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Original Research Article

Effect of Production Systems on Milk Yield and Calf Performance in North Kordofan State, Sudan

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Abstract: This study was conducted in two locations, Kazgail and Um arada, Sheikan locality, North Kordofan State, Sudan. Objective of the study to evaluate the effects of production system on milk production and quality and calf performance. Thirty (30) dairy cattle were employed in this experiment. Cows were weighed and divided into two groups each with Fifteen (15 cow) in complete randomized design. Group A was located in Kazgail village and considered as close production system and group B in Um arada village as open production system. Data were analyzed by using T test for analysis of variance procedures and least significant difference (LSD) for mean separation. The results revealed that production system significantly ($p<0.001$) affected milk production, where group A had maintained higher milk yield compared with group B. the respectively milk yield were 153.60 and 65.57 Lb for Group A and B respectively. Results showed significant differences ($p<0.05$) between systems for the milk quality during first and second month of lactation period on fat content (4.67 vs 4.87%) for A and B groups respectively and lactose content (4.61 vs 4.77%) for A and B groups respectively. Results revealed that calves birth weight significantly ($p<0.05$) affected by production system. The mean birth weights were (35.58 vs 31.98 kg) for A and B groups respectively. The study demonstrated that production system had no significant effect on weaning weight. Results showed that production system significantly ($p<0.05$) affect daily body weight gain. In conclusion, dairy cattle in different production system; showed variable milk production during lactation period and variation in milk composition during three month.

Keywords: Production system, milk production, milk composition, calf, birth weight, Sudan.

INTRODUCTION

Sudan comprises one of the most important livestock species and plays a major role in the livelihood and providing food security of large amount of protein to small farmers and nomadic, and also provide income resource for poor people which caters their day-to-day social and economic needs (Prathap *et al*., 2017). Dairying is an important enterprise for many countries of the world and is especially important source of income generation for rural families in the 3rd world agricultural countries. The production of milk from those cattle in different production systems is very low with increase in the population, urbanization and improved wealth may increase the demand for milk increases (Prathap *et al*., 2017; Tahir *et al*., 2013), and therefore, it is necessary to adopt new and different strategies in animal production to increase productive performance (Arnould *et al*., 2013; Hammami *et al*., 2009). Milk production systems vary between and within agro-ecological zones (Kollalpitiya *et al*., 2012), the variation is due to differences in management system, physical environment, social-economic status of producers, relative cost of labor, nutrition economics, available reproductive technologies and breeding costs and the regulatory environment with adaptability and genetic composition of cattle (Ali and Yilma., 2015).

The majority of Sudanese cattle breeds are kept by nomadic or semi-nomadic people. Generally the systems of production for cattle in Sudan are not well

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characterized, the traditional range grazing system that includes the pastoral and semi-pastoral types is considered to be the most common as under which more than 80% of livestock is raised (Yousif and Fadl El Moula, 2006). The other improved system was newly intervened round some towns depended on concentrate and cultivated lands (zero grazing), so milk production is one of main issue for the production system. The production from both systems has remained comparatively lower than those from other areas of the world due to inadequate feeds both in quality and quantity and poor management of husbandry practice (Fadall, 1999). Birth weight, total milk yield, average milk yield per day, is the important parameters that determine cattle reproductive and productive efficiency and these are important factors in terms of economics of dairy management (Kollalpitiya *et al*., 2012). Development of the dairy sector may positively affect the lives of many people, as production is spread widely over the rural population. Therefore, the aim of the present research was to investigate the effect of systems of production on daily milk yield, milk quality, calf birth weight and weaning weight in North Kordofan State, Sudan.

MATERIALS AND METHODS

Study area

The experiments carried out at two locations, Kazgail and Um arada, Sheikan locality, North Kordofan State, Sudan (Latitudes 11^{o}:15'-16o:30'N; Longitudes 27-32^{o}E). Average temperature varies between 30-35^{o}C during most of the year with peaks of above 40^{o}C during April, May and June. The rainy season extends from July to October with maximum rainfall in August. Long-term averages annual rainfall is about 280 mm. Soils vary from sandy in the north to heavy cracking clay in the south (Technoseve, 1987).

Experimental animals and management

Thirty (30) dairy cattle were employed in this experiment. The dairy herds compass of local and cross breeds. The cows were divided into two equal groups of 15 each (A and B,) according to their body weight. Group A was located in Kazgail village and considered (zero grazing), where cows are housed indoors with no access to pasture, but cows were offered the roughage with full requirements and supplemented with concentrate. Group B (open system) was located in Um arada village was managed according to the prevailing traditional system where cows had access to pasture depending mainly on grazing with no supplementation. Group B was daily turned to grazing from 8.00 a.m to 6.00 p.m. All animals were vaccinated against foot and mouth disease, Anthrax and Hemorrhagic Septicemia. Internal and external parasite was treated too. The two groups were housed in partially shaded pens. The pen for group A was equipped with feeders and water troughs with clean water. Inside each enclosure the animals were kept together at sufficient distance space, and offered feed and water in gathered troughs. Calves were kept in a separate enclosure during the night and left with their dams during the morning and evening to suckle their mothers for milk let down.

DATA RECORDING

Data from 30 dairy cattle were taken after calving, and arranged according to system of production. The calf birth weight and growth performance to weaning was followed and measured by measuring the girth width using a weight band. The cows were milked twice a day by hand at morning for 90 consecutive days. The daily, monthly and total milk yield per lactation (kg) was calculated for each cow.

Fresh milk samples (20 ml) from each cow/group were collected were taken at monthly interval and kept in a refrigerator adjusted at 5°C for chemical analysis for three months. The analysis has been done according to methods of AOAC (1990), in the laboratory of Juod factory of ELObied, North Kordofan state.

STATISTICAL ANALYSIS

The data was analyzed statistically according to the analysis of variance procedure using the General Linear Model (GLM) applicable to the experimental design of a 2x2 Factorial of complete randomize design (Snedecor and Cochran, 1982) by using the Statistical Package for the Social Sciences software package (SPSS, 2005). Mean comparison was done using the Least Significant Difference (LSD) for parameters with significant difference. Differences were considered statistically significant at 5% level of significant.

RESULTS

Effect of system of production on milk production

Results of effect of husbandry system on milk production were presented in Table (1). The follow of lactation period of the two systems of production indicated that close system produce significant ($P<0.05$) a highly milk production three months post calving compared with grazing system. The respective yield was 24.98, 23.26 and 20.03kg for close system and 12.06, 10.09 and 6.99 kg for open system. The cows in close system had registered highest significantly ($P<0.05$) more milk (39.13 kg) than those in group open system. The least total milk (29.14 kg) and daily milk (0.32 kg) was produced by the open system and which was significantly less than close system production ($P<0.05$) with high total milk yielding (68.27 kg) and daily milk (0.76 kg).

Effect of system of production on milk composition

The effect of system of production on milk chemical composition of experimental cows was illustrated in Table (2). The data indicated that system of production had exerted a significant ($P<0.01$) effect on fat content during first month (4.67 vs 4.87) for zero grazing and open grazing respectively and lactose during second month of lactation (4.77 vs 4.61) for zero

grazing and open grazing respectively. On other hand, system of production had no significant effect on protein, fat and lactose during second and third months of calving.

Table-1: Effect of system of production on milk production

Production system	No.	1st month	2nd month	3rd month	Total milk/kg	Daily yield/kg
Close system	15	24.98[a]	23.26[a]	20.03[a]	68.27[a]	0.76[a]
Open system	15	12.06[b]	10.09[b]	6.99[b]	29.14[b]	0.32[b]
Overall mean ± SE	30	18.52±14.53**	16.68±14.82**	13.51±14.67**	48.70±44.02**	0.54±0.48**
[ab] Values in same column with different superscripts differ at P<0.001						

Table-2: Effect of system of production on milk composition

Production system	No.	1st month			2nd month			3rd month		
		Lactose	Protein	Fat	Lactose	Protein	Fat	Lactose	Protein	Fat
Close system	15	4.75	3.61	4.67[b]	4.61[b]	3.49	4.62	4.71	3.64	4.76
Open system	15	4.80	3.57	4.87[a]	4.77[a]	3.35	4.69	4.77	3.68	4.66
Overall mean ± SE	30	4.77±.03	3.59±.02	4.73±.06*	4.69±.08*	3.42±.07	4.66±.03	4.74±.03	3.66±.02	4.71±.05
[ab] Values in same column with different superscripts differ at P<0.05 and P<0.001										

Effect of Production system on calf birth weight

The data on birth weight of calves as affected by system of production are shown in Table (3). The production type, had highly significant (p<0.05) effect on calf birth weight whereas, calves from zero grazing rearing had registered highly body weight 35.58 kg compared to other animal in traditional grazing with lower body weight at birth as 31.98 kg.

Table-3: Effect of production system on calf birth weight

Production system	No.	Birth weight
Close system	15	35.58[a]
Open system	15	31.98[b]
Overall mean ±SE	30	33.78±1.80*
[ab] Values in the same column followed with different letters are significant at P<0.05		

Effect of production systems on calf weaning weight

The effect of production systems, on calf's weaning weight and body weight gain were demonstrated in Table (4). System of production had no significant effect on body weight at weaning. Whereas total body weight and daily weight gain were significantly (p<0.05) affected by the mentioned parameter. Open system secured higher (p<0.05) daily gain as 349.67 g/h/day compared with close system 318.33g/h/day.

Table-4: Effect of production system on calf weaning weight (kg)

Production system	No.	Weaning weight/kg	Total body weight gain/kg	daily body weight gain/g
Close system	15	64.23	28.65[b]	318.33[b]
Open system	15	63.45	31.47[a]	349.67[a]
Overall mean ± SE	30	63.84±0.39	30.06±0.55*	334.00±0.64*
[ab] Values in same column with different superscripts differ at P<0.05&0.001				

DISCUSSION

Effect of system of production on milk production

In the last two decades, the dairy sectors have faced new challenges regarding sustainability issues. The current challenge is to improve the economical efficiency of dairy cows by improving and increase milk production and lowering costs (Arnould *et al*., 2013). The results of this study on the effect of management system on milk production showed that milk production and daily milk from zero grazing system (improved) had higher yielding compared with traditional system (open grazing) this results with line of Chataway *et al*. (2010), Kollalpitiya *et al*. (2012), El-Awady (2013), Nalubwama *et al*. (2016) and Ahmad *et al*. (2017) who reported that management conditions have pronounced effect on milk production and reproduction.

High milk production from zero grazing animals may be due of adding concentrate to fill the gap of low nutritive value of roughage that was offered to them and of the good management practice in zero grazing system. This result similar to Kollalpitiya *et al*. (2012), Ahmad *et al*. (2017) and Nalubwama *et al*. (2016) who stated that cows were fed with higher quality feeds that possibly met the cows' requirements to a higher degree of milk production. Contrast to this results Grimaud *et al*. (2007) they documented that cows kept under tethering system and fed with only natural pastures yielded less than those under zero-grazing systems. Differences in milk production in

cows managed in open grazing system may be associated with reduced quality and availability of feed provided to animals during dry periods that limit energy supply to the mammary tissue epithelium, and thus, mammary secretion of milk, same results was obtained by Williams *et al*. (2016), Also the Gillah *et al*. (2014) reported that the average milk yield was 7.0 l/day for grazing animals in tropics. Nilufar *et al*. (2017) who demonstrated that the low milk yield is attributed to poor nutritive values of feeds and improper feeding practices, which supply inadequate nutrients to meet the maintenance, production and reproduction requirements of the animal. Notes that at the early stage of lactation, dairy cows are in negative energy balance, and increase their feed intake to sustain milk production and to compensate for the mobilized body energy reserves, if not animal supplemented during late gestation to reserve energy for this critical period will reflect in low milk production.

Effect of system of production on milk composition

The analysis of milk composition could provide some interesting information about the efficiency of the feed management system (Boichard and Brochard, 2012). In this study milk composition were vary between two systems. That fat and lactose content were significant high in open system and the other content didn't affected by system of production. Similar results were obtained by different authors Zeleke (2007), Rutherford *et al.*(2009); Forsbäck (2010), Garmo *et al*. (2010) and Honorato *et al*. (2014) who stated that Fat and total solid contents were greater in the intensive farms than in the open farms may be due to altered through management interventions such as changes in diet. On other side the results obtained here was disagreed with finding of Nilufar *et al*. (2017) stated that management practices had no significant effect on milk composition. Generally milk composition varies due to nutritional factors such as grain intake, dietary fat, energy intake, seasonal and regional effects, and dietary fat supplements (Jensen, 2002).

Effect of production system on calf birth weight

One of the important breed characteristic in cattle breeding is calf birth weight. Since birth weight is considered as an initial reference point with regard to subsequent development of individual as well as other characteristics (Bakir *et al*., 2004). The mean calves birth weight in this study was higher than that achieved by Moaeen-ud-Din and Bilal (2017), Abera *et al*. (2012), Menale *et al*. (2011) Fogera calves (20.7±0.11 kg), Addisu *et al*. (2010) and lower then that reported by Johanson and Berger (2003) 40.84 ± 4.9 kg, Kollalpitiya *et al*. (2012) 35 kg.

In this study the birth weight of calves was affected by production system which agreed with Menale *et al*. (2011) and Addisu *et al*. (2010). Research has shown that the birth weight of the calf would be approximately 7% of the dam's body weight (Westhuizen and Bergh, 2014). Calf from zero grazing was heavier than that from open system (35.58 vs 31.98 kg) similar results obtained by Kollalpitiya *et al.* (2012) and Abera *et al.* (2012). Also agreed with Bakir *et al*. (2004) reported the effect of farm on birth weight highly significant and he concluded that the difference between farms could be attributed to feeding, climate and maintance conditions and farming practices, additionally it may be due to the differences between environments in particular age, management practices and inconsistencies in feed availability.

Effect of system of production on calf weaning weight

The overall least squares mean weaning weight and body weight gain in this study were 63.84 kg and 314.30g/day was higher than what reported by Getinet *et al*. (2009) and lower than mentioned by Hernandez-Hernandez *et al.* (2015) and Moaeen-ud-Din and Bilal (2017). In cattle and other mammals the calf and the dam contribute to the weaning weight. Growth during the suckling period is affected both by the calf which growth is measured and by the dam which provides the developmental environment (Segura-Correa *et al*., 2017). In this study the weaning weight did affected by production system, while body gain did. These results disagreed with Habtamu *et al*. (2008) and Abera *et al*. (2012). Significant body gain as reported by Abera *et al*. (2012) and Sousa *et al*. (2015). Low weaning weight reported here may be is associated with differences in management practices and geographical differences as well as maternal ability of the breeds used in each study.

Generally early weaning management programs can be practical and profitable for cow–calf operations. Compared to weaning at a normal time, early weaned (EW) cows experience improved body condition and greater body weight (BW) gain during the breeding season (Sousa *et al*., 2015).

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