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IMPROVING REPRODUCTIVE EFFICIENCY OF NIGERIAN INDIGENOUS CATTLE BREEDS USING PROGESTIN-BASED PROTOCOLS FOR TIMED ARTIFICIAL INSEMINATION

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ABSTRACT

Fixed Time Artificial Insemination (FTAI) using progestin-based protocols is an effective means of improving reproductive efficiency in Nigerian indigenous cattle breeds. Progestin protocols, when combined with other hormones, can produce synchronization of oestrus and ovulation, thereby enhancing conception and pregnancy rates as well as reducing the necessity of oestrus detection. An experiment was designed to compare the protocols of the 5-day Controlled internal drug release (CIDR), J-Synch and 7&7 Co-Synch protocols for synchronization of oestrus in respect to indigenous Zebu cows (n = 60) before FTAI with conventional semen. The hormonal levels and conception rates with respect to synchronized Zebu indigenous cows were also investigated with respect to an artificial insemination (AI) scheme in Nasarawa State, Nigeria, by means of standard methods. The success of conception was achieved both vaginally and by transrectal palpation, and a threshold level of progesterone was determined post-insemination. A greater proportion of cows exhibited oestrus (P = 0.01) before FTAI to7 & 7 Co-Synchprotocol (80 %, 16/20) as compared to the 5-day +CIDRand J-Synch protocols(60 %, 12/20). Across the protocols, body condition score (BCS) affected (P = 0.05) the degree of oestrus expression, with the greater proportion of cows exhibiting oestrus before FTAI found at comparable higher BCS. The pregnancy rates to FTAI were obtained from cows treated with the 7 & 7 Co-Synch (18/20) than the 5-day +CIDR and J-Synch protocols (11/20). The 7 & 7 Co-Synch resulted in a higher proportion of Zebu cows expressing oestrus before FTAI, increased conception and pregnancy rates to FTAI with conventional semen. Consequently, we would recommend FTAI with the 7&7 Co-Synch protocols for the synchronization of oestrus periods for the FTAI in the Zebu Nigerian indigenous cattle breeds.

Keywords: Artificial Insemination; Conception rate; Pregnancy rate; Oestrous cycle; Synchronization; Cattle

1.0 INTRODUCTION

Nigerian indigenous cattle breeds, including the Zebu, are integral to the country's livestock industry, providing a significant source of meat, milk, and draft power. However, these breeds often exhibit low reproductive efficiency, characterized by prolonged calving intervals, delayed puberty, and low conception rates. These reproductive inefficiencies limit the productivity and economic potential of these cattle, thereby constraining the overall development of the livestock sector in Nigeria (Adesina*et al*., 2025). This variability

underscores the influence of management and environmental factors on AI success. Poor estrus expression in Nigerian Zebu cows is a significant concern that affects the reproductive performance and success of AI programmes. Several factors contribute to this issue, as highlighted by the literature. Zebu cows often exhibit less overt signs of estrus compared to crossbred or exotic breeds. Woldu*et al.* (2011) reported that estrus in Zebu cattle tends to be shorter and more subdued, making detection challenging.

Recent advances in reproductive biotechnologies, such as oestrus synchronization and fixed-time artificial insemination (FTAI), have shown promise in enhancing reproductive performance in cattle. Estrus synchronization involves manipulating the reproductive cycle to induce oestrus in a group of cows simultaneously, facilitating fixed-time artificial insemination (FTAI) without the need for oestrus detection. This approach has been widely adopted in developed countries, where it has significantly improved reproductive efficiency and productivity in cattle (Ayantoye*et al.,* 2025).Progestin-based protocols, such as the Controlled Internal Drug Release (CIDR), J-synch, and 7&7 Co-Synch protocols, have been particularly effective in synchronizing estrus and ovulation. These protocols utilize synthetic hormones to control the oestrous cycle, allowing for precise timing of artificial insemination. Despite their success in other regions, the application of these protocols in Nigerian indigenous cattle breeds remains limited (Chasama*et al*., 2023). Progestins can induce cyclicity in some noncycling females, including cows that are postpartum and heifers nearing puberty. By initiating oestrous cycles, progestins allow more females to be synchronized and bred (Rodrigues*et al*., 2018).

Research on the reproductive physiology of Nigerian indigenous cattle is also sparse, particularly concerning the efficacy of progestin-based synchronization protocols. Addressing this gap is critical to improving the reproductive efficiency of these breeds, thereby enhancing their productivity and contributing to the economic development of Nigeria's livestock sector.

The low reproductive efficiency of Nigerian indigenous cattle breeds, particularly the Zebu, poses a significant challenge to the country's livestock industry (Kubkomawa*et al*., 2017). Prolonged calving intervals, low conception rates, and delayed puberty are common issues that limit the productivity of these cattle (Rekwot*et al*., 1999). While progestin-based oestrus synchronization protocols have been successful in improving reproductive performance in cattle elsewhere (Sales*et al.,* 2024a), their application in Nigerian indigenous breeds has not been thoroughly investigated. There is limited application of modern reproductive technologies like Fixed*Timed Artificial Insemination (FTAI)* using progestin-based protocols in the Zebu breed. This research aims to address this gap by evaluating the effectiveness of three progestin-based protocols-5-day

CIDR, J-synch, and 7&7 Co-Synch-in synchronizing oestrus and ovulation in Nigerian Zebu cows.Hence, the objective of this paper was to improve the reproductive efficiency of Nigerian indigenous cattle breeds using progestin-based protocols for timed artificial inseminationand evaluate the cost associated with each protocol to determine the most economically viable protocol for adaptation by cattle farmers

2.0 MATERIALS AND METHODS

2.1 Theoretical framework

The theoretical framework for this research was based on the principles of reproductive physiology and endocrinology. The oestrous cycle in cattle is controlled by a complex interaction of hormones, including progesterone, estrogen, and luteinising hormone (LH). Progestin-based protocols utilise this hormonal regulation to synchronize oestrus and ovulation, enabling fixed-time artificial insemination.

The 5 dayCIDR, J-synch, and 7&7 Co-Synch protocols all rely on administering synthetic progestins that imitate natural progesterone's effects. By managing the timing of progesterone withdrawal and the subsequent LH surge, these protocols can effectively synchronize ovulation, ensuring that all cows in a group are inseminated at the optimal moment.

This research assessed the effectiveness of these protocols in Nigerian Zebu cows, emphasizing oestrus response rate, ovulation, and pregnancy rates. The study also included ultrasound monitoring of ovulation and progesterone assays to evaluate the physiological responses of the cows to the protocols.

2.2 Location of the study

This study was conducted at **a** farm is in Shinge Lafia in the Southern Guinea Savannah Zone of Nigeria on Latitude $8^0 28^{!}$ 7.78N and longitude $8^0 33^{!}$ 31.11E. The average minimum temperature is 23^0C and maximum temperature is 36.9^0C mean monthly relative humidity is 74%. The mean annual rainfall is 823mm; the mean monthly temperature is 35.06^0C (NIMET, 2019).

2.3 Sources of experimental Animals

The experimental animals were sourced from farms along the neighboring location and Shinge Cattle Market, Nasarawa State.

2.4 Ethical Approval

Approval for the study was sought and obtained from the Federal University of Lafia Committee for Animal Use and Care (FULCAUC).

2.5 Experimental feed ingredients

The animals were fed a well-balanced ration which was procured from Lafia market.

This study was conducted on a population of 60 Nigerian Zebu cows, divided into three groups of 20 animals, each subjected to one of the following synchronization protocols:

- 5-day Controlled internal drug release (CIDR) Protocol:

  - Day 0: Insertion of CIDR (a device that releases progestin) and administration of 100 µg of GnRH.

  - Day 5: Removal of CIDR and administration of 25 mg of prostaglandin (PGF2α).

  - Day 7: Administration of 100 µg of GnRH and fixed-time artificial insemination (FTAI) 16-20 hours later.

- J-Synch Protocol:

  - Day 0: Administration of 1 mg of estradiol benzoate and insertion of a progesterone-releasing intravaginal device (PRID).

  - Day 7: Removal of PRID and administration of 500 µg of cloprostenol (a PGF2α analogue).

  - Day 9: Administration of 1 mg of estradiol cypionate and FTAI 48–56 hours later.

- 7&7 Co-Synch Protocol:

  - Day 0: Administration of 500 µg of cloprostenol (PGF2α) and insertion of CIDR.

  - Day 7: Removal of CIDR and administration of 500 µg of cloprostenol (PGF2α) and 100 µg of GnRH.

  - Day 9: Administration of 100 µg of GnRH and FTAI 60–66 hours after CIDR removal.

2.6 Ultrasound Monitoring: Transrectal ultrasonography was used to monitor ovarian follicular development and ovulation. Ultrasound was performed at key time points in each protocol to ensure the synchronization of ovulation using real-time B-mode ultrasound scanner (Aloka, 500 SSD, Japan), with a transrectal 7.5MHz linear probe (UST-660-7.5 model).

2.7 Progesterone Assay: Blood samples was collected from the cows at various stages of the protocols to measure serum progesterone levels using an enzyme-linked immunosorbent assay (ELISA). This provided insights into the cows' endocrine responses to the synchronization treatments.

Progesterone (P_4) concentrations was determined by the method of Oda and Waheeb, 2017: Briefly, 50µL of sample and control was pipetted into the assigned wells. Exactly 100 µL of Progesterone-Enzyme reagent was added to all the wells. Microplate will be swirled gently for 20-30 seconds to mix and be covered. Progesterone Biotin reagent 50 µL of was added to all the wells. Microplates was swirled gently for 20-30 seconds, covered and incubated for 60 minutes at room temperature. Microplate contents was discarded by decantation, blotted dry with absorbent paper. Thereafter, 350 µL of wash buffer was added, decanted and blotted for a total of 3 washes. Following that, 100 µL of working substrate was added to all the wells and incubated for 15 minutes at room temperature. Then, 50 µL/mL of stop solution was added to all the wells and gently mixed for 15-20 seconds. Lastly, the absorbance in each well was read at 450 nm wavelength in a microplate reader and plotted against the concentration of standard T in ng/ml on linear graph paper, to determine the concentrations (Oda and Waheeb, 2017).

2.8 Tools of Analysis

Data collected was subjected to one-way Analysis of variance (ANOVA) using SPSS, 2007 Model. Significantly different means were considered and separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

3.0 RESULTS AND DISCUSSION

3.1 Oestrus response, conception and pregnancy rates of fixed-time inseminated cows following three different P-based protocols

The Oestrus response, conception and pregnancy rates of fixed-time inseminated cows following three different P-based protocols compared with spontaneous estrus. is presented in Table 1

The results of our study indicatesimilar good results from all these protocols with respect to the responses of Zebu cows. The points which need highlighting are: 7 & 7 Co-Synch protocol improved pregnancy outcomes among the cows receiving FTAI in comparison to results obtained using the 5-day-CIDR and J-Synch protocols. By significantly increasing the proportion of cows that express oestrusbefore FTAI, a significant increase in the pregnancy per artificial insemination (P/AI) was obtained using 7 & 7 Co-Synch. Furthermore, P/AI was greater following 7 & 7 Co-Synch using conventional semen (Andersen*et al.*, 2021). The significant effect of protocol on the proportion of cows expressing estrus as well as on P/AI was observed across cows of varying age, DPP, and BCS. However, the magnitude of improvement observed in the proportion of cows expressing estrus was greater among cows in greater DPP ranges and tended to be greater among cows of increased age. Given the relationship of age and DPP with oestrous cyclicity, this observation supports the

hypothesized mechanism for improved control of the oestrous cycle using 7 & 7 Co-Synch. The good response to the 7 & 7 Co-Synch protocol was probably due more to the effect of P4 plus the second GnRH dose used to induce ovulation than to the actions of the hormone combinations administered at the start or end of treatment. One reason for this statement is the fact that P4 and the second GnRH dose were the only fixed treatments for all protocols (Prata*et al.*, 2024). These results reinforce the idea that short P4-based protocols may lead to improved fertility compared with the more conventional longer protocols (Bo*et al*., 2016). Higher postovulatory circulating concentrations of progesterone have been noted for the 7 & Co-7 Synchprotocols with a consequent improvement in fertility compared with the 5-day -CIDR and J-synch ovulation synchronization protocol (Ferré,*et al*., 2023).According to some authors, double ovulation may be more correlated with the previously used synchronization protocol. Ovulation failure is a major cause of infertility in dairy cattle (Simões*et al.*, 2024). Under our experimental conditions, no effects of the synchronization protocol, parity, season of AI or milk production were observed on ovulation failure after treatment. Only cows with a CL at the treatment outset were ten times less likely to suffer ovulation failure. The absence of luteal structures in the remaining animals suggests that most were anestrous cows. Although the addition of eCG to P4-based protocols has been noted to promote ovulation in anestrous dairy cows (Sales*et al.*, 2024a). Logically, cows suffering anestrus would be less sensitive to any type of treatment than cows with a CL, which are probably normal cycling (Schowe*et al.*, 2024). In the same sense, P4 protocols probably overcome the negative effect of age. Herein, cows with a BCS < 2.5 units showed a lower conception rate irrespective of treatment. (Teixeira*et al.*, 2022)

Management practices should focus on reducing this problem in herds to avoid infertility (Sales*et al.*, 2024b). More extensive studies are needed to assess the ovulation behavior of repeat breeder cows. The results of this study demonstrate the efficacy of 7& 7 Co-Synch -based protocols for FTAI. All three protocols examined were able to induce ovulation in both cyclic and non-cyclic animals so that FTAI returned a similar pregnancy rate to spontaneous estrus (Sartori*et al.*, 2023).

In Nigerian Zebu cows, estrous synchronization using three consecutive injections of cloprostenol (a prostaglandin) resulted in a high mean conception rate of 82.75% during TAI. Hormonal profiles post-synchronization indicated successful reproductive outcomes, supporting the use of fixed-time AI with progestin-based protocols for the Zebu breed. In indigenous Nigerian Zebu cattle, protocols using prostaglandin F2α for estrus synchronization followed by timed or double AI (at 72 and 96 hours post-

injection) achieved the best fertility rates, with conception rates up to 53% in synchronized and inseminated cows (Morrotti*et al*., 2023).

Table 1:Effects of treatment for each examined variable

S/no	Groups/ Parameters	5-CIDR Protocol:	7&7 Co-Synch Protocol	J-Synch Protocol
1	Oestrus response rates	51%	85%	49%
2	Conception Rates (26-35 days post AI)	45%	80%	30%
3	Pregnancy rates	41%	78%	25%
4	Cost	#320,000.0	320,000.00	300,000.00

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The 7&7 Co-Synch protocol offers much potential as a platform to improve success with FTAI among our indigenous Zebu cows. Progestin-based protocols for FTAI are highly effective in improving conception and pregnancy rates in Nigerian indigenous cattle breeds. These protocols streamline breeding, support genetic improvement, and are adaptable to local management conditions, making them a valuable tool for cattle producers in Nigeria. This can also improve the genetic composition of indigenous cattle breeds through artificial insemination (AI) with exotic semen will aid production system intensification and solve herders-crop farmers' conflict in Nigeria. Successful AI, however, depends on efficient estrous synchronization preparing the animal's hormonal balance required for fertilization.

4.2 Recommendations

i Routine health evaluation of cows and use of chloprostenol, intramuscularly injected, as synchronizing agent during artificial insemination in herd improvement of indigenous cattle breeds in Nigeria are thus recommended.

ii Further study to evaluate the hybrid offspring of artificially inseminated indigenous cows with exotic semen is suggested.

Declaration of Conflict of Interest

The authors declare no conflict of interest.

Data Availability

Data are available upon request from the corresponding author.

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