	49.14 ± 2.89^{Aa}	52.80 ± 2.73^{Aa}	51.73 ± 1.91^{A}	0.58
	Toupouri n = 18	48.67 ± 5.10^{Aa}	37.50 ± 4.40^{aA}	47.00 ± 5.27^{Aa}	45.44 ± 3.08^{A}	0.72

Continued

	Average	46.78 ± 2.19^{A}	46.78 ± 2.50^{A}	48.91 ± 2.41^{A}	47.24 ± 3.04^{B}	0.04
	p-value	0.3	0.19	0.77	0.5	__
Urea (mg/l)	Arab n = 18	29.32 ± 8.26^{aA}	34.39 ± 9.17^{aA}	33.37 ± 8.73^{aA}	31.67 ± 5.73^{A}	0.70
	Kouri n = 22	28.63 ± 3.54^{aA}	33.76 ± 12.63^{aA}	31.68 ± 4.67^{aA}	31.19 ± 9.47^{A}	0.32
	Toupouri n = 18	32.26 ± 8.78^{aA}	34.64 ± 11.20^{aA}	33.51 ± 8.27^{aA}	32.39 ± 9.24^{A}	0.71
	Average	30.07 ± 6.78^{A}	34.26 ± 10.54^{A}	33.18 ± 7.14^{A}	31.75 ± 7.85^{A}	0.6
	p-value	0.53	0.50	0.17	0.3	__

Note: a, b, c: on the same row, values assigned the same letter do not differ significantly (P > 0.05); A, B, C: on the same column, values assigned the same letter do not differ significantly (P > 0.05); A, B: on the same row, values assigned the same letter do not differ significantly (P > 0.05), *α*, *β*: In the same column, values assigned the same letter do not differ significantly (P > 0.05). *α*, *β*: In the same row, values assigned the same letter do not differ significantly (P > 0.05).

4. Discussion

The different breeds studied are almost equally represented (33.9%, 35%, and 31.1%) in this study although the Kouri breed has generally shown better results. Regarding the mean Body Condition Score, the study revealed that the cows used had an average BCS of 3.3 ± 0.34. This value is similar to the findings of Fassi *et al.* [14] and Azafack *et al.* [15], which were 2.94 ± 0.89 and 2.93 ± 0.64, respectively, in Morocco and Cameroon. This low BCS may be due to the long dry season and the scarcity of pastureland observed in this area; but above all to poor farming techniques practiced by local populations. Furthermore, farmers often lack the resources to provide supplementary feed for their animals. This results in decreased performance, leading to the sale of animals in poor physical condition to butchers, wholesalers, or slaughterhouses, who then transport them to the abattoir. Similarly, a lack of health monitoring promotes the incidence of diseases, which in turn influence physical development.

The results of this study also revealed that, most of the cows slaughtered were young (3 to 5 years old). This situation can be explained by the fact that, older cows (10 - 15 years old) have lost more weight, a consequence of protein degradation in this age group. Indeed, BCS is an indicator that allows for an indirect assessment of nutritional status [16]. The proportion of pregnant cows slaughtered during the study (18.9%) corroborates that reported by Alaku and Orjiude [17] (21.34%). The slaughter of pregnant cows can be explained on the one hand by non-compliance with veterinary legislation imposed by the state and on the other hand by the neglect of the ante-mortem examination which should be applied to the animals before their introduction to the slaughterhouse.

The significant increase in phosphorus levels observed in young animals (3 - 5 years old) in this study could be explained by the main functions of this element and its involvement in skeletal growth in young animals. Indeed, numerous studies have shown that plasma phosphorus is generally higher in young animals than in adults [18]. The significant increase in protein levels observed in middle-aged

animals (6 - 9 years) in this study is a factor that could influence female fertility. Protein intake affects reproduction through direct effects on corpus luteum function (decreased progesterone levels) and on the uterine environment, where toxic waste products of nitrogen metabolism, including rumen ammonia, can be incompatible with sperm, egg, or embryo survival [19]. Protein intake also impairs endocrine function [20]. Furthermore, excess protein leads to the formation of ammonia, and subsequently urea.

The low hormone levels recorded in this study could be, in one hand, attributed to the poor nutritional status of the cows [21], and on the other hand, to environmental conditions such as the long-distance transport of animals to the slaughterhouse, which could be the cause of stress in cows, the breed, and the season. A consequence of the extensive farming system to which they are subjected [22]. This could be explained by the slight superiority observed in certain values in the Kouri breed cow, which is naturally a little more robust than the Arabian and Toupouri breeds. Indeed, it has been observed that underfeeding inhibits the feedback mechanism exerted by estradiol on FSH. Furthermore, a favorable nutritional status is associated with high plasma levels of IGF-1, a hormone essential for stimulating follicular and oocyte growth. It would thus increase the sensitivity of granulosa cells to FSH stimulation, given that basal folliculogenesis is primarily controlled by growth factors such as IGF-1 (Insulin Growth Factor-1) [20]. Ryan *et al.* [23] found a correlation between adequate feed intake and blood IGF-1 concentration and BCS.

In this study, LH and estradiol levels were in general elevated in older cows (10-15 years old). Indeed, in younger animals, where maturity has not yet peaked, hormonal secretion is controlled by the hypothalamic-pituitary axis, which stimulates hormonal release. This study also revealed that the urea level observed in all slaughtered cows was low. In fact, Ferguson and Chalupa [24] observed that the success rate of Artificial Insemination (AI) was three times lower in cows with urea levels above 0.43 g/L compared to cows with normal urea levels. In fact, urea is toxic to sperm and oocytes [19]. This could explain the lower AI success rate and embryonic mortality.

5. Conclusion

In this study, which aimed to contribute to the evaluation of the effects of breed, age, and body condition score on the biochemical and hormonal parameters of three cattle breeds in Chad (Arabian, Kouri, and Toupouri). The results showed that most cows were in low and average BCS and are mainly young cows. Hormone levels were generally higher in young cows (3 - 5 and 6 - 9 years) although some older cows were an exception. The Kouri breed has generally shown better results. Thus, to optimize the productivity of local breeds, particularly Kouri, young and average BSC cows must be used. Also, supplementary feed should be provided for animals. The percentage of pregnant cows slaughtered was considerable. Thus, ante-mortem examination should be compulsory.

Ethical Approval

Experimental protocols used in this study were approved by the Ethics committee 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.

Acknowledgements

The authors are grateful to the Cameroon Livestock Development Corporation (SODEPA) for providing an ideal framework for data collection.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] MINEPIA (2009) Directing Diagram for the Development of the Dies of the Breeding in Cameroon. Report No. 2, 82.

[2] MINEPIA (2011) Document de stratégie du sous-secteur de l'élevage, des pêches et des industries animales. Report No. 12, 104-123.

[3] MADRPM (1998) Direction d'élevage. Etude sur l'analyse et l'évaluation génétique des reproducteurs bovins laitiers. Rapport 3: Évaluation génétique. 3-11.

[4] Ebangi, A.L., Erasmus, G.J., Mbah, D.A., Tawah, C.L. and Ndofor-Foleng, H.M. (2011) Evaluation of Level of Inheritance in the Growth Traits in the Gudali and Wakwa Beef Cattle Breeds of Adamawa, Cameroon. *Livestock Research for Rural Development*, **23**, 111-130.

[5] Umutoni, C. (2012) Ressources alimentaires disponibles et utilisables comme suppléments en alimentation pour l'amélioration de la production laitière dans les régions de Kaolack et de Kolda (Sénégal). Ph.D. Thesis, École Inter-États des Sciences et Médecine Vétérinaires, 87 p.

[6] Kouamo, J., Dawaye, S.M., Zoli, A.P., Bah, G.S. (2014) Evaluation of Bovine (Bos Indicus) Ovarian Potential for *in Vitro* Embryo Production in the Adamawa Plateau (Cameroon). *Open Veterinary Journal*, **5**, 128-136. https://doi.org/10.5455/ovj.2014.v4.i2.p128

[7] Sawadogo, G.J., Oumarou, A.A., Sene, M. and Diop, M. (1991) Effects of Poor Pasture Conditions and Type of Feeding on Some Biochemical Values of Gobra Zebu in Senegal. *British Veterinary Journal*, **147**, 538-544. https://doi.org/10.1016/0007-1935(91)90023-g

[8] Sow, F.M.M., Kalandi, M., Bathily, A., Dieng, K. and Sawadogo, G.J. (2015) Performances et paramètres biochimiques des vaches métisses F1 et F2 dans les élevages tradi-tionnels des régions de Kaolack et de Louga au Sénégal. *Revue Africaine des Sciences et Productions Animales*, **13**, 25-30.

[9] Lhoste, P. (1969) Les races bovines de l'Adamaoua. Institut d'élevage et de médecine vétérinaire des pays tropicaux. 19.

[10] Moussa Garba, M., Marichatou, H., Issa, M., Abdoul Aziz, M.L. and Hanzen, C.

(2014) Tractus génital des vaches zébus (*Bos indicus*) au Niger. *Revue d'élevage et de Médecine Vétérinaire des Pays Tropicaux*, **66**, 137-142. https://doi.org/10.19182/remvt.10153

[11] Natumanya, R., Owiny, D. and Kugonza, R. (2008) The Potential of Ankole Cattle Abattoir Ovaries for *in Vitro* Embryo Production. *African Journal of Animal and Biomedical Sciences*, **3**, 1819-4214.

[12] Wang, Z., Yu, S.D. and Xu, Z.R. (2007) Effects of Collection Methods on Recovery Efficiency, Maturation Rate and Subsequent Embryonic Developmental Competence of Oocytes in Holstein Cow. *Asian-Australasian Journal of Animal Sciences*, **20**, 496-500. https://doi.org/10.5713/ajas.2007.496

[13] Santos, S.S.D., Ferreira, M.A.P., Pinto, J.A., Sampaio, R.V., Carvalho, A.C., Silva, T.V.G., *et al.* (2013) Characterization of Folliculogenesis and the Occurrence of Apoptosis in the Development of the Bovine Fetal Ovary. *Theriogenology*, **79**, 344-350. https://doi.org/10.1016/j.theriogenology.2012.09.026

[14] Fassi, F., Lakhdissi, H., Derqaoui, L., Hajji, K., Naciri, M. and Goumari, A. (2005) 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 Journal of Biotechnology*, **4**, 9-13.

[15] Dorice, A.K., Ferdinand, N., Justin, K., Augustave, K. and Linda, K.K. (2019) Effects of Breed, Age, Body Condition Score, and Nutritional Status on Follicular Population, Oocyte Yield, and Quality in Three Cameroonian Zebus Cattle *Bos indicus*. *Advances in Agriculture*, **2019**, Article ID: 2979740. https://doi.org/10.1155/2019/2979740

[16] Leperre, P., Dwinger, R.H., Rawlings, P., Janneh, L., Zurcher, G., Faye, J., *et al.* (1991) Etude des paramètres zootechniques de la race Ndama en milieu traditionnel villageois en Gambie. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, **45**, 55-62. https://doi.org/10.19182/remvt.8959

[17] Alaku, S.O. and Orjiude, B.A. (1991) Slaughter of Pregnant Animals for Meat in Subsahelian West Africa. *Tropical Veterinarian*, **9**, 171-176.

[18] Quiroz-Rocha, G.F., LeBlanc, S.J., Duffield, T.F., Wood, D., Leslie, K.E. and Jacobs, R.M. (2009) Reference Limits for Biochemical and Hematological Analytes of Dairy Cows One Week before and One Week after Parturition. *Canadian Veterinary Journal*, **50**, 383-388.

[19] Greenhalf, J.O. and Diggory, P.L.C. (1971) Induction of Therapeutic Abortion by Intra-Amniotic Injection of Urea. *BMJ*, **1**, 28-29. https://doi.org/10.1136/bmj.1.5739.28

[20] Visek, W.J. (1984) Ammonia: Its Effects on Biological Systems, Metabolic Hormones, and Reproduction. *Journal of Dairy Science*, **67**, 481-498. https://doi.org/10.3168/jds.s0022-0302(84)81331-4

[21] Domínguez, M.M. (1995) Effects of Body Condition, Reproductive Status and Breed on Follicular Population and Oocyte Quality in Cows. *Theriogenology*, **43**, 1405-1418. https://doi.org/10.1016/0093-691x(95)00126-s

[22] Boland, M.P. and O'Callaghan, D. (1999) Nutrition and Early Embryonic Development. *Reproduction in Domestic Animals*, **34**, 127-132. https://doi.org/10.1111/j.1439-0531.1999.tb01229.x

[23] Ryan, D.P., Spoon, R.A., Griffith, M.K. and Williams, G.L. (1994) Ovarian Follicular Recruitment, Granulosa Cell Steroidogenic Potential and Growth Hormone/Insulin-Like Growth Factor-I Relationships in Suckled Beef Cows Consuming High Lipid Diets: Effects of Graded Differences in Body Condition Maintained during the Puer-

perium. *Domestic Animal Endocrinology*, **11**, 161-174.
https://doi.org/10.1016/0739-7240(94)90024-8

[24] Ferguson, J.D. and Chalupa, W. (1989) Impact of Protein Nutrition on Reproduction in Dairy Cows. *Journal of Dairy Science*, **72**, 746-766.
https://doi.org/10.3168/jds.s0022-0302(89)79168-2