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Review Article

Mother-Kid Bonding in Goats: A Very Important Issue for Kids' Survival and Performance

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Abstract

Mother-offspring attachment is a crucial determinant for the survival of offspring. These relationships are supported by various factors such as hormone, olfaction cues, chemosensory stimuli, acoustic recognition etc. during early phase of bonding. Bonding occurs at various stages, in numerous brain structures, and the release of certain hormone allows the development of early learning and recognition abilities between mother and kid. It is evident that a selective and exclusive attachment forms between the mother and kids within few hours of parturition. Oxytocin and prolactin are two major hormones play key roles in expression of maternal behaviors and bond formation. Smelling, licking and grooming are vital activities in the establishment of unique olfactory memory in the mother for her offspring. Primiparous goats may delay nursing to neonates with aggressive/rejection behavior when compared to multiparous. Human meddling, drug and other stimulations from the natural environment are the causal factors for breakdown of connections between the mother and kids. During the first week of life, interruptions in mother's care, maternal selectivity, and failure in mutual recognition may have a negative impact on the newborn's survival and future performance.

Introduction

In goat, sheep, pig and other domestic livestock species quality care and maternal behaviour of female are very important for survivability of offspring. Therefore, studies on behavioural interactions on the development of mother-kid bond, pre and post parturition factors affecting bond formation are very pertinent aspects for improvement of livestock management practices. Among parents, it is only the mother, who assures intra-uterine care of offspring, bears stress of pregnancy and delivery, to be present at birth and invariably plays primary roles on post-natal survivability, development and growth of young through lactation, protection and care. However, in small-brained (high ratio of limbic to cortical structure) mammals, unfortunately mothering does not occur spontaneously; unless primed by hormones of pregnancy. The trophoblast cells play pivotal roles by secretion of steroids and hormonal peptides that not only regulate growth and development of placenta, but also influence the maternal neuroendocrine system to ensure synchronization of birth with maternal instinct, care and induction of lactation [1-3]. In livestock and other mammals, biologically significant life events like individual recognition, mate selection, maternal-offspring interactions and other social behaviours are regulated by olfactory cues. The critically important hormones for mediation of maternal and other social behaviours are estrogen, progesterone, prolactin, oxytocin, β-endorphins, arginine vasopressin, corticotrophin releasing factors etc. [4,5].

Initiation, Maintenance and Termination of Mother-Offspring Bonds

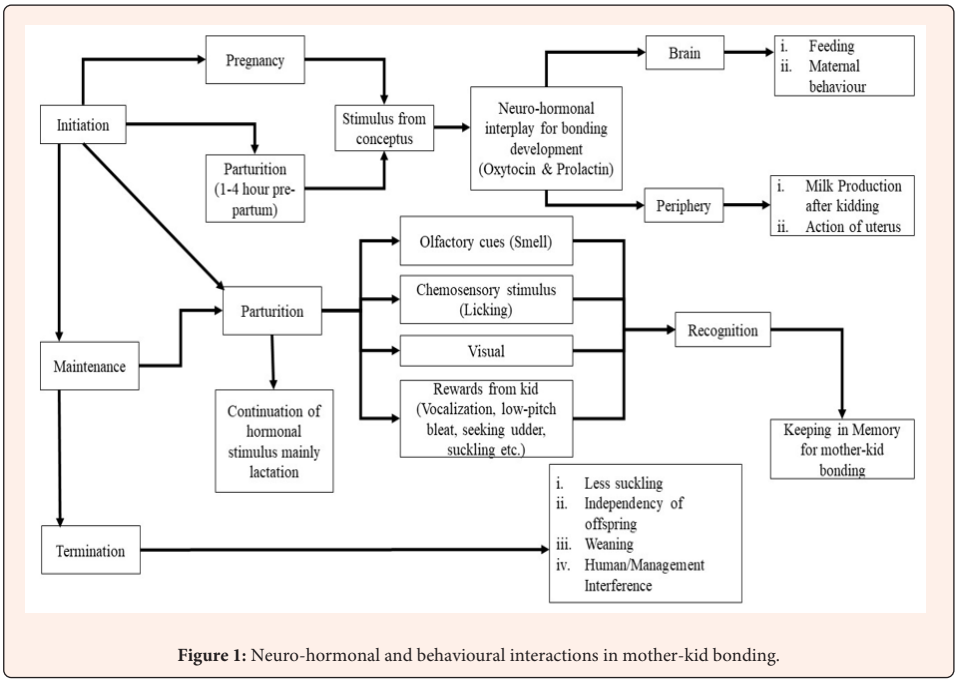

Figure 1: Neuro-hormonal and behavioural interactions in mother-kid bonding.

Figure 1 depicts the importance of various signals that underpin the formation, maintenance and termination of mother-kid bonds. In human, mothering is dominated by socio-cultural inheritance. The major significance in human and primates maternal care is endogenous opioid system [1]. In some primates maternal care occurs even in absence of priming by hormones of pregnancy, parturition and lactation. The development of temporary alliances and deployment of behvioural strategies and social organizations in primates emancipated the exclusivity context determined by hormones [1]. In contrast, in goat, sheep and other domestic mammals' hormonal context, olfactory cues, vision, vocalization, suckling, tactile stimulus, recognition, learning, selection of owns kid and rejection of others are very important for the bond formation. The most crucial phase of bond development in goats is few hours pre-partum to 1-4 hours post-partum.

Pre-partum maternal behavior for development of mother-kid bonding

Although goats are typically gregarious animal, the initiation of maternal behaviour occurs in the hours before kidding, when goats separate themselves from flock mates and choose a special location to give birth of offspring [6,7]. Natural selection of birth place promotes mother to express maternal behaviour and habitat choice can enhance survival of newborn's [8]. However, between 1-4 hours pre-partum, pregnant goats show social separation from the rest of the flock and a decrease in their behavioural reaction to social isolation [9-17]. Increased vocalizations and enhanced overall activity are typical reactions to being separated from social mates [14,18-20]. Isolation of does from the rest of her conspecifics may be good to the establishment of early bond with offspring [6,14,16]. Furthermore, longer the mother stays at the birth site, better the offspring's survival chances [6,7,21], probably due to strong bond formation. Therefore, establishment of a mother-young relationship requires complete isolation from other goats, and this behaviour may promote mutual identification and quick access to the udder upon delivery, hence increasing the likelihood of young survival and development of the mother-young bond.

Development of mother-kid bond at birth

During and immediately after birth, goats are highly attracted to the smell and taste of amniotic fluids, and lick amniotic fluids that have been coated over the kids' body and on the ground for transferring attraction to their newborn kid [22-24]. Parturient goats need licking of amniotic fluids not only to establish maternal attentiveness, but also to develop selective bonding to own kid. Because, these fluids contain chemosensory information that facilitates exclusive bonding [22,23,25,26]. Goats are very receptive to the smell of their offspring just after parturition [27]. The olfaction cue play vital role in bond formation and the information is processes via both main and accessory olfactory system viz vomeronasal organs. The most selective way for mothers to recognize their own newborns is through olfactory imprinting [28,29]. The olfactory interactions with the newborn young accelerate the maturation of new neurons in the maternal olfactory bulb [30-32]. During the first few hours following birth, the mother's behaviour is characterized by intense licking and grooming of the offspring, which is followed by numerous low-pitched bleats, as well as acceptance of the newborn at the udder [33-35]. Licking and grooming is important in the establishment of a unique olfactory memory in the mother for her own newborns and to learn the specific odor of her own neonate [22,26]. Failure to develop this attachment, the mother is unlikely to recognize the kid as her own and she will reject the newborn's attempts to access the udder and nurse [25,36]. These licking and grooming behaviors by the mother to her kids have two purposes: first, they aid in the drying and second, she develops an exclusive and selective bond to her own kids [6,26]. The newborn young stands on its feet 10 to 40 minutes after birth [10,25,37], begins nuzzling its mother's body, and quickly reaches the udder and suckle successfully by 20 to 60 minutes after birth [25,37-39]. Within an hour of birth, a selective attachment forms between the mother and the newborn young; this mother-young bonding is essential for the young to learn and recognize each other at a distance and then by their vocalizations [26,40,41]. An interruption in maternal care, maternal selectivity and in the mutual recognition may have a detrimental effect on the newborn young's survival during the first week of life [26,35,36,42,43].

Post-partum mother-kid bonding and kid survivability

The survival of a newborn kid depends on the development of a strong bond between the doe and the kid associated with the expression of coordinated behavior [44-46]. Mothers groom and nurse their kids immediately after parturition, but quickly learn to discriminate and only nurse their own infants [47,48]. In sheep and goats, 5 to 10 minutes of interaction after birth with the neonate are enough for does to become selective, and mothers reject alien kids 2 to 4 hours after delivery, regardless of their age or coat similarity to their own young [43,49,50,51]. In sheep and goats, 50% of mothers exhibit no maternal interest in their young after 4 hours of separation beginning at birth, and 75% reject their own kids after 12 hours of deprivation [52,53].

Emancipation of hormonal control and dominance of behavioural response at post-partum

Few days after kidding, memory-based bonding, learning experience and behavioural rewards overrule the nuero-hormonal controls on mother-kid bonding. The vocalizations of newborns promote care and play a significant role in the regulation of early interactions in many species [54-60]. Despite long periods of separation, mother and offspring frequently use vocalizations to find and recognize each other [55-57]. Within hours of birth, newborns begin to vocalize in order to attract the attention of their mothers when they need to be fed or protected [61,62]. During the first three hours following delivery [63], the mother shows an intense period of vocal activity [64,65]. Up to 24 hours after giving birth, the number of vocal events gradually decreases [66]. Auditory recognition occurs bi-directionally between mothers and their offspring, varying with age, breed, and time since bonding took place [57,67,68].

Neurobiological event during development of bonding

Bonding takes place at numerous phases, in various brain structures, and the release of hormone cascades that result allows for the development of early learning [69]. Bonding involves the transfer of a sensory activation stimulus as well as a neural alteration that allows individuals to acquire, retain, and retrieve information [70]. During bonding process, neurotransmitters communicate within the nervous system resulting in morphological changes of neurons, which creates new connections as the offspring learn to recognize the signals [71]. Specific neurotransmitters are essential for the development of the mother-kid bond. Endogenous oxytocin is important in mediating the onset of maternal behavior in numerous non-human species [72]. The oxytokinergic and dopaminergic systems are believed to play a role in maternal behavior, as oxytocin activates dopamine pathways in response to social cues [73]. An alteration of the maternal oxytocin system during pregnancy is strongly linked to later dysfunctional maternal behaviors [74]. Prolactin is well known for its role in milk production, but it also plays an important role in maternal care and parental behavior in both birds and mammals [75]. The concentration of prolactin increases during pregnancy, which likely participate in the processing of olfactory signals acquired by the new mother as she learns to meet the needs and challenges of raising newborn young [76].

Factors Responsible for Weak Bonding During the Sensitive Period

Any internal or external condition to the mother and her offspring during bonding can endanger not just the mother-kid bond, but also the learning process itself, and potentially the offspring's well-being and survival. External factors that might cause rupture the bonding include human interference, other stimuli from the natural environmentdrugs like naloxone, other opioid blockers, heroin etc. [1,77-79]. Negative behaviours of some ungulate mothers have been reported, including failure to seek a protected and isolated location to give birth; moving away from the birth site after parturition, brief and insufficient postpartum care and aggressiveness toward the newborn [80-82].

Animals' factor

Mothers with inexperience or poor physical health or with several young may not be able to recognize and care for more than one newborn. In comparison with multiparous does, primiparous does are more likely to display inappropriate maternal behavior [83]. Goat with inexperience might delay the kid's first nursing with aggressive or rejection behaviors, which can negatively affect the kid's growth and survival [83,84]. In one of our study, it has been observed that one doe out of 14 experimental Black Bengal goats exhibited poor mother-kid bonding (repeated high pitch bleats, non-recognition of own kid, less suckling, repeated searching for kid etc.) for unknown reasons. Although the birth weight of the kid of this poor-bonding doe was similar to the average birth weight of flock mates, however, the kid under performed at future life stages (Table 1). Milk yield of the doe was quite less as compared to flock mates. Similar to goat, more experienced mothers exhibit fewer negative behaviors and more maternal care than inexperienced ewes [85,86]. However, some breeds exhibit a stronger bond between mother and young than other breeds of same species [80,87].

Table 1: Growth of kid and milk yield of mother in a poor doe-kid bonding.

Particulars	Average of Flock Mates		% (less/more)
Birth weight of kid (Kg)	1.16	1.21	(-) 4.1
Body weight at 3 months (Kg)	5.21	5.37	(-) 3.0
Body weight at 6 months (Kg)	7.50	7.95	(-) 5.7
Body weight at11 months (Kg)	10.81	12.84	(-) 15.8
Age at first breeding (days)	287	267	(+) 7.5
Milk Yield of Doe (g/day)			
7-14 days	270	370.84	(-) 27.2
15-30 days	255	302	(-) 15.6
30-45 days	190	324	(-) 41.4
45-60 days	170	266.90	(-) 36.3

Multiple births

The number of newborns per parturition is also a factor that impact bonding during the sensitive period. Taking care of the first offspring causes some does to ignore the second after giving birth to twins. When twins are born, the second born neonate receives less licking from its mother than the first [56]. Furthermore, in multiple births, the weakness of newborn young at birth leads to the permanent separation from mothers [88].

Birth difficulty

Labor complications with longer expulsion periods increase mortality because these complications cause improper behaviour in both mother and newborn [89]. Owing to exhaustion and prolonged pain, mother abandon newborns more frequently [90]. Furthermore, difficult and extended parturitions result in weak newborns that need longer time to stand, reach the udder, and feed successfully [88,90] and it has reduced reward response to mother.

Human handling

Handling of goat during pregnancy had a negative impact on placental morphology, foetal survival, and postpartum mother behaviours, as well as kids' behavioural development [91,92]. There is a high incidence of abandonment of offspring in sheep due to human handling [85].

Maternal nutrition and bonding

Undernutrition during gestation can negatively affect the fetal thermoregulatory capacity and, thus, decrease the newborn's health and viability [37,65,93,94]. In pregnancy, maternal undernutrition results in the kid's lack of ability to stand and sucking after birth, along with poor colostrum quality and quantity of milk [95-97]. Furthermore, colostrum and milk yields are related to bonding between mother and kid at birth, neonatal survival, immune response and postnatal growth [26,64,98,99]. Poor mother-young bonding and perinatal kid losses are strongly associated with low birth weight and mis-mothering due to undernutrition of dam [100].

Conclusion

Mother-kid bonding is a process that includes physiological, anatomical, hormonal and ethological factors, the change of which might lead to survival risks for the neonates. The recognition of mother-kid occurs primarily through the exchange of sensory stimuli (olfactory, tactile, visual, and auditory stimuli) between mother and her offspring. The survival and welfare of kids are dependent on the early recognition and formation of the mother-kid bond, which occurs during the sensitive phase that starts immediately after birth. Maternal care and suckling are essential to the development of the mother-kid bond; therefore, it is vital that the pair remain together and is not disturbed. Mothers that exhibit timely and appropriate maternal behaviours, such as bonding and maternal care, are an essential factor in neonate survival, growth and future performance which has beneficial impact on farm profitability.

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