



Maternal Behavior of Najdi ewes Under Intensive Conditions

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ABSTRACT

The study aimed to evaluate the maternal behavior of Najdi ewes lambing under intensive farming conditions in Saudi Arabia. A total of 242 lambings were monitored and litter size (LS), dystocia, parturition length (PL), maternal behavior measured as lamb acceptance and licking (LD, licking delay; LL, licking length), and concurrent parturitions in the same pen, were recorded. Najdi ewes showed moderate LS (1.31 lambs/ewe), which increased according to parity. Despite being considered as a poor motherhood sheep breed, low dystocia (4.5%), fast and easy parturition (28.5 min) were observed in Najdi ewes in our study. The ewes take good care of their lambs, licking them early (LD, 1.2 min) and for enough time (LL, 28.5 min) after parturition. On the contrary, the studied flock showed a high incidence of lamb rejections (20.7%) which increased in primiparous ewes. No effects of LS, season or dystocia were detected on lamb acceptance, but concurrent parturition was identified as the main cause of lamb rejections.

Keywords: Dystocia, Lambing, Litter size, Maternal behavior, Najdi sheep

The Najdi, a native sheep breed from the Naj'd plateau in the Central Arabian Peninsula, is a multipurpose sheep breed highly appreciated in Saudi Arabia. Najdi ewes have medium frame, fat-tail, white and ultra-convex head, long dropping ears, and are coated by long, coarse and hairy black wool. The Najdi are adapted to extreme weather conditions and to temporary feed and water scarcities (Alamer and Alhozab, 2004). Litter size for the Najdi sheep ranges between 1.11 and 1.38 lambs/ewe (Pritchard *et al.*, 1977; Abouheif and Alsobayel, 1982), which is reduced by the high neonatal losses and poor motherhood as reported by farmers. A fair degree of genetic diversity and moderate inbreeding has been reported in the breed, revealing the lack of effective genetic improvement (Mustapha *et al.*, 2012).

Immediate interaction between ewe and newborn lamb is important for creating a strong mother-offspring bond and for lamb survival (Poindron *et al.*, 1994; Dwyer, 2003;

Nowak and Poindron, 2006). Reliable measures of ewe's maternal behavior have been thoroughly characterized (Everett-Hincks *et al.*, 2005; Leedy and Alexander, 2007; Darwish and Ashmawy, 2011). At birth, ewes demonstrate specific maternal behavior such as licking and grooming, which are critical for lamb survival and for enhancing the ewe's olfactory memory (Alexander *et al.*, 1986; Levy *et al.*, 1991; Nowak *et al.*, 2000).

Lamb survival depends on factors from the ewe, the lamb, parturition and production system as shown by several authors (Gardner *et al.*, 2007; Dwyer 2008; Plush *et al.*, 2011).

The aim of this work was to study the maternal and neonatal behavior of Najdi ewes and lambs around parturition and the relationship with the main variation factors under intensive conditions in Saudi Arabia. The final aim of this study was to test the general hypothesis that Najdi ewes



are poor mothers and to assess if their productivity would be increased by improving their maternal traits.

MATERIALS AND METHODS

All procedures described in this study were approved by the Faculty Research Ethics Committee at the King Saud University.

ANIMALS AND MANAGEMENT

Najdi ewes ($n = 270$, parity, 2.5 ± 0.4) giving birth during winter and spring, were used. Ewes were permanently housed in a semi-shaded yard at Almuzahmiah (Riyadh, Saudi Arabia) and managed under intensive conditions with free mating regime (1 ram per 25 ewes). Feeding consisted of alfalfa hay and barley straw *ad libitum*, supplemented with 0.4 kg/d of barley grain. Mineral blocks and fresh water were permanently available.

Lambing behavior recording

When signs of parturition were detected, selected ewes were moved to a connected barn (10×10 m) with sand-bedded pens for behavior monitoring where they were maintained for approximately 7 d. Lambing was monitored during the day (0600 to 1800 h) and date, time and type of birth of each event recorded. The following lambing data were recorded: 1) parturition length (PL, min; time elapsed between appearance of the first conceptus and the complete delivery of the last lamb), 2) litter size (LS, total number of lambs born per ewe), 3) dystocia (yes or not), 4) acceptance of the lambs (accepted or rejected), 5) lamb's licking delay (LD, min; time elapsed from the end of parturition to the start of lamb's licking), 6) licking length (LL, min; time spent licking the lambs after parturition), 7) lamb sex (ram or ewe), 8) concurrency of simultaneous lambings (number of parturitions occurring in the lambing pen at the same time), and 9) any relevant interaction between the ewe and her lambs. Udder health was manually assessed and suspected mastitis diagnosed by clinical exam conducted by a veterinarian. Intramammary infected ewes ($n = 28$) were removed from the experiment.

Ewes were allowed to give birth and to take care for their lamb unaided. Dystocia was considered to happen when $PL > 90$ min from the first sign of labor (Dwyer, 2003) or when intervention was needed. Ewes rejecting their lambs

(i.e., kicking or butting the newborns, and not allowing the lambs to suckle) after more than 30 min, were transferred to individual foster pens for 3 to 7 d to encourage the ewe-lamb bonding under surveillance.

Statistical analysis

Performance data were analyzed using the General Linear Model (GLM) procedure of SAS v.9.2 (SAS Inst. Inc., Cary, NC). The model included the effects of the season, parity, litter size, lamb sex, dystocia and concurrency in the lambing pen, and the residual error. Discrete data effects, such as dystocia and lamb acceptance were assessed by independency test (Chi-squared tests). Time non-normal distributed variables (i.e., parturition and licking time) were transformed into the inverse of the square according to the Box-Cox transformation method. Pearson's correlations were also calculated. Pooled data according to ewe's parity and age were also compared using Chi-squared tests. Differences between means were detected using the Tukey's test and differences were declared at $P < 0.05$, otherwise indicated.

RESULTS AND DISCUSSION

Lambing performances

Lambing of 242 ewes giving birth to 317 lambs were recorded and data are summarized in Table 1. Of the parturitions, 59.8% were in spring and 40.2% in winter. Of the ewes lambing, 70.6% gave birth to singletons, 27.7% twins and 1.7% triplets, LS being on average 1.31 lambs/ewe (Table 1).

Values of LS varied according to parity ($P < 0.01$) ranging from 1.12 to 1.53 lambs/ewe. Change of LS with parity was remarkable (i.e., triplets were only seen at $\geq 3^{\text{rd}}$ parity), showing a quadratic trend Fig. 1 and peaking at 3.4 parity ($r^2 = 0.94$; $P < 0.001$). No LS differences were detected by season or other factors ($P > 0.05$). Lamb sex ratio (ram-lambs/total) averaged 0.498 and no differences were detected by season, parity or by other variation factors considered ($P > 0.05$).

In sheep, as in other precocious species, the lamb becomes at least as important as the mother for ensuring its survival (Dwyer, 2003). Alexander and Peterson (1964) attributed

Table 1: Lambing performances of Najdi ewes under intensive conditions in Saudi Arabia

Item	No. ewes	No. lambs	Litter size ¹	Sex ratio ²	Dystocia, %
Ewe's parity, no.					
1	78	87	1.12 ^c	0.586	2.7 ^c
2	51	66	1.29 ^{bc}	0.530	5.6 ^b
3	40	60	1.50 ^a	0.467	8.1 ^a
4 or greater	73	104	1.42 ^{ab}	0.423	3.8 ^{bc}
1	78	87	1.12 ^b	0.586	3.8
3 or greater	164	230	1.40 ^a	0.465	5.3
Litter size¹					
1	171	171	1.00	0.515	4.2
2	67	134	2.00	0.482	5.5
3	4	12	3.00	0.667	0
Lambing season					
Winter	98	135	1.38	0.511	2.7
Spring	144	182	1.26	0.489	5.7
Overall data					
Mean	242	317	1.31	0.498	4.5
SEM ³	—	—	0.05	0.020	0.7

¹ Lambs/ewe; ² Ram-lambs/total lambs; ³ Standard error of the mean; ^{a, b, c} Different letters in the same column within a variation factor indicate differences at $P < 0.05$.

14% lamb deaths to the ewe's behavior, 33% to the lamb's behavior, and 52% to the ewe-lamb interaction in Merino. We tested the general hypothesis that Najdi ewes are poor mothers by measuring their behavior around parturition and seeing whether it was related to ewe traits (parity), parturition (dystocia, daily time), lamb traits (litter size, sex) or environmental conditions (season of the year, concurrence of simultaneous lambings).

The average LS observed in the current study was approximately 10% higher than the mean value (1.18 lambs/ewe) calculated from the scarce and relatively old literature published on the breed (Pritchard *et al.*, 1977); 1.11 lambs/ewe; (Abouheif and Alsobayel, 1982); 1.25 lambs/ewe. Given the lack of effective genetic improvement in the Najdi breed (Mustapha *et al.*, 2012), this result may have been consequence of the improved management and nutrition conditions used. It is known that nutrition and ovulation rate contribute to LS differences between sheep breeds (Hanrahan and Quirke, 1985; Deag, 1996). Nevertheless, our results also showed that Najdi ewes under favorable conditions have still low LS, when

compared to breeds intensively raised under semi-arid or arid conditions. Cloete *et al.* (2000) reported 1.00 to 1.73 lambs/ewe for South African Dorper ewes according to nutrition and management conditions.

Incidence of twins and triplets markedly increased until third parity in our Najdi results agreeing Abouheif and Alsobayel (1982). A similar trend was reported by Altarriba *et al.* (1998) and Casellas *et al.* (2007) in Spanish sheep breeds under semi-arid conditions. Increase of LS according to parity stressed the importance of enhancing the short life span of Najdi ewes (2.5 parities, on average, in the studied flock) and of reducing their culling rate by poor motherhood. However, increasing LS may also increase lamb mortality (Knight *et al.*, 1988; Lindsay *et al.*, 1990; Dwyer, 2003).

Ewe maternal behavior

Ewes isolated themselves near parturition and showed clear signs of discomfort and uneasiness (i.e., pawing, circling, down bleating) and frequent changes of position

(i.e., lying and standing up). About half of the parturitions occurred before 0800 h and most ewes (83%) gave birth while lying, the rest standing up (17%).

Overall dystocia was 4.5%, mean values varying between 0 and 8.1% (Table 1). Dystocia showed a quadratic trend with ewe's parity ($r^2 = 0.87$; $P < 0.001$; Fig. 1), peaking at 2.7 parity, although differences were only significant between first and third parities ($P < 0.05$). No differences were detected by other variation factors considered ($P > 0.05$; Table 1) although spring-lambing dystocia was numerically twice that of winter-lambing.

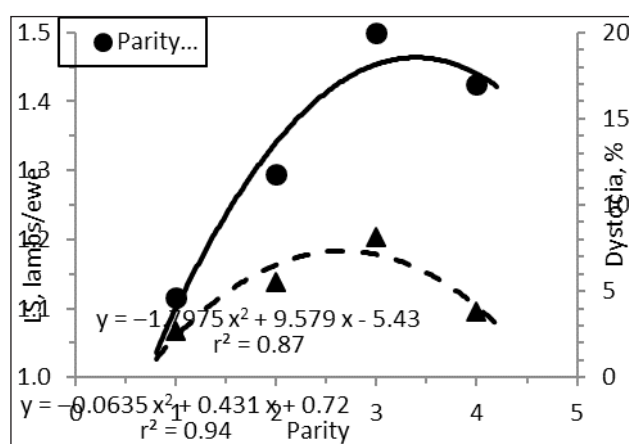


Fig. 1: Variation of litter size (LS) of Najdi ewes according to parity ($r^2 = 0.94$). Dystocia rate also varied according to the parity ($r^2 = 0.87$) of the ewes

Parturition length was on average 28.5 min (Table 2) and, for about half the Najdi ewes, did not exceed 10 min (data not shown). Only 10% of the ewes lasted more than 30 min for delivery. No PL differences were found by ewe's parity and between singleton and twins ($P > 0.05$), but parturition was much longer for triplets ($P < 0.05$; Table 2). Also, PL was shorter for ram- than for ewe-lambs, and for winter- than spring-lambing ($P < 0.05$; Table 2).

On average, 79.3 % ewes accepted their lambs immediately after parturition and started licking them in 1.25 min (Table 2). About 72.2% of ewes started licking their lambs from the head, while the rest started from the neck or other parts of the body. Ewe's parity, lamb sex or LS did not affect LD ($P > 0.05$), but there was an effect of season, the spring-lambing ewes starting earlier than the winter-lambing ewes ($P < 0.05$; Table 2).

Najdi ewes devoted, on average, a similar LL time to what they needed for delivering the lambs. Ewe's parity and lamb sex did not affect LL ($P > 0.05$), but we detected differences according to LS and season ($P < 0.05$). Licking length was longer for triplets than for twins, for twins than for singletons and in winter than in spring lambing ($P < 0.05$; Table 2).

Table 2: Effect of the studied variation factors on parturition behavior of Najdi ewes under intensive conditions (values are mean $\pm$ standard error of the mean)

Item	Parturition length, min	Lamb's licking	
		Delay, min	Length, min
Parity, no.			
1	28 ± 4	1.5 ± 0.4	29 ± 3
2	30 ± 3	1.2 ± 0.3	30 ± 3
3	28 ± 3	1.3 ± 0.3	25 ± 2
≥4	28 ± 5	1.0 ± 0.5	29 ± 3
Litter size, lambs/ewe			
1	27 ± 1 ^a	1.2 ± 0.1	27 ± 1 ^a
2	31 ± 2 ^a	1.4 ± 0.2	31 ± 1 ^b
3	41 ± 4 ^b	1.0 ± 0.4	49 ± 3 ^c
Lamb's sex			
Male	26 ± 2 ^a	1.2 ± 0.2	28 ± 1
Female	30 ± 2 ^b	1.3 ± 0.2	29 ± 1
Lambing season			
Winter	22 ± 2 ^a	1.6 ± 0.2 ^a	31 ± 1 ^a
Spring	33 ± 2 ^b	1.0 ± 0.2 ^b	27 ± 1 ^b
Overall mean	28.5 ± 1.2	1.25 ± 0.06	28.5 ± 1.5

a, b, c Different letters in the same column within a variation factor indicate differences at $P < 0.05$.

Near one fifth of the Najdi ewes refused to accept their lambs after parturition (Table 3). Rejection of the lambs varied according to parity number (Table 3; $P < 0.05$), the primiparous ewes showing the greatest percentage of rejections.

Concurrent lambing dramatically affected lamb rejections, the more ewes giving birth simultaneously in the same pen, the more lambs being rejected (Table 3; $P < 0.01$). No effects of LS, lamb sex (data not shown), lambing season or occurrence of dystocia were detected in the acceptance of the lambs by the ewe (Table 3; $P > 0.05$).

Table 3: Factors affecting the rejection of lambs immediately after parturition in Najdi ewes

Item	Ewes, no.	Lamb's acceptance, no. (%)		Significance
		Accepted	Rejected	
Ewe's parity no.				
1	78	53 (68.3)	25 (31.7) ^a	$\chi^2 = 10.08$ d.f. = 3, $P = 0.018$
2	51	43 (84.3)	8 (15.7) ^{bc}	
3	40	36 (90.0)	4 (10.0) ^c	
4 or greater	73	60 (82.2)	13 (17.8) ^b	
Litter size, lambs/ewe				
1	171	135 (78.9)	36 (21.1)	$\chi^2 = 0.00$ d.f. = 1, $P = 0.999$
2	67	53 (79.1)	14 (20.9)	
3	4 ²	—	—	
Lambing season				
Winter	98	79 (81.8)	19 (18.2)	$\chi^2 = 0.16$ d.f. = 1, $P = 0.687$
Spring	144	113 (77.9)	31 (22.1)	
Concurrency ¹ , no.				
0	82	77 (94.4)	5 (6.1) ^c	$\chi^2 = 24.55$ d.f. = 2, $P < 0.001$
1 to 3	122	95 (76.4)	27 (22.1) ^b	
>3	38	21 (54.7)	17 (44.7) ^a	
Dystocia				
No	231	184 (79.4)	48 (20.6)	$\chi^2 = 0.04$ d.f. = 1, $P = 0.841$
Yes	11	9 (81.8)	2 (18.2)	
Overall mean	242	192 (79.3)	50 (20.7)	

¹Simultaneous parturitions in the pen; ²All the lambs were accepted but their data were not included in the analysis; ^{a, b, c}Different letters in the same column within a variation factor indicate differences at $P < 0.05$.

Ewe maternal behavior

Ewes may lamb at any time of the day, but it is accepted that lambing time is related with feeding and management schedules (i.e., feeding at noon results in a greater daytime lambing). We observed more frequent lambing during early hours of daytime. Hudgens *et al.* (1986) reported no effects of diet and feeding time on lambing time and ewe's lambing behavior but, when data were pooled across treatments, two peak lambing times were observed before dawn and getting dark, agreeing with our results. Dwyer (2003) and Aleksiev (2007) also reported more frequent lambing during daytime.

Typically, parturition is an adaptive mechanism, and ewes are indirectly selected to improve lamb survival, the main outcome of the selection process being an increase in the speed and ease of parturition (Cloete *et al.*, 1998). In our data, most Najdi ewes gave birth while they were

lying down but nearly 1/6 of ewes lambed standing; no relationship with ewe or lamb behavior were detected.

Percentage of dystocia was low (<5%), most lambs being delivered without difficulties or human intervention. Dystocia varied quadratically according to parity, peaking at the third parity which may have been an indirect consequence of the increased LS. On the other hand, our results did not show effects of LS, lambing season, lambing time and concurrence of simultaneous parturitions on dystocia, agreeing Dwyer (2003). Nevertheless, breed has significant influence on lambing difficulties (Smith, 1977; Cloete *et al.*, 1998; Dwyer and Bünger, 2012). The parturition difficulties and need of assistance values obtained in our Najdi ewes was markedly lower than the 37% reported in Scottish Blackface and Suffolk ewes intensively reared (Dwyer and Bünger, 2012); from those assisted, 25% required minor assistance, 11% major assistance and 1% ewes needed a caesarean (Dwyer and



Bünger, 2012). Consequently, our results showed that Najdi sheep is an easy parturition breed.

Agreeing with the low dystocia, PL was short and not affected by parity, as also reported by Darwish and Ashmawy (2011) and Dwyer and Lawrence (2005). Despite the expected differences between ram- and ewe-lamb birth weights, PL was shorter in ram-lambs (–4 min, on average) than in ewe-lambs, which was unexpected and needs further research. Nevertheless, there was a greater ram-lamb ratio in singletons which showed numerically shorter PL. However, as expected and reported by other authors, total PL was longer for triplets, when compared to singletons and twins, the last not differing between them. Alexander *et al.* (1993) and Dwyer (2003) did not find effects of parity and LS on PL, but they reported longer PL in litters suffering birth stress (Cloete *et al.*, 1998). Also, ewes that lambd during spring have longer PL compared with those lambing during winter, which may be related to the expected heavier lambs and better nutrition of the spring-lambing ewes during pregnancy in arid conditions (i.e., hay quality, temperature). Darwish and Ashmawy (2011) reported that ewes facing birth difficulties do not show competent maternal behavior when compared with mothers having easy births. Comparing our PL results with other data from intensive sheep breeds (Dwyer and Lawrence, 2005). Najdi ewes gave birth more-easily and required less assistance than others.

Ewes accepting their lambs started to lick them early after delivery (less than 2 min), most of them starting from the head. Licking the lambs has a critical role for both ewe and lambs, including drying and cleaning the lamb, stimulating activity and respiration and enhancing the formation of the mother's olfactory memory (Alexander *et al.*, 1986; Levy *et al.*, 1991; Nowak *et al.*, 2000). Moreover, as concluded by Dwyer (2003), any assistance given to aid delivery had retarding effects on the lamb's behavior and should be reduced as much as possible.

In our Najdi ewes, most factors studied did not affect DL except lambing season, as it was noticed that Najdi ewes started licking their lambs earlier in spring- compared to winter-lambing, agreeing with the expected better general conditions of both the ewe and the lambs. Our results agree with those of Dwyer (2003) who reported that ewes that mobilize less fat during pregnancy have lambs that stood earlier and seek the udder earlier, which may be expected to happen in the spring-lambd ewes.

Najdi's LL was long enough (approximately 30 min) to establish a satisfactory ewe-lamb bond when compared with other references (Dwyer, 2003, 2005) and did not vary by ewe's parity and age. As expected, LL increased with LS, being approximately double and quadruple in twins and triplets, respectively, than in singletons. This extended maternal behavior in the more prolific Najdi ewes reinforced the neonatal cues for lamb recognition and ewe-lamb bonding. Spring-lambd ewes, spent less time licking their lambs than the winter-lambd ewes. There are no similar results previously reported in sheep but this may be a consequence of a greater vitality of the spring-born lambs which most probably stand up and suck the udder earlier.

Nevertheless, Najdi ewes showed a high incidence of lamb rejections (approximately 1/5) which was the most important maternal disorder detected and which compromised lamb's survival. Lamb rejection was especially important in primiparous, as generally known (Dwyer, 2008), but also increased in older ewes. No effects of LS, season or dystocia on lamb rejection were detected, although most references indicate that long and difficult parturitions impair maternal behavior in sheep (Dwyer and Bünger, 2012).

Number of ewes giving birth simultaneously in the pen had a negative effect on lamb's acceptance and it was identified as a key aspect in the maternal behavior of Najdi ewes and has not been explored enough previously in other breeds. Rejection rate increased approximately 4 and 9 times when more than 1 and more than 4 ewes, respectively, concurred giving birth at the same time in the same pen. This aspect should be carefully attended and may be avoided by making available more space for Najdi lambing flocks or by preparing isolating facilities (i.e., fostering pens) for confinement during approximately 1 week (Alexander and Bradley, 1985). Special attention should be paid to the primiparous ewes which showed the greater lamb rejections. Further research is required to evaluate the impact of some corrective actions and to clarify the unexplained factors conditioning the maternal behavior of Najdi ewes.

Najdi ewes showed moderate prolificacy, which increased according to ewe's parity. Despite being known as a poor motherhood sheep breed, low dystocia, fast and easy parturition were observed in our study. Moreover,

the Najdi ewes took good care of their lambs, licking them early after parturition and for enough time. On the contrary, Najdi ewes showed frequent lamb rejections (1/5 approximately) which was greatest in primiparous (1/3 approximately). No effects of litter size, season or dystocia were detected on lamb acceptance, but concurrent parturition was identified as the main cause of lamb rejections and should be avoided.

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