COMPARATIVE EVALUATION OF DAIRY PERFORMANCE AND THERMOREGULATORY TRAITS OF TWO EXOTIC BREEDS OF CATTLE IN THE HOT CLIMATE OF ADAMAWA, NIGERIA.

Abstract

A study was conducted to evaluate the dairy performance and thermoregulatory of two exotic cattle in hot tropical conditions of Adamawa State. Milk production traits measured were 305 day fat corrected milk yield, daily milk yield, total fat yield, total protein yield while thermoregulatory traits measured rectal temperature, respiratory rate and skin temperature. All descriptive statistical analyses (Mean, coefficient of variation and standard error of mean) and T-test were done using R commander (2016) Software. The least significant difference procedure for mean comparison was used to rank the means after a significant effect ($P<0.05$) was observed. Milk production and efficiency traits were greatly influenced ($P<0.01$) by the genotypes of cows in Adamawa State, with the exception of 305FCM per cows per day protein yield, lactation length, net energy efficiency and dairy merits. Brown-Swiss had significant ($P<0.05$) higher respiratory rate than Jersey cows. It is evident that considerable variation exist in milk production and thermoregulatory traits of the two exotic cows.

Introduction

The global population has been predicted to approach 10 billion people by the year 2050 while the economic status of people in developing countries such as Nigeria will continue to improve. As a result, there will be a profound increase in the quest for protein sufficiency leading to high demand of animal-based products. The global demand for animal food products is growing and projected to more than double in Africa by 2050 (FAO, 2018), resulting in concerns for sustainability and food security. The low milk productivity of cattle in the tropics is characterise by low genetic potential, nutrition and lack of efficient breed improvement programmes using high resolution genomic tools to optimize productivity (Akinsola, 2017). Despite the enormous benefits of cattle production, it has remained inefficient and unprofitable to most farmers due to thermal assault and partly due to factors such as poor genetics, inefficient utilisation of bi-products and pastoral system of production—characterised by up to 70% losses due to predation, theft, and poor nutrition, weather, and housing as well as conflicts between farmers. Little effort has been made towards breeding for improved milk and reproductive traits of Nigeria local genetic resources cattle through genetic improvement. Hence, there is a need for research on some exotic cattle for production and thermoregulatory traits in Nigeria to address the concern for food security and sustainability, creating more jobs and increasing economic returns.

Material and methods

Adamawa State

Sebore farm in Adamawa State is located at an altitude of 200 to 300 metres, between latitude 9^0 $20^{'}$ and 9^0 $33^{'}$N and longitude 12^0 $30^{'}$ and 12^0 $50^{'}$ E. It is bordered by Borno State to the North West, Gombe to the West and Taraba to the South West and has an Eastern border with Cameroun Republic. It has average daily minimum and maximum temperatures of 23.2 ^{0}C and 35.2 ^{0}C respectively. The average annual rainfall is 718.1 millimetres and relative humidity, 44.2 %. It occupies an area of 39,742.12 square kilometres. The is generally characterized by many rivers; the major one being the Benue whose source is from the highlands of the Cameroun and flows southwards to join the River Niger (Climate-Data, 2015)

Animal management

The farm was subdivided into seven paddocks. As cows displayed signs of approaching parturition they were moved to the steaming paddock. All cows in this camp were regularly checked daily. Morning milking was done between 6.00 am and 9.30 am daily while the evening milking took place between 3.30 pm and 7.00 pm daily and it varies according to the number of lactating cows. Cows were disbudded using caustic soda, which is done at 5 days of age. Female calves with supernumerary teat have the teat removed with scissors or a blade. Calves were usually weaned at around 7 days. Following weaning, calves were vaccinated against certain bacterial or viral diseases and be given treatment for parasites. Vaccination usually requires a course of injections. Cows were impregnated either naturally by a bull in the herd, or via artificial insemination (AI). Cows were fed total mixed ration (TMR) which includes hay, fermented grass (silage), maize silage and high energy grains like brewers grains, soy bean and cotton seed. Cows were milked twice a day in DELAVAL computerized milking parlour.

Milk yield measurement

Cows were milked using an automatic DELAVAL suction milking machine with teat cups which was used to collect raw milk produced from the cows' udders. Measurement was taken twice a day (06:00 hrs and 13.00 hrs) and was recorded in litres.

Milk component measurements

Butter fat and protein percentages were measured by infrared spectroscopy, using a Lactoscan analyser in the quality control laboratory of Shonga Dairy Holdings in Kwara State. Three (3) mls of raw milk from the bulk milk tank were injected into the automated lactoscan milk analyzers for determination of butterfat, protein and total solids in Shonga and Sebore farms while in Integrated Dairies Limited, analysis were done using the conventional method. For the determination of total solids content (milk solid with fat), two (2) mls of fresh cows raw milk sample were thoroughly mixed and 5 g was transferred to a pre-weighed and dried flat bottom crucible (AOAC, 1990). The milk samples were dried in a hot air oven (Serial No-96H203, Model-EDSC made in England) at 102 ^{o}C for 3 hours. Finally, the dried samples were taken out of the oven and placed in desiccators to cool to room temperature. Then samples were weighed again and total solids was calculated by the following formula (Richardson, 1985).

Total solids = Crucible weight +Oven dry sample weight - Crucible weight x100 Sample weight

Fat content of milk

The fat content was determined by the Gerber method according to Richardson (1985). Ten ml of sulphuric acid (density 1.815 gm/ml at 20 °C) was pipetted into a butyrometer. Then eleven ml of milk sample was added into the butyrometer and mixed with the sulphuric acid. This was followed by addition of one ml amyl alcohol into the butyrometer which was then closed with a lock stopper. Then the mixture was shaken and inverted several times until the milk was completely digested by the acid. Finally, the butyrometer was kept in water bath for 5 minutes at 65 ^{0}C and centrifuged in a Gerber centrifuge for 5 minutes. The butyrometer was placed in water bath again at 65 ^{0}C for 5 minutes. At the end, the butyrometer reading was recorded.

Crude protein content of milk

The crude protein content of milk samples was determined by the Kjeldahl method (AOAC, 1990). 5 g of milk sample was warmed in water bath at 38 ^{0}C and poured into a Kjeldahl tube. A mixture of 15 g potassium sulphate, one ml of copper sulphate solution and 25 ml of concentrated sulphuric acid were added to the tube and mixed gently. The digestion was carried out for 120 minutes at 35 ^{0}C using micro-Kjeldhal digester in the presence of catalyst (1 ml of copper sulphate and 15 g potassium sulphate) where sulphuric acid was used as an oxidizing agent. Then it was allowed to cool at room temperature over a period of 25 minutes. The digested solution was diluted with 250 ml of distilled water. The Kjeldahl tube was placed in the distillation equipment. Then, 75 ml of 40 % sodium hydroxide solution was added into the tube. Then ammonia was distilled using 50 ml of 4 % boric acid solution with bromocresol green/methyl red as indicators until blue color appears. Finally, the sample was titrated with 0.1N hydrochloric acid solution until a faint pink color is formed and the burette reading was taken to the nearest 0.01 ml. Blank test was carried out using the above procedure except that water was used instead of the test sample. The percentage of nitrogen in the milk samples was calculated using the formula provided by AOAC (1990). % N = 1.4007x (vs-vb) X N HCl x 100 Weight of sample % CP = % N x 6.38 Where: % N = percentage of nitrogen by weight; Vs = volume of HCl used for titration of sample; Vb = volume of HCl used for titration of the blank; % CP = percent of crude protein Butter fat and protein yields were calculated by multiplying each percentage by the average between morning and evening milk yield.

Thermoregulatory Measurement

Vital health parameters such as Heart Rate (HR), Rectal Temperature (RT) and Skin Temperature (ET). Measurements were taken at 08.00 to 10.00h and 14.00h to 16.00h of the day. The skin temperature was measured by placing the digital thermometer in direct contact with the body of the animal. Respiratory rate was measured using a stethoscope while RT was measured using a thermometer.

Data Analysis

All descriptive statistical analyses (Mean, coefficient of variation and standard error of mean) and T-test were done using R commander (2016) Software. The least significant difference procedure for mean comparison was used to rank the means after a significant effect (P<0.05) was observed.

RESULT AND DISCUSSION

Table 1 shows the variations in milk production traits of Jersey and Brownswiss in Adamawa State. Milk production and efficiency traits were greatly influenced (P<0.01) by the genotypes of cows in Adamawa State, with the exception of 305FCM per cows per day protein yield, lactation length, net energy efficiency and dairy merits. Brown Swiss had the heaviest milk weights and fat yield, than Jersey cows. Brown-Swiss had significant (P<0.05) higher respiratory rate than Jersey cows though rectal and skin temperature were similar. The characteristics estimating the efficiency of milk production in genotypes of cows in Adamawa State were highly variable (CV=22.79 – 40.02 %).

The variations of milk production traits between pure Brown-Swiss and Jersey cows in our study may be attributed to the fact that such parameters were not adjusted for differences in days open for cows. Days open in current lactation has been reported to have a significant effect on lactational production (Lee et al. 1997); however, proper adjustment for current days open is difficult. Fewer days open causes decreased lactational production, but increased lactational production causes more days open. The present study contradicts former trials, which evidenced the heat-stress resistance of pure Brown-Swiss (Calderón-Robles et al. 2011). Furthermore, Brown-Swiss cows showed less sensitivity to heat stress than Jersey cows, which might be attributed to their coat colour and stature. Jersey and Brown-Swiss have a light brown colour, which reduces the inward flow of heat than black cows (Finch 1986), producing less metabolic heat, and were reported to have a higher rate of cutaneous evaporation, which resulted in a lower skin temperature (Armstrong et al., 2008). The influences of the ambient temperature on production traits have been reported by establishing critical ambient environments for the animal (Berman et al., 1985).

Table 2 shows the correlations, and of milk production traits for Jersey purebred (above diagonal) and Brown Swiss (below diagonal) cows in Sebore farm in Adamawa State. In Jersey breed, LL was significant ($P<0.05$), high and negatively correlated with milk yield ($r= -0.65$) and moderately correlated with MYCD ($r = -0.28$). This implies that selection for increase in milk yield will cause a decrease in LL. 305 d FCM had significant ($P<0.05$), positive and moderate correlations with 100 dMY (0.30) and MYCD (0.21). Positive, significant and very strong correlations existed between PY and 100 dMY ($r = 0.43$). Thus, selection for PY should result in improvement in the 100dMY. In Brown Swiss, higher estimates were obtained for 305 d FCM, 100 dMY and fat yield than Jersey breed but converse trend were recorded for MYCD, protein yield and lactation length. The 305 d FCM had positive, highly significant ($P<0.01$) and high positive correlations with 100 dMY (($r = 0.49$) in Brownswiss cows. This implies that selection for part period milk yield will cause a corresponding increase in milk volume at 305 days of full lactation cycle. Positive, significant ($P<0.05$) and moderate correlation was obtained between 305 d FCM and fat yield ($r =0.23$) and with protein yield ($r =0.26$). Strong and positive phenotypic correlation was obtained between protein yield and LL ($r =0.56$) while genetic correlation between 100 dMY and MYCD ($r =0.02$) had near zero correlation. The moderate to high positive correlations between 305dFCM and 100dMY and MYCD except in the lactation length where the correlation was antagonistic is an indication of pleiotropic effect indicating that the same set of genes are responsible for the milk production. High and positive positive correlations between 305dFCM and milk production traits agree with the report of Hammami *et* *al*. (2009) for dairy cows. Low and positive correlations between 305dFCM and milk production traits agree with some reports in literature (Hammami *et al*., 2009). The correlation between 100dMY and 305 day fat corrected milk yield was high and significant which implies that early milk production could be used to predict later milk production. High and positive correlations between 305dFCM and milk production traits agree with the report of Hammami *et al*. (2009) for dairy cows. Low and positive correlations between 305dFCM and milk production traits agree with some reports in literature (Hammami *et al*., 2009).

Table 1: Least squares means (±standard error) and coefficient of variation of milk production and efficiency traits among different genetic groups of cows in Sebore herd in Adamawa State

Traits	Jersey	Brownswiss	CV %	SEM
Dairy performance				
Milk yield (kg)	1668.4±50.41[b]	1780.4±54.61[a]	17.54	86.71
305 FCM /cow/per day(kg)	4.9±0.25	5.3±0.35	22.35	1.21
100d FCM (kg)	609.8±8.07[b]	642.8±8.88[a]	13.76	10.45
Fat yield (kg)	30.4±2.04[b]	35.2±2.22[a]	40.03	3.85
Protein yield (kg)	24.3±2.35[a]	21.7±1.46[b]	40.02	4.46
Lactation length (days)	342.3±6.84	334.5±4.15	11.09	9.60
NEE (%)	36.7±1.18	31.9±0.72	22.79	1.67
Dairy Merit (%)	54.4±0.74	54.9±0.63	8.14	1.65
Thermoregulatory traits				
Rectal temperature (°C)	39.84	39.95	8.22	4.62
Respiration rate (bpm)	69.44[b]	87.22[a]	26.1	5.02
Skin temperature (°C)	35.77	36.94	3.07	10.6

[ab]Means of the same trait across genetic groups with different superscripts differ significantly ($P<0.05$); SEM-Standard of error

Table 2: Correlations of milk production traits for Jersey purebred (above diagonal) and Brown Swiss (below diagonal) cows in Sebore farm in Adamawa State.

Parameters	**305dFCM**	**100Dmy**	**MYCD**	**Fat yield**	**Protein yield**	**Lactation length**
Milk yield	**1**	0.30*	0.21*	-0.12	0.17	-0.65**
100dMY	0.49**	**1**	0.10	0.26*	0.43**	-0.17
MYCD	0.10	0.02	**1**	0.09	0.10	-0.28*
Fat yield	0.23*	0.21*	0.32*	**1**	0.17	0.28*
Protein yield	0.26*	0.18	0.30*	0.19	**1**	0.25*
Lactation length	-0.10	0.31*	0.55**	0.03	0.56**	**1**

* = P<0.05: ** = p<0.01; 305dFCM -305 day fat corrected milk yield; dMY-day milk yield; MYCD-Milk yield per cows per day; J-Jersey (upper)

Conclusion

This study revealed that Brown-Swiss cows had superior milk and fat content, than Jersey cows. Furthermore, pure Brown-Swiss were robust and can better tolerate the adverse conditions of heat stress in Adamawa.

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