Heterosis of crossbred genotypes of muturu cows mated with white fulani bulls using modified co-synch protocol under natural grazing conditions

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Abstract

Heterosis is the improved performance of the offspring over the parents. The experiment was carried out to determine the heterosis of some anthropometric traits from crossing of Muturu cows with the White Fulani bulls using artificial insemination (AI). This experiment was carried out during the period of dry season and on-set of rainy season (November to February) between 2016 and 2019. Sixty adult Muturu cows were inseminated using semen from 15 different White Fulani bulls. Fifty-one crossbred calves were produced (32 females and 19 males). Data on different anthropometric traits were taken of the calves when they were a yearling. The data was compared with the parent's data at yearlings by analyzing using T test in SPSS version 19 window. The results showed that all the traits were significantly (P<0.05) different between the crossbred and the parents presenting direct and positive heterosis over and above the parents. Heterosis occurred in both the crossbred bull and heifer calves. Crossbred calves grow faster than their inbred parents.

Keywords: Heterosis, Anthropometric traits, Muturu, White Fulani and Crossbred.

Hétérosis de génotypes croisés de vaches Muturu accouplées avec des taureaux White Fulani en utilisant un protocole de synchronisation modifié dans des conditions de pâturage naturelles

Résumé

L'hétérosis est l'amélioration des performances de la progéniture par rapport aux parents. L'expérience a été réalisée pour déterminer l'hétérosis de certains traits anthropométriques du croisement des vaches Muturu avec les taureaux White Fulani par insémination artificielle (IA). Cette expérience a été réalisée pendant la période de saison sèche et au début de la saison des pluies (novembre à février) entre 2016 et 2019. Soixante vaches Muturu adultes ont été inséminées à partir de la semence de 15 taureaux White Fulani différents. Cinquante et un veaux croisés ont été produits (32 femelles et 19 mâles). Des données sur différents traits anthropométriques ont été prises sur les veaux lorsqu'ils étaient un an. Les données ont été comparées aux données des parents chez les yearlings en analysant à l'aide du T-test dans la fenêtre SPSS version 19. Les résultats ont montré que tous les caractères étaient significativement (P<0,05) différents entre les croisés et les parents présentant une hétérosis directe et positive au-delà des parents. L'hétérosis s'est produite à la fois chez les taureaux croisés et les génisses. Les veaux croisés grandissent plus vite que leurs parents consanguins.

Mots-clés : Hétérosis, Traits anthropométriques, Muturu, White Fulani et Croisé

Introduction

Crossbreeding in commercial animal production system is mainly aimed at increasing hybrid vigour impact in crossbred genotypes. It is a means of combining breeds (complementarity) deficiencies in one breed by the other. Crossbreeding may lead to improved performance of the crossbred over the parents. This improved performance is recognized as heterosis. In animal breeding, crossbreeding allows the exploitation of breed qualities from genetic and biological point of view (Nwakpu *et al*., 2016).

Muturu are small bodied cattle known as the West African dwarf short horn. The word '*muturu'* means humpless and it is Hausa designation for the West African shorthorn. Muturu have blocky conformation with short limbs. It is characterized with a compact body, a straight back with no hump, and a broad head with very short horn (Kubkomawa, 2017). Muturu cattle are raised primarily for their meat, which is highly valued by consumers due to its organoleptic qualities (Adolighe *et al*, 2020). The Muturu cattle are reportedly very fertile with a capacity to produce one viable calf per annum (Tijjani *et al*, 2019). Ezekwe and Kamalu, (2000) reported that Muturu heifers under improved management attain puberty at an early age (12.25 – 14.60 months) and weighed 90.50kg and 85.20kg for supplemented and un-supplemented feeding, respectively. They mature earlier than the zebu in the region and the intervals between consecutive calvings were shorter (Adebambo, 2001).

The White Fulani, also known as 'Bunaji' is a type of West African Zebu that is indigenous to Northern Nigeria, Southern Niger and Northern Cameroom (Desie and Mwai, 2019). White Fulani is the most numerous and widespread of all Nigerian cattle breeds (Kubkomawa, 2017). The White Fulani are however, important for their genetic predisposition of hardiness, heat tolerance, and adaptation to local conditions (Alphonsus *et al*, 2021). White Fulani cattle is a white, black eared and medium-horned breed (Blench *et al*, 1999). The White Fulani are generally taller and narrower bodied cattle, the average birthweights computed in the different regimes range from 18.2 to 24.2kg; mature weights of bulls and cows in the improved system of management is 350 – 665 and 250 – 380kg, respectively (Tawah and Rege, 1996).

The Muturu breed is known to be more resistant to trypanosomiasis than the White Fulani, while the White Fulani is known to be more heat tolerant and resistant to dermatophilosis than the Muturu and also resistant to intestinal helminth parasites (Tawah and Rege, 1996). There is need for improving the productivity of uniquely adapted animal genetic resources (Angr) for use both within the country and for export purposes. Improving the reproductive performance of Muturu cows in Nigeria can greatly impact on increasing beef production as well as encourage ample inclusions of substantial population of Muturu cows into any genetic improvement programmes (Nwakpu *et al.,*2016).

Given the stressful environment prevalent in the tropics, such as high temperatures and humidity, high prevalence of ectoparasites and poor quality forages, especially (during dry seasons of November to April, every year). Artificial insemination (AI) is one of the best alternatives to introduce new genes into the Muturu herds. However, only a small percentage (if any) are subjected to any form of artificial insemination. Bo *et al.* (2013) had suggested that, the most useful alternative to significantly increase the number of animals involved in AI programmes is the use of protocols that allows for AI without the need for estrus detection, usually called fixed-time Artificial insemination (FTAI) protocols. One of the main advantages of implementing FTAI programmes are that, more cows can be impregnated earlier in the breeding season to genetically improved bulls or semen of it resulting in heavier weaning weights (Cutaia *et al.*, 2013). Improving cow productivity is a major

way to increase the economic efficiency of cattle (Muturu) production systems in the future. Due to their adaptability, disease resistance, high reproductive rate and resilience, the Muturu cows of Nigeria could play significant roles in achieving sustainable cattle production under the harsh environmental and low input traditional production system (Nwakpu *et al*, 2016). The effectiveness of this improvement is realized when the crossbred animals is a combination of breeds genetically far removed and/or efficiency is increased through the use of specialized sire and dams. Therefore, crossbreeding strategies: combining the tall and long legged heat resistant and hardy White Fulani with the dwarf, meaty, robust, compact bodied and trypanotolerant Muturu cows will help to exploit hybrid vigour. There is a significant variation (heterosis) between the crosses of White Fulani (semen) and the Muturu cows due to large genetic distance.

This study was designed to estimate the crossbreeding parameters of the main economically important traits in crosses involving the Muturu cows and the White Fulani breed using a modified co-synch protocol.

Materials and Methods

This study was conducted at Abakaliki, Ezza north and Ezza south LGAs, all located in Ebonyi State, Nigeria. Abakaliki town is situated within the South eastern part of Nigeria. It exists on Latitude 6º40 N and 7º30 N and Longitude 5º40 E and 6º45 E and 91.44m above sea level in the derived Savannah of South Eastern agro-ecological zone of Nigeria. The minimum and maximum temperatures of the area are 27ºC and 31ºC respectively (Ofomata, 1975).

At the moment, Ebonyi State houses the majority of the Muturu breed of cattle in Nigeria. This experiment was carried out during the period of dry season and on-set of rainy season (November to February), between the years 2016 to 2019. The experiment was conducted at three different locations. One location for the control was at the cattle breeding and multiplication centre of Ebonyi State University, Abakaliki, Ezza north and Ezza south LGAs, all located in Ebonyi State. 60 adult Muturu cows were inseminated using semen from 15 different White Fulani bulls. 51 crossbred calves were produced (32 females and 19 males). Anthropometric measurements were taken when the calves turned one year, these measurements were compared with the anthropometric measurements of their corresponding parents at yearling.

AI synchronization protocol

A modified co-synch (FTAI) protocol involves day 0 where the animals were administered GnRH (gonadotropin releasing hormone) and CIDR (controlled internal drug release). This was followed by day 7, here the animals were administered eCG (equine chorionic gonadotropin) and PG (prostaglandin Fα). CIDR were subsequently removed and on day 10 and the animals were artificially inseminated. The semen used for the experiment was purchased from National Animal Production Research Institute (NAPRI) Zaria. They were obtained from sound and proven breeding bulls of the While Fulani breed. The semen was thawed by bringing it out from the ice and exposing to warmth for 5 minutes and then, it was loaded into the insemination gun and inseminated into the animals. All the cows were inseminated twice using the pm/am rule.

Anthropometric traits

For the assessment of anthropometric traits, data were collected and recorded using a format based on standard breed descriptor list developed by FAO (2012). The parameters were obtained by a measuring stick modified with a sliding caliper encompassed by an adapted tape calibrated in centimeters (cm) after restraining and holding the animals in an unforced position. All measurements were taken early in the morning prior to supply of feed while cows are tethered during measurement. The following linear body measurements were taken as shown in Table 1.

Table 1: Linear body measurements and techniques used for measurement.

S/N	Measurements traits	Measurement Techniques
1	Chest girth (CG)	Measured by taking the measurements of the circumference of the chest, behind the forelegs.
2	Height at withers (HW)	Measured as a distance from the surface of the platform to the withers of the animal.
3	Body length (BL)	The distance from the point of shoulder to the pin bone
4	Ear length (EL)	Taken from the base to the tip of the ear
5	Head length (HL)	The length of the front head from the middle of the top head of the end of the mouth.
6	Neck length (NL)	The length between the atlas vertebrate till the vertebrae just ahead of the first thoracic.
7	Hind Limb (HDL)	From the hip bone to pin bone (outside)
8	Fore Limb (FL)	From the breath in points of shoulder points
9	Birth weight (LW)	Taken early in the morning before proceeding with feeding the animals.
10	Weaning weight (WW)	As in (No. 9 above)

(FAO, 2012)

Statistical Analysis

The data were analyzed using T test in SPSS version 19 window. The calves were classified according to their sex

Estimation of Heterosis

Heterosis was calculated using the data obtained from the parents and the crossbreds

$$\%\ Heterosis = \frac{Offspring\ Average - Parental\ Average}{Parental\ Average}\ x\ 100$$

Results

The results of the birth weight (BW) and other morphometric traits of inbred parental and F1 crossbred bulls and heifers aged one year old are presented in table 2 and table 3 respectively. The results showed that, all the traits were significantly ($P<0.05$) different between the crossbred calves presenting direct and positive heterosis over and above the inbred parents. Results of direct heterosis ranged from 6.89 % in the weaning weights of the crossbred bulls to 54.62% in their ear lengths at one year old, whereas, similar positive and direct heterosis of 6.74% in the height at withers to 48.51% in the ear lengths of the crossbred heifers were recorded also, at one year old.

Table 2: Morphometric measurements (cm) and live weight (kg) of inbred parent bulls and the F1 crossbred calves (bulls) aged one year old.

Traits(cm)	White Fulani bulls	F1 crossbred calves (bulls)	% Heterosis
Chest girth (CG)	53.20 ± 3.74^a	58.14 ± 2.81^b (18)	9.29
Height at withers (HW)	50.70 ± 2.43^a	56.23 ± 1.48^b (18)	10.91
Body length (BL)	37.38 ± 1.33^a	40.16 ± 2.30^b (18)	7.44
Ear length (EL)	13.20 ± 1.99^a	20.41 ± 3.81^b (18)	54.62
Head length	29.63 ± 2.14^a	34.32 ± 1.83^b (18)	15.83
Neck length (NL)	18.40 ± 2.10^a	25.10 ± 1.17^b (18)	36.41
Hind Limb (HL)	56.20 ± 3.51^a	60.40 ± 3.31^b (18)	7.47
Fore Limb (FL)	42.30 ± 3.10^a	48.30 ± 1.8^b (18)	14.18
Birth weight (LW) (kg)	14.96 ± 1.12^a	18.33 ± 1.14^b (18)	22.53
Weaning weight (kg)	56.49 ± 2.61^a	60.38 ± 1.66^b (18)	6.89

Table 3: Morphometric measurements (cm) and live weight (kg) of inbred parental cows and their F1 crossbred calves (cows) at one year old.

Traits(cm)	Muturu cows	F1 crossbred calves (heifers)	% Heterosis
Chest girth (CG)	43.10 ± 1.17[a]	48.30 ± 2.30[b] (32)	12.06
Height at withers (HW)	43.20 ± 2.30[a]	46.11 ± 1.40[b] (32)	6.74
Body length (BL)	21.10 ± 1.43[a]	27.05 ± 3.31[b] (32)	28.20
Ear length (EL)	13.13 ± 2.10[a]	19.50 ± 1.41[b] (32)	48.51
Head length	23.40 ± 1.32[a]	27.18 ± 3.81[b] (32)	16.15
Neck length (NL)	14.31 ± 1.70[a]	18.10 ± 2.20[b] (32)	26.48
Hind Limb (HL)	44.10 ± 2.20[a]	48.11 ± 1.21[b] (32)	9.09
Fore Limb (FL)	33.30 ± 1.87[a]	38.30 ± 1.81[b] (32)	15.02
Birth weight (LW) (kg)	12.81 ± 2.31[a]	16.14 ± 2.10[b] (32)	25.99
Weaning weight (kg)	43.21± 1.81[a]	47.10 ± 1.30[b] (32)	9.00

Discussion

Heterosis occured in the crossbred calves. Crossbred calves grow faster than their inbred parent. Breed complementarity is the major advantage of crossbreeding. This relates to the fact that there are no perfect breeds and that each breed possesses certain strengths and weaknesses. In a systematic crossbreeding programme, breed resources are combined to balance the positive and negative aspects of each breed in the genotypes. Estimates of the percentage direct heterosis of the body weight of the calves at one year of age were positive. Improvement in morphometric traits as a result of crossbreeding have also been reported in literature (Adoligbe *et al.*, 2020).

The results obtained suggest that simultaneous selection for body measurement and growth traits is feasible. It also suggests that any one among the morphometric traits or their combinations could be used to predict live weight in calves, though variations existing in values for different climes, environment and breed combinations. The result obtained in different climes or breed combination for body weight and morphometric traits showed that there are differences in body conformation of these genotypes reared in different environments; though they belong to the same breeding group.

It is suggested that for any successful breeding programme, data obtained from body weight and linear measurements be analyzed and applied for the animal in that particular environment and not using values obtained a zone different from where the breeding values were obtained from, where the breeding programme was carried out. According to El-labban (1999), a positive correlation among traits could be as a result of pleitropic effects of genes and linkage effects which operate on these traits. Therefore, attempt to perform phenotypic selection for one trait will consequently result in improvement of the other trait.

Conclusion:

There were direct and positive heterosis over and above the inbred parents. Heterosis occurred in both the crossbred bull and heifer calves. Crossbred calves grow faster than their inbred parents.

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