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Influence of season of birth and parity order of lactating Desert goat during dry period

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Abstract
The effect of season of birth and parity order on growth, body weight change, litter size and milk yield and composition of Sudanese desert goats has been studied. The experiment was conducted with Desert goats in EL Obied locality, Northern Kordofan state. Twenty eight (28) adult doe's of Desert goats were used in experiment. The does were divided into two groups, G1 and G2, with 15 and 13 dams, respectively according to parity number for 2nd and 3rd parities respectively. All does in all groups were subjected to natural grazing. The results indicated that the effect of season of birth on body weight before kidding, at kidding, weaning and body weight change were not significant, where high weight secured by does kidded during rainy season as compared with does kidded in dry season. High lost in weight seen in does kidding during dry season as 7.90%. Also the results revealed that parity order significantly (P<0.05) effect the body weight at kidding, high weight in 3rd parity (25.31 kg) as compared with 2nd parity (23.98 kg). The results indicated that litter size significantly (P<0.05) affected by season of birth and parity order, high litter were observed in rainy season and in 3rd parity, the respective were 1.5 and 1.58. The season of birth significantly (P<0.05) effect milk production. High milk production was noticed in rainy season kidders as compared with kidders in dry season. The variation in total milk production between rainy and dry season kidder were 2.77%. The results indicated that parity order did not affect milk production and milk composition.

Keywords: goat, Desert, range, season of birth, parity order, body change, reproductive, Sudan

Introduction
Goat ruminants play a crucial role in food production and provide meat and milk and its products and contribute in developing countries (Simela & Merkel, 2008) [60]. Mean, while Sudan has one of the largest population of goat estimated to be about 44 million head, and about 4 million are found in north Kordofan (MARF, 2012) [39]. Sudanese desert goats are kept and raised for meat production especially in rural areas and they also provide some milk for family needs and household cash income for smallholder farmers (Galal, 2005; Toplu and Altinel, 2008) [26, 66]. Low genetic potential, non-genetic factors and lack of adequate management are among the factors that threaten the productivity of desert goats. Thus, non-genetic factors that affecting the economic viability which are associated with growth, body weight are the most economically important and easily measurable trait that require particular attention in any breeding program aiming at improving the productivity of goats, especially meat type (Moaeen-ud-Din *et al.*, 2008) [48]. The reproductive activities during the pre- and post-partum period are good indicators of the overall reproductive and productive performance of an animal (Delgadillo, 2007 and Hossain *et al.*, 2003) [22, 30]. This should have an impact on productivity trait of goats, as body weight pre and post kidding, birth weight and weaning rate (Mahgoub and Lu, 2004) [37].
Under tropical environmental conditions, the main factor influencing the productivity of goat's flocks is climatic seasonality. Since raising goats under extensive conditions implies that environmental factors and their interactions are of central importance and they determine the levels of performance and productivity (Bushara *et al*., 2013 and Nassif and El Amiri, 2011) [14, 50]. The supply of nutrients from the veld fluctuates between years and seasons, so when basic requirements are not fulfilled goats start to use body weight loss, this might be reflected on goat's productivity performance (Ramirez-Perez *et al*., 2000) [56]. Also better reproductive performance and milk production increased significantly with increasing age and parity of the dam which has great effect on birth weight and all growth traits (Mellado *et al*., 2006) [43]. Therefore, any breeding scheme aiming to improve the overall productivity of Sudanese desert goats must first identify the influences of non-genetic factors that hinder the growth rate before applying the strategy, because environmental factors can overshadow the potential of genetic factors. Therefore, the present study was to assess the effects of non-genetic factors like season of parturition and parity order on pre and post growth, weaning weight, litter size and milk production of Sudanese desert goats in North Kordofan, Sudan.

Materials and Methods
The experiments carried out in EL Obeid in North Kordofan State, Sudan (Latitudes 11º:15'-16º:30'N; Longitudes 27-32ºE). Average temperature varies between 30-35ºC during most of the year with peaks of above 40ºC 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 (Technoseve, 1987).

Experimental animals
Twenty eight (28) adult doe's Desert goats were employed for this experiment. The goats are purchased from local market around

that area. The does were of different in age with a range of >1 year to three years of age, with average body weight of 21.4 kg. On arrival they were divided into two groups G1 and G2, with 15 and 13 dams, respectively according to parity number for 2nd and 3rd parities respectively. All the groups were eared tagged and treated against endo- and ecto- parasites, vaccinated against diseases endemic to the area such as anthrax and Hemorrhagic septicemia and drenched with broad spectrum anthelmintic (Ivomic). The Two groups were housed in partially shaded pens, constructed from local materials of woods. Each pen was equipped with clean water troughs. The animals were allotted to free grazing (from 8:00 am to 6:00 pm). Live weight was weekly recorded before kidding and post kidding (12 weeks). Milk yield, milk compositions were also monitored up to three months. The analysis for milk composition was done according to methods of AOAC (1990) [4], in the laboratory of Animal Production of ELObied agricultural Research Station, North Kordofan state. T-test was used to analysis of data from reproductive traits from the experiment. All techniques of the statistical analysis were conducted using Statistical Package for the Social Sciences, software package (SPSS, 2005) [61].

Results

Effect of season of birth and parity on the body weight at kidding, at weaning and body weight changes

The data in Table (1) indicated the effect of season of birth and parity order on body weight of the does at kidding, at weaning time and body weight change. The results indicated that season of birth did not affect body weight of does before and after kidding. Does that have been born during rainy season had better body weight before kidding, at kidding and weaning compared with does been born during dry season. The does that had 3rd parity secured higher body weight at one week before kidding and weaning compared with does that kidded twice. The results showed that the body weight at kidding was significantly (P<0.05) affected by parity order, where higher body weight were obtained by 3rd parity groups (25.31 kg) compared with 2nd parity group (23.98kg). The results showed that the dams experienced variable body weight losses imposed by season of birth and parity order.

Table 1: Effect of season of birth and parity on the body weight at kidding, weaning and body weight changes

variables	N	Body wt before kidding	Body wt at kidding	Body wt at weaning	Body wt change	%change
Season of birth						
rainy season	18	27.87	23.87	23.87	-1.10	4.41
dry season	10	27.07	22.28	22.28	-1.91	7.90
Overall mean ± SE	28	27.24±0.60	23.3±0.73	23.3±0.73	1.93±0.69	6.16
Parity order						
2nd parity	15	26.90	23.98[b]	21.85	-2.13	8.88
3rd parity	13	28.37	25.31[a]	22.83	-2.48	9.80
Overall mean ± SE	28	27.24±0.56	24.65±0.64*	22.34±0.73	2.31±0.54	9.34

ab Values in same column with different superscripts differ at P<0.05

Effect of season of birth and parity on litter size of desert does

The data highlighting the effect of season of birth on litter size is displayed in Table (2). The results suggested that the does gave significantly (P<0.05) a bigger litter size (1. 5) during rainy season kidding as compared to does kidding during dry season (1.00). Out of the all kids born, 72.9% kids were born during the rainy season and the remaining 27.1% kids were born in the dry season. Parity order significantly (P<0.05) affected litter size, with beigest litter secured with 3rd parity (1.58) compared with litter size in 2nd parity (1.13).

Table 2: Effect of season of birth and parity on litter size on desert goats

variables	No. of does	No. of kids	Litter size
Season of birth			
rainy season	18	27	1.50±0.11[a]
dry season	10	10	1.00±0.16[b]
Overall mean ± SE	28	37	1.32±0.08*
Parity order			
2nd parity	16	19	1.13±0.09[b]
3rd parity	12	18	1.58±0.15[a]
Overall mean ± SE	28	37	1.32±0.08*

ab Values in same column with different superscripts differ at P<0.05

Effect of season of birth and parity on milk yield

Table (3) showed the effect of season of birth and parity number on total milk yield. Season of birth was secured significantly (P<0.05) affected milk production. Does that kidder during rainy season give higher milk yield in 2nd and 3rd month of lactation period. Highest daily milk production recorded by does kidding during rainy season as 0.32 kg compared with that kidded in dry season 0.26 kg. Parity number exerted non-significant (P<0.05) effect on both total and daily milk yield. Does that have kidded 3rd parities, however produced more milk compared to 2nd parities kidder, the total milk yielding of 2nd and 3rd parities kidders were 26.72 and 27.82 kg respectively. The daily yielding of the 3rd and 2nd parities amounted were 0.29 and 0.30 kg respectively.

Table 3: Effect of season of birth and parity on milk production/kg

variables	N	1st month	2nd month	3rd month	Total milk	Daily milk
Season of birth						
rainy season	18	6.44	10.30[a]	12.46[a]	29.17[a]	0.32[a]
dry season	10	6.28	8.04[b]	9.62[b]	23.95[b]	0.26[b]
Overall mean ± SE	28	6.32±0.46	9.49±0.61*	11.45±0.63	27.31±1.45*	0.30±0.02*
Parity order						
2nd parity	15	6.17	9.10	11.45	26.72	0.29
3rd parity	13	6.57	9.84	11.45	27.82	0.30
Overall mean ± SE		6.38±0.46	9.49±0.66	11.45±0.72	27.31±1.56	0.29±0.02

ab Values in same column with different superscripts differ at P<0.05

Effect of season of birth and parity on milk composition

The effect of season of birth and parity order on milk chemical composition of experimental goats is illustrated in Table (4). The season of kidding exerted non significant effect, on milk composition, whereby, does that kidded during the dry season had the highest fat content 3.43 compared with rainy season kidders 3.42. Same results in the lactose content which was highest in does kidding in rainy season (3.93) compared to dry season kidders (3.63). The milk components including crude protein and ash content are not also affected by season of kidding. The parity order also exerted non significant effect, on milk composition, whereby; that protein and lactose content was highest for does kidded three time 3.59 and 3.95 respectively compared with 2nd parity kidders 3.26 and 3.71 respectively. Same results in the fat and ash content were not affected by parity number.

Table 4: Effect of season of birth and parity on milk composition

variables	N	Fat	Crude protein	Lactose	Ash
Season of birth					
rainy season	18	3.42	3.40	3.93	0.81
dry season	10	3.43	3.43	3.63	0.81
Overall mean±SE	28	3.43±0.18	3.41±0.14	3.82±0.18	0.81±0.01
Parity order					
2nd parity		3.33	3.26	3.71	0.81
3rd parity		3.52	3.59	3.95	0.81
Overall mean±SE		3.42±0.10	3.41±0.13	3.82±0.17	0.81±0.01

Discussion

Effect of season and parity on kidding weight, weaning weight and weight changes

The effect of season on growth rate and reproductive performance of the goats has been reviewed by many authors Madibela *et al*. (2002) [36], Dadi *et al*. (2008) [19] and Bushara and Abu Nikhiala (2012) [12] they indicated that seasonal effects on body weight change results from seasonal availability of quality grazing. In the present experiment the season did not affected body weight growth, although the high body weight of does was obtained during rainy season, any way the season effect on body weight change this could be due to the changing nutritional status of the animals with the seasonal availability of green grasses. Same results were obtained by Bushara *et al*. (2013) [14] or maybe probably had enough feeds from grasses, trees weeds and shrubs, and this reflected that natural grazing supplied enough nutrients to meet the requirements, these results in agreement with Bushara *et al*. (2013) [14]. It has been reported that during late pregnancy there is preferential nutrient utilization for foetal growth at the cost of mobilization of maternal body tissues (Rojo-Rubio *et al*., 2016) [57] and results in weight loss of doe if the dietary supply of nutrients is inadequate (Al-Totanji and Lubbadeh, 2000) [1]. Observation of low body weight of does kidding during the dry season, may be due to unavailability of feed in dry season or due to low nutrients value of grasses as they get mature, however the doe may conceived in late rainy season and faced the long pregnancy period with decline of the nutritive value in grazing pasture during dry season. This results in match with Mshelizah *et al*. (2015) [49] and Mbahi *et al*. (2006) [42] who stated that raised animal on natural pastures which decline rapidly in quantity and quality during the dry season and such seasonal variation in nutritional status result in irregular growth and weight gain in animal. Does kidding during the dry season lost big mass of body weight and this may be due to decline nutritive value of the grasses which affect body condition score that faced the lactation period, same studies reported by Malau-Aduli *et al*., (2003) [38].

The parity order affected body weight at 8 weeks before kidding, but days after that showed no significant influence on body weight growth. In spite of the effects, does with third parity were heavier during all period of gestation than does with second parity, this-results agreed with Thiruvenkadan *et al*. (2011) [65], however these-result is in contrast with Bagnicka *et al*. (2007) [6] and Annor *et al*. (2012) [3] who reported that parity of dam significantly affects all the production performances. Parity order did not affect weight at kidding, where does that had 3rd parities were heavier than does of 2nd parities, same trend was reported by Hossain *et al*. (2003) [30] who reported that postpartum weight increased with increasing parity number, but weaning weight was affected significantly by parity number, where does with 3rd parities had higher weight compared with 2nd parities, because there was a tendency to increase weight with the advance of parity and age, due to increase of digestive system which mean more feeds, this results on line with Paul *et al*. (2014) [54]. More lost in weight in 3rd parities does, this results contrasted by Bushara *et al*. (2011) [11].

Effect of season of birth and parity on litter size of desert does

The average litter size for Desert goat in this study was 1.32±0.09; this result is lower than that obtained by Bushara *et al*. (2017c) [13] for same breed (1.50) and for Taggara goat (1.42), Sumartono *et al*. (2016) [62] 1.75, Pan *et al*. (2015) [53] and higher than that obtained by Mengistie *et al*. (2013) [44] for Central Highland goats (1.16±0.04) and Rojero *et al*. (2005) [58] for Celtibernan (1.1). The season of birth significantly affected litter size, does that kidding during the rainy season maintained higher litter size compared with dry season kidders, This result complies with several authors, Madibela *et al*. (2002) [36] and Dadi *et al*. (2008) [19]. Contrast to Mengistie *et al*. (2013) [44] who reported large litter size during hot dry season. The large litter size during the rainy season could be due to the availability of green folder grasses and forages during conception which resulted in higher body condition score and body weight at mating which in turn increases the number of ova shed and fertilized. This result complies with several authors (Bushara *et al*., 2013; Dadi *et al*., 2008; Mellado *et al*., 2006) [14, 43, 19], and the low litter size during dry season may be due to high temperature occurring during dry season which delay feed intake, these results agreed with Marai *et al*. (2008) [40] who reported that the heat-induced loss of appetite.

Parity of doe had showed significant difference in litter size that higher parity does gave higher litter than lower parity ones. This agrees with the research findings of Pan *et al*. (2015) [53], Hasan *et al*. (2014) [29] and Mengistie *et al*. (2013) [44] whom stated that the largest litter sizes achieved at about sixth parity. Hossain *et al*. (2004) [31] has also reported an increase litter size for 2nd parity was 1.76 and for 3rd was 1.96, and he suggested that the increase litter size from 1st parity up to 3rd parity. The highest litter size may be due to that advancement in age of does improve weight results in improved ovulation rate, uterine capacity and other maternal traits affecting the reproductive efficiency which in turn increases fecundity. Generally the reduction in litter size observed in the present study in does was possible due to a reduced ovulation rate in this group of does. Some authors have provided evidence of a retarded fetal folliculogenesis by maternal malnutrition, or may be due to low body weight during ovulation (Rae *et al*., 2001) [55].

Effect of season of birth and parity on milk yield

Milk production and composition are more depending on composition of the diet fed to animal, the energy balance and energy reserved of the animal. The average total milk production for Desert goats in this study was 27.30±1.97 kg, this is equivalent to 0.30 kg per day in a lactation period of 90 days, this level of production was comparable to that reported by Bushara *et al*. (2011, 2010) [11, 15] for Taggar goats, and lower than that reported by Berhane and Eik (2006) [8] for Feral goats, and higher than that reported by El-Abid and Abu Nikhaila (2010) [23] and Degen (2007) [21].

The effect of season of kidding on total milk yield and daily yield revealed variations in average total milk yield in 90 days between different seasons of years, goats kidded in rainy season produced higher milk yield compared with the milk yield of goats kidded in dry season, this was in agreement with the findings of Hamed *et al*. (2009) [28], Kondyli *et al*. (2012) [35], Salari *et al*. (2016) [59] and Bushara *et al*. (2011) [11] whom reported that does kidding in wet rainy season had higher lactation milk yields and longer lactation length compared with does kidded in dry season. The high milk production during the rainy season may be due to the availability of forages in the wet season; this is on line with Bhatta *et al*. (2015) [9], El-Abid *et al*. (2009) [24] and Caricella *et al*. (2008). The low milk yield during the dry season may be due to unavailability of pasture and increased ambient temperature reduced the dry matter intake that condensed both quantity and quality of milk, which agree with the finding of Bhatta *et al*. (2015) [9] and El-Abid and Abu Nikhaila (2010) [23].

Parity of doe at kidding influences milk yield (Norris *et al*., 2011). Milk production analysis of variance shows that there were no significant differences between total milk yields and daily milk yield of different parities, these results agreed with El-Abid and Abu Nikhaila (2010) [23] and Olechnowicz and Sobek (2008) [52], however, these results were contradicting the findings of Assan (2014) [5], Goetsch *et al*. (2011) [27] and Kaskous *et al*. (2015) [33] reported that the daily milk yield increased with parity as 0.58, 0.93 and 1.13 kg for 1st, 2nd and 3rd parity for Maltese goat in Italy. According to Klir *et al*. (2015) [34] and Carnicella *et al*. (2008) [17], amount of milk significantly increases with the parity. The increase in milk yield with age and parity in producing goat's because as the age of the animal increases, the hormonal status of the animal body, metabolic activity, improvement in the udder and secretory cells and nutrient intake which are used in milk synthesis increase too and increase in its size during the trimester of pregnancy due to increase in hormonal activities (placenta lactogen) with the increase in the size of the placenta in advanced parity producing goat compared with the small parity producing ones or might be due to variation of lactation lengths of different parities and variation of prevailing climatologically conditions for each parity (Capuco *et al*., 2001) [16], which agreed with Kaskous *et al*. (2015) [33] and Carnicela *et al*., (2008). Generally Tropical breeds have low milk yield due to their low genetic potential and prevailing environmental conditions like stress caused by harsh weather and diseases.

Effect of season of birth and parity on milk composition

Differences in the milk composition of goats have been attributed to factors such as age and availability of nutrition. The season of birth showed non-significant effect on milk composition. Milk fat is most susceptible to dietary variations and can vary over a range of nearly three percent (%). According to some previous workers dietary variations result in milk protein concentration varying at about 0.60 percent (Millogo *et al*., 2009) [46], however, these results were contradicting the findings of Alawa and Oji (2008) [2] and Bushara *et al*. (2013) [14] who found significant high fat and lactose in rainy season compared with cool dry season. The mean value of fat was lower in the dry season and higher in the wet season; this might be due to nutritional status of the animals during wet season, where feeds are available and richer in minerals and vitamins, which confirmed by Marín *et al*. (2011) [41] who reported that the reduction in fat and protein concentration in goat milk has been a result of hot or warm ambient temperature. On the other hand, Szymanowska *et al*. (2002) [63] and Czarniawska-Zajac *et al*. (2006) [18] found that milk produced over the winter months contained significantly more fat and protein, and significantly less lactose. According to Prasad *et al*. (2005) seasonal effects in milk composition may arise from the feed that may vary with the fodder consumed by

the goats, which is mainly dependent on the climatic conditions of the area.

The parity number exerted non-significant effect on milk composition. Results of protein and lactose and fat was highest for does kidded three times compared with does kidded twice, same results reported by, Mioč *et al*. (2008), Olechnowicz and Sobek (2008) [52] and Kaskous *et al*. (2015) [33] who stated that the components of the milk were not affected by parity. Results showed that the fat content tend to increase as parity increase this might be due to increase in age, similar reported showed by Bhatta *et al*. (2015) [9], Klir *et al*. (2015) [34], Bagnicka *et al.* (2015) [7] and Zahraddeen *et al*. (2008) [67] they found highest milk fat and protein yields were attained in the 3rd and 4th lactations from goats. Generally in dairy goats, because of their seasonal lactation, it is usual contents of lactose, protein and fat are high in early lactation, decrease as lactation peaks and increase when milk volume decreases towards late lactation (Mestawet *et al*., 2012 and Fekadu *et al*., 2005) [45, 25]. Regarding the milk composition, Bhosale *et al*. (2009) [10] observed gradually increase of protein, and fat percentage as lactation advanced, except lactose percentage in goat milk, from 1st to 4th parity. In this study may be the differences in composition due to lactation curve which agreed with Idamokoro *et al*. (2017) [32] who reported that, milk fat, protein, and solid non-fat were negatively correlated to increase in milk yield with advance lactation period.

Conclusions

It will be concluded that most of the traits considered were influenced by the non-genetic factors that affect reproductive performance of goats. Season of birth was the most important source of variation in this study. does differ in parity order kidding during rainy season, they showed less lost in body weight during lactation period and minimizing the negative effects of fat mobilization during early lactation, produced higher milk yield. Litter size and milk production increase positively with advance in parity number. The present result on live weight and growth rate of desert goats indicated that most of the environmental factors had positive effect. Certain management adjustment should be taken to increase the growth rate in the range for desert goats. To compare the significance of different traits under similar environmental condition, the number of observation should be comparable.

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