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ORIGINAL ARTICLE

Productive, reproductive, and estrus characteristics of different breeds of buffalo cows in Bangladesh

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ABSTRACT

Objective: The objective of this research work is to know the productive and reproductive performances and problems of local, crossbred, Nilli, and Murrah buffalo cows in selected study areas in Bangladesh.

Methodology: A total of 1,241 local, crossbred, Nilli, and Murrah buffalo cows were surveyed in the selected areas with a pre-set questionnaire. Among 1,241 buffalo cows, 112 buffalo cows were randomly selected at day 0 of the estrus cycle for studying ovarian features.

Results: Results showed that the average age, body condition score, and body weight were significantly ($p < 0.05$) different among the studied breeds. Milk production in Murrah and lactation length in Nilli cows were significantly ($p < 0.05$) higher than indigenous, crossbred, Nilli, and indigenous, crossbred, Murrah buffalo cows, respectively. Results also illustrated that sexual maturity, estrus cycle length, insemination time after the onset of estrus, and gestation length insignificantly ($p > 0.05$) varied among the surveyed breed. But, the fallout of the study denoted that estrus duration, first calving age, parity number, number of service per conception, calving interval, and voluntary waiting period varied significantly ($p < 0.05$) in different breeds. Ovarian physiological characteristics such as vaginal electrical resistance, average number of follicles in two ovaries, and largest follicular diameter, estrogen, and progesterone at day 0 of the estrus cycle of local, crossbred, Nilli, and Murrah buffalo cows showed insignificantly ($p > 0.05$) differences.

Conclusion: The study will help the veterinarian and researcher to identify the constraints for the reproductive efficiency of buffalo in Bangladesh.

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Introduction

Dairying is one of the most important modules of the agriculture sector in Bangladesh. Cattle, buffalo, sheep, and goat are considered as dairy animals. At present, there is a huge shortage of milk production in Bangladesh; to fulfill the demand, we import a huge amount of milk and milk products every year with spending about Tk. 2901 million [1]. Out of total milk production, cattle, goat, and buffalo produce 90%, 8%, and 2%, respectively [2]. Though present milk production of native buffalo cows is very poor, we cannot disregard them because they have some unique appearances such as they are well adapted to adverse environment, they can easily utilize the low quality of feed with better efficiency and farmers can rear the buffalo smoothly in both extensive and intensive system as well as in traditional housing facilities. Buffalo is one of the most important bovine including African wild buffaloes (*Syncerus*) and Asian buffaloes (*Bubalus bubalis*), which are being domesticated in later [3]. In Asia, including Bangladesh, domestic water buffalo have two prime sub-species such as the river type and the swamp type [4], with dissimilar 50 and 48 chromosome karyotypes, respectively [5], differences in morphology (body frame, body weight, horn shape, and skin color), diverse behavior (wallowing in water or mud), and variation in lactation (higher in river type than swamp type). Murrah, Mediterranean, Jaffarabadi, Nili-Ravi, Surti, Mehsana, Kundi, Nagpuri, and Bhadawari are the most important buffalo breeds in Asian countries [6]. Mainly

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char and coastal peoples are rearing buffalo in Bangladesh for their won nutrition and extra earning sources.

There are about 1.464 million total buffalo in Bangladesh reported by DLS [7]. Buffalo is a versatile domestic bovine that provides high-quality milk and meat, dung as fuel and organic fertilizer, draft power, and hides [8]. Successful reproduction of buffalo like other domestic animals is very essential for buffalo farming. Reproductive efficiency of buffalo depends on some factors such as climate, management, nutrition, and diseases. Climatic hassle dampens the estrus cycle, sign of heat, and fertilization [9]. Furthermore, buffalo have some unique characteristics such as delayed puberty, asymmetrical estrus cycle, low sign of heat, silent heat, seasonal breeder, poor conception, and extended calving interval. For future dairy development program, it is very important to know the histories of productive capability and reproductive features of buffalo cows [10]. Considering the above circumstances, the study was designed to explore the productive and reproductive performances and problems of different breeds of buffalo cows in the selected study areas of Bangladesh.

Materials and Methods

Ethical approval

This study was permitted by the Animal Welfare and Ethical Committee, Bangladesh Agricultural University, Mymensingh (No. 07/AWEC/BAU/2018, dated 15/10/18).

Study areas and study period

The resource populations, as well as local and cross breed female buffaloes of this study, have been comprised from five areas of Buffalo zone of Bangladesh: Bhaluka and Trisal Upazila of Mymensingh, Madarganj Upazilla of Jamalpur, Subarnachar Upazilla of Noakhali, Milkvita buffalo farm of Madaripur, and Government Buffalo Breeding and Development Farm of Bagherhat District. Each and every stated area has a desired population bank. The study was conducted in the following mentioned and selected areas of Bangladesh during September 2016–October 2018.

Design of questionnaire

To obtain farm and cow level variables, a well-designed questionnaire was developed as described by Thrusfield [11]. Data were collected by face to face interviewing to the farm's owner with the questionnaire.

Selection of farms and animals

Farms including smallholding, commercial, and institutional buffalo farms having ≥ 5 cows with ≥ 1 parity were considered for the study. A total of 1,241 local water buffalo cows, cross breed, Nilli, and Murrah were surveyed in the selected areas with farms and cows level variables for analysis of the biological characteristics and 112 number female buffaloes among the breeds were studied for ovarian features.

Determination of reproductive and productive performances

The reproductive and productive performance parameters, i.e., ovarian cycle span, heat period, age at puberty, first calving, parity, length of gestation, period calving interval, service per conception, average daily milk production, and lactation period were collected from 1,241 animals reared under different farming system in different regions in Bangladesh. The body weight in this study was estimated using the formula of: live weight (kg) = $(L \times G^2) / (300 \times 2.25)$, where L = Length, G = Hearth girth, and body condition score (BCS) of cows were determined using a 1 to 5 scale where 1 is emaciated and 5 is obese.

Recording of vaginal electrical resistance (VER)

At day 0 of the estrus cycle, VER values were recorded in the selected buffalo cows by the use of electronic heat detector (DRAMINSKI® Owocowa 17, Poland), with the procedure described by Talukder et al. [12].

Measurement of the ovarian follicular diameter by the ultrasonographic examination

During the estrus period of buffalo, follicular development was monitored by the use of B mode ultrasonography machine (Sono Scape, China) with a 6.5 MHz animal transrectal linear array probe as described by Sharma et al. [13].

Blood sampling, estrogen (E2,) and progesterone (P4) assay

Estrogen and progesterone levels were assessed in the peripheral blood of 112 surveyed cows at the time of AI by the use of progesterone enzyme-linked immunosorbent assay (ELISA) kit (Nova Tec Immunodiagnogtica GmbH, Germany) and ELISA reader at the laboratory of Community-based Dairy Veterinary Foundation as described by Talukder et.al. [12]. Concentration of estrogen (pg/ml) and progesterone (ng/ml) was calculated by the use of formula like, $y = -0.37\ln(x) + 2.6632$ and $y = -0.14\ln(x) + 0.792$, respectively, obtained from standard curve of optical density value.

Statistical analysis

Data from questionnaires and laboratory tests were organized in the Microsoft Excel-2010 software. All productive, reproductive, and ovarian features were statistically analyzed by one-way "analysis of variance" using computerized SPSS software version 20. The Post Hoc tests were done for comparison of different parameters among the breeds with 95% level of confidence.

Results and Discussion

General survey throughout the randomly selected buffalo cows

Results exposed that average ages of randomly selected local, crossbred, Nilli, and Murrah buffalo cows in the study areas are 9.08 ± 2.49, 8.54 ± 2.45, 7.71 ± 1.61, and 6.86 ± 2.44 years, respectively (Fig. 1A), where local is significantly ($p < 0.05$) higher than Nilli and Murrah but crossbred ($p < 0.05$) is significantly higher only than Murrah. Similarly, average bodyweight among the studied four breeds is 276.08 ± 65.84, 310.89 ± 70.38, 320.00 ± 28.06, and 403.35 ± 59.06 kg, respectively (Fig. 1B), where Murrah and Nilli are significantly ($p < 0.01$) higher than crossbred and local buffalo cows. The average BCS (out of 5) are 2.8053 ± 0.39, 3.04 ± 0.36, 3.15 ± 0.39, and 3.12 ± 0.28 in local, crossbred, Nilli, and Murrah buffalo cows, respectively, in the study areas (Fig. 1C) and fallouts presented that local is significantly ($p < 0.05$) lower than others. Banerjee [14] reported that bodyweight of Indian Murrah and Nilli is 450 kg and 500 kg which are more than the surveyed result of the present study. The age of buffalo is a significant element of the reproduction. The variation in body weight and BCS among breeds might be due to the variation in genetics, management, and environment.

Productive characteristics of the selected buffalo cows

The result illustrated that milk production is 1.53 ± 0.51, 2.38 ± 0.87, 3.41 ± 0.71, and 3.85 ± 0.85 liters per day in

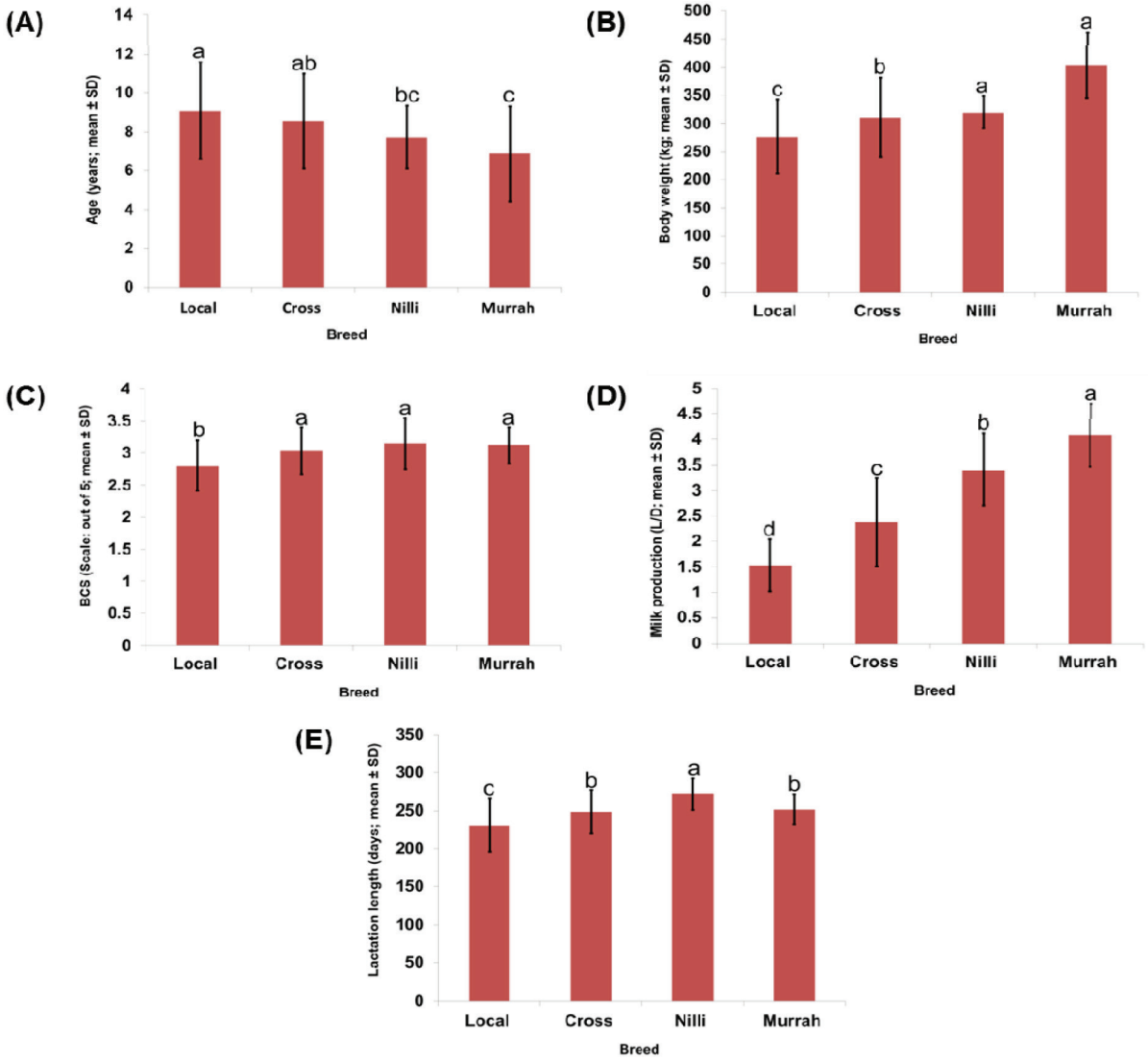

Figure 1. Comparison of physiological and production features in different breeds of buffaloes: (A) age, (B) body weight, (C) BCS, (D) milk production, and (E) lactation length. Values of a, b, c, and d differed significantly ($p < 0.05$).

local, crossbred, Nilli, and Murrah, respectively (Fig. 1D), where all the surveyed breeds significantly ($p < 0.05$) differ from each other. Similarly, average lactation length is 230.56 ± 34.78, 246.51 ± 27.39, 260.59 ± 22.49, and 250.88 ± 18.81 days in local, crossbred, Nilli, and Murrah, respectively (Fig. 1E), where Nilli is significantly ($p < 0.05$) higher than others but crossbred and Murrah are significantly ($p < 0.05$) higher than local buffalo cows. Milk production and lactation length in Murrah and Nilli cows are higher compared with crossbred and local buffalo cows. Huque [15] reported that daily average milk production is 2.8 l/day and average lactation length is 227 days which are close with local and crossbred but lower than the Nilli and Murrah buffalo cows in the present study. Uddin et al. [16] reported the milk production in semi-extensive and extensive farming's were 799 and 435 liters/lactation, respectively, which are lower than the Nilli and Murrah in this study. Daily average milk yield by local buffalo is 2.70–2.89 liters per day in Bangladesh [17], which is similar to the milk production of cross breed cows but higher than the milk production of local and lower than Nilli and Murrah cows in our findings. The substandard heredity of breeds along with other factors might be the causes of variation in milk production. However, the variations in milk yield and lactation length are important factors for research to establish the breeding policy in sustainable buffalo farming in Bangladesh.

Reproductive characteristics of the selected buffalo cows

The reproductive characteristics such as sexual maturity, estrus cycle length, estrus duration, insemination time after onset of estrus, first calving age, parity number, number of service per conception, length of gestation, calving interval, and voluntary waiting period (VWP) of the studied local, crossbred, Nilli, and Murrah buffalo cows which are presented in Table 1. The results illustrated that the sexual maturity of the studied breeds insignificantly differed from each other. Uddin et al. [16] and Nahar et al. [18] reported the age of puberty as 39 and 40 months in household and bathan farming system in Mymensingh and Laximpur district, respectively. The Indian buffalo (*B. bubalis*) attain puberty between 16 and 40 months but according to the report of Central Institute for research on Buffalo [19], the average time of puberty is over 2.5 years. Balanced feeding and improved management can be helpful in better growth and early sexual maturity [20]. Inadequate feed supply and essential nutrition during the growing period are the main causes of delayed puberty. The secretion of a gonadotropin-releasing hormone (GnRH) from the hypothalamus which stimulates the release of gonadotropin hormone, i.e., luteinizing hormone (LH) is the fundamental requirement for the onset of puberty. GnRH has an important role in the regulating secretion of LH, development of follicles, and secretion of steroid hormones. In this study, estrus cycle length in local, cross, Nilli, and Murrah buffaloes is 21.88 ± 1.93, 21.91 ± 1.49, 21.18 ± 1.47, and 21.68 ± 1.96 days, respectively (Table 1) and there are no significant ($p > 0.05$) differences among the studied breed. These results are more or less similar with the findings of Mujawar et al. [21] and they observed that estrus cycle length is 21.25 ± 2.37 days in Marathwadi buffaloes. This variation depends on several factors such as adverse environmental conditions, nutritional status, and irregularities in the secretion of ovarian steroid hormones [22].

Estrus duration in local, cross, Nilli, and Murrah buffaloes is 24.68 ± 3.01, 23.90 ± 2.96, 23.47 ± 1.55, and 24.31 ± 3.08 h, respectively (Table 1), where local and Murrah are significantly higher than others. Qureshi et al. [23] reported that estrus duration was 17–29 h in Indian Murrah buffalo cows and 21 h in Pakistani Nilli-Ravi buffalo cows and these findings

Table 1. Reproductive characteristics of female buffalo in different breeds in the study area.

Parameters	Mean ± Standard deviation			
	Local (*N* = 885)	Cross (*N* = 169)	Nilli (*N* = 17)	Murrah (*N* = 170)
Sexual maturity (months)	34.41 ± 2.02^{a}	34.74 ± 1.81^{a}	34.12 ± 1.65^{a}	34.53 ± 1.96^{a}
Estrus cycle length (days)	21.88 ± 1.93^{a}	21.91 ± 1.49^{a}	21.18 ± 1.47^{a}	21.66 ± 1.83^{a}
Estrus duration (hours)	24.68 ± 3.01^{a}	23.90 ± 2.96^{ab}	23.47 ± 1.55^{ab}	23.13 ± 2.97^{b}
Insemination time after onset of estrus (hours)	11.80 ± 0.81^{a}	11.59 ± 0.86^{a}	11.59 ± 0.71^{a}	11.50 ± 1.02^{a}
First calving age (months)	46.12 ± 1.66^{b}	46.56 ± 1.64^{ab}	47.06 ± 1.64^{a}	46.56 ± 1.46^{ab}
Parity number	2.91 ± 1.17^{a}	2.50 ± 0.99^{a}	1.88 ± 0.60^{b}	1.93 ± 1.00^{b}
Number of service per conception	1.64 ± 0.78^{ab}	1.78 ± 1.26^{ab}	1.88 ± 0.70^{a}	1.38 ± 0.59^{b}
Gestation length (days)	312.15 ± 12.04^{a}	313.40 ± 4.97^{a}	314.47 ± 3.78^{a}	313.68 ± 4.70^{a}
Calving interval (months)	19.36 ± 2.39^{a}	19.37 ± 2.63^{a}	19.41 ± 1.66^{a}	18.31 ± 1.97^{b}
VWP (days)	66.92 ± 7.47^{ab}	65.41 ± 7.23^{ab}	68.12 ± 5.58^{a}	64.87 ± 8.54^{b}

Mean values with different superscripts (a, b, c) within the rows differ significantly ($p < 0.05$). Mean values with the same superscripts (a) within the rows differ insignificantly ($p > 0.05$).

are closely similar with our present study. Results fallout that insemination time after the onset of estrus in local, crossbred, Nilli, and Murrah buffalo cows is 11.51 ± 1.02, 11.59 ± 0.86, 11.71 ± 0.69, and 11.80 ± 0.81 h, respectively (Table 1), which are insignificantly ($p > 0.05$) different from each other. Study of some workers, the average ovulation time after ending of estrus 12–24 h in Surti buffaloes [24], 14.8 ± 0.4 h in Nagpuri buffaloes [25], and 13.9 h in swamp buffaloes [26]. Hamid [27] reported that ratio of overall pregnant buffalo cow was 0%, 50%, 60%, and 10% when inseminated within 0–6 h, 6–12 h, 12–18 h, and 18–24 h, respectively, after seeing the first sign of heat. To obtain maximum fertility and conception rate of buffalo cows, timely insemination with the proper heat detection technique is very important for accurate breeding.

The first calving age of buffaloes in local, crossbred, Nilli, and Murrah breeds is 46.12 ± 1.66, 46.56 ± 1.64, 46.18 ± 0.88, and 46.25 ± 1.81 months correspondingly which are presented in Table 1. According to the report of Mudgal [28], the age of first calving ranges from 30 to 54 months and 48 to 57 months for Nili-Ravi and Khundi buffaloes, respectively. Thiruvenkadan [29] reported that the first calving age of Indian Murrah buffalo is 51.9 months which is higher than the present result. Besides these, Pilla and Moiloi [30] reported that the first calving age of Italian buffalo was 20–26 months which is extremely dissimilar with the present study. Results illustrated that the parity of surveyed local, crossbred, Nilli, and Murrah cows is 2.91 ± 1.17, 1.88 ± 0.60, 2.50 ± 0.99, and 1.93 ± 1.02, respectively

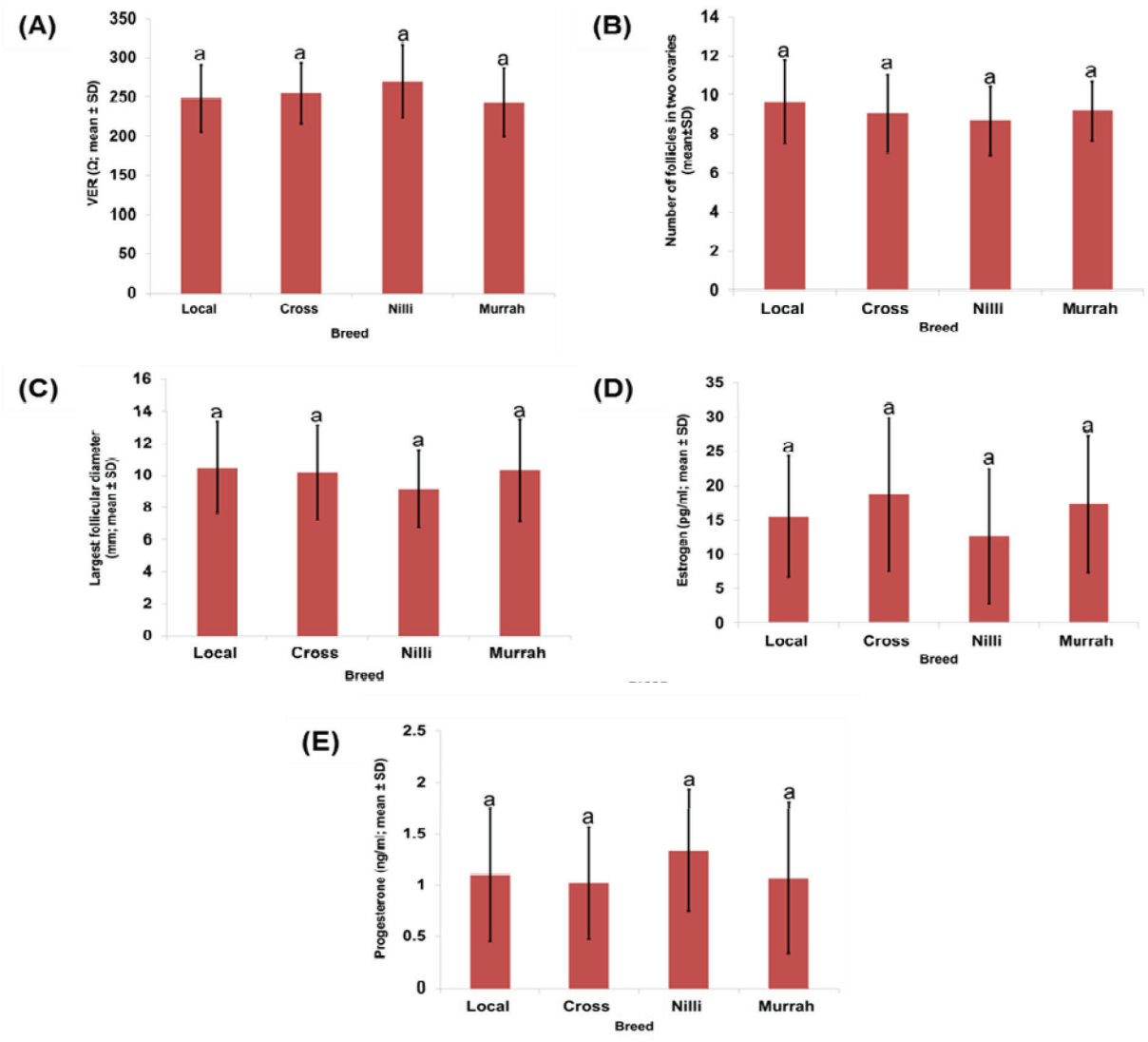

Figure 2. Comparison of ovarian features in different breeds of buffaloes: (A) VER, (B) number of follicles in two ovaries, (C) largest follicular diameter, (D) estrogen, and (E) progesterone. Value of a differed insignificantly ($p > 0.05$).

(Table 1), where local and crossbred significantly differ from Nilli and Murrah. According to Patel et al. [31], parity is an important factor for milk production and reported that average milking time and milk letdown were the lowest in the first lactation followed by third lactation, second lactation, and fourth lactation.

The number of service(s) per conception of local, cross, Nilli, and Murrah breeds is 1.64 ± 0.78, 1.78 ± 1.26, 1.88 ± 0.70, and 1.71 ± 0.68, respectively (Table 1), which are highly significantly ($p < 0.05$) different from each other. The present findings are dissimilar with the study of Saacke [32] and Khan et al. [33] who reported 2.8 and 2 services per conception in cross breed buffalo and Murrah buffalo cows at organized farm, respectively. The greater rate of service per conception might be due to improper detection of heat, postpartum problem of the buffaloes, and management. The standard feeding seems to influence the service per conception and the buffalo fed low protein-diet required 0.75 more services per conception than those maintained under protein-rich diets [34].

Result exposed that the average gestation period of local, crossbred, Nilli, and Murrah buffalo cows in the study areas is 312.15 ± 12.04, 313.40 ± 4.97, 313.65 ± 5.16, and 311.59 ± 6.17 days, respectively (Table 1) and there is no significant variation among the breed. Hamid et al. [35] reported that the average gestation length in native and crossbred buffalo cows was 309.63 days and 308.9 days (data based on Lal Teer Livestock Development BD. Ltd), respectively. In Bangladeshi water buffalo, the gestation length is 319.56 ±5.93 days at Mathbaria, Pirojpur, and 319.12 ± 4.69 days at Patharghata, Barguna [36], which are higher than the present study. The lower length of gestation in the present study from the above last two authors could be due to the difference in genetics and different nutritional management practiced in separate areas.

The result showed that the calving interval is 19.36 ± 2.39, 19.37 ± 2.63, 19.41 ± 1.66, and 18.31±1.97 months in local, crossbred, Nilli, and Murrah, respectively (Table 1), where Murrah is significantly ($p < 0.05$) lower than others. The results of our study are higher than the results of Shashi et al. [37] (15.00 ± 0.05 months in Murrah, Diara, and nondescriptive type's buffaloes at Patna, India); Wangdi et al. [38] (507.6 days in Bhutan). Karim et al. [36] also reported that the lower calving interval of local buffalo is 547.92 ± 10.88 days at Mothbaria and 547.24 ± 14.32 days at Pathorghata in Bangladesh compared to the current study. In the present study, VWP is 66.92 ± 7.47, 65.41 ± 7.23, 68.12 ± 5.58, and 64.87 ± 8.54 days in local, crossbred, Nilli, and Murrah, respectively (Table 1), where Murrah is significantly ($p < 0.05$) lower than Nilli. The findings of VWP in the present study are extremely dissimilar with other study. According to the report of Qureshi et al. [39], the time of involution of the uterus from calving ranged from 21 to 74 days in buffalo. These differences could be due to the dissimilarity of genetics and different management practiced in different areas.

Estrus characteristics of the studied buffalo cows

Result illustrated that VER values are 248.42 ± 42.46, 254.37 ± 38.75, 270.00 ± 46.90, and 242.92 ± 43.49 Ω in local, crossbred, Nilli, and Murrah, respectively, at the time of estrus period (Fig. 2A). This lower level of VER at estrus is similar with the findings of Gupta and Purohit [40]. Daily regular monitoring of VER in buffaloes [41] revealed that VER declines at estrus than others day of cycle due to the conductivity towards flow of current in the vagina increases at estrus due to decrease in the resistance towards passage of low voltage current possibly because of increased blood flow and the increased hydration in the vaginal mucosa. Gupta and Purohit [42] also reported that the conception rates in buffaloes were the highest when they were inseminated at VER level between 260 and 300 Ω. In our study, result exposed that number of follicles in two ovaries is 9.64 ± 2.14, 9.06 ± 2.02, 8.67 ± 1.75, and 9.19 ± 1.52 in local, crossbred, Nilli, and Murrah, respectively, at the day of estrus (Fig. 2B). This result is a little bit lower than the results of Kumar et al. [43] they observed that the mean number of follicles detectible on each ovary was 5.2 ± 1.0. Result also showed that the largest follicular diameter is 10.51 ± 2.85, 10.19 ± 2.93, 9.17 ± 2.40, and 10.31 ± 3.16 mm in local, crossbred, Nilli, and Murrah, respectively, at the time of estrus period (Fig. 2C) and there is no significant variation among the breed; which is closely similar with the results of Bartolomeu et. al. [44]. However, the result of our current study is lower than results of Barile et al. [45] (14.4 ± 0.6 to16.4 ± 0.3 mm in Italian Mediterranean cows after treatment with Progesterone Releasing Intravaginal Device (PRID) - Pregnant mare's serum gonadotropin (PMSG) - Prostaglandin F2α (PGF2α); PRID-PMSG-PGF2α), Oropeza et al. [46] (15.2 ± 0.2 mm in Indian Murrah cows with Ovsynch protocol) and Derar et al. [47] (13.6 ± 0.2 mm in Egyptian buffalo cows with Ovsynch protocol). Results fallout that the estrogen level at estrus is 15.56 ± 8.77, 18.77 ± 11.15, 12.71 ± 9.82, and 17.32 ± 9.95 pg/ml in local, crossbred, Nilli, and Murrah, respectively (Fig. 2D), which is lower than the reports of Mondal et al. [48]. In the study, (Fig. 2E) also showed the level of progesterone at the time of estrus is 1.10 ± 0.65, 1.02 ± 0.55, 1.34 ± 0.59, and 1.07 ± 0.74 ng/ml in local, crossbred, Nilli, and Murrah, respectively. Arora and Pandey [49] was also reported the progesterone basal levels (0.1–0.3 ng/ml) at the time of estrus and remained near to 1 ng/ml after the next 3–4 days. However, Mondal et al. [50] observed that the level of plasma progesterone as 0.30 ± 0.06 to 1.94 ± 0.03 ng/ml during the estrus period in buffaloes.

The study was conducted in selective areas of buffalo zone in Bangladesh with limited parameters. Further study should be conducted in other areas of Bangladesh with more parameters including hematobiochemical and ovarian follicular dynamics.

Conclusion

The study mainly focuses on the present scenario of the reproductive, productive, and ovarian characteristics of different breeds reared in different farming systems in different regions in Bangladesh. Delayed maturity of animals, seasonal breeder, prolong calving interval, and poor sign of heat are the main obstacle for the reproductive efficiency of female buffalo. Dairy buffalo reproduction has positive prospects in Bangladesh by increasing milk and meat production and it could be possible by taking a systemic breeding program through AI with imported proven bull semen in native buffaloes.

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Conflict of interests

The authors state no potential clash of interests with respect to this research.

Author contributions

Rashid MH and Juyena NS designed the study, interpreted the data, and drafted the manuscript. Rashid MH and Sarkar AK executed overall the experiments. Rashid MH and Hasan MMI contributed to hormone estimation. Rashid MH and Hasan M contributed towards analyses of data.

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