

Determining the influence of rearing method on lamb weaning behaviour

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Abstract: Weaned lambs experience changes in feeding and management practices that may influence growth and behaviour. The aim of the present study was to evaluate the change in growth, and behaviour in early weaned lambs subjected to two rearing methods (natural and artificial) prior to weaning. The experiment was conducted with 24 lambs of the Assaf breed, divided into two groups (12 animals per group). The control group was reared naturally with their mothers until weaning (NR), while the lambs in the other group were reared artificially (AR) with milk replacer. After weaning, the AR lambs grew faster, allowing them to approximate the body weight of the NR lambs. On the first day after weaning, the NR lambs spent less than 1% of their time consuming concentrate and less than 2.5% of their time consuming alfalfa hay, resulting in 34.4% fewer feeding attempts than the AR lambs ($p < 0.01$). During the trial period, the NR lambs spent more time standing and moving ($p < 0.05$), and less time lying down, playing ($p < 0.05$) and feeding, compared to the AR lambs. This shows that the method of rearing before weaning has a significant influence on the behaviour. This warrants further research into factors influencing behaviour and its control in early weaned lambs.

Key words: small ruminants, sheep, lambs, animal nutrition, weaning, animal behaviour, animal welfare

Ugotavljanje vpliva tehnologije reje na obnašanje jagnjet ob odstavitev

Izvleček: Jagnjeta so ob odstavitev izpostavljena spremembam v prehrani in načinu reje, kar lahko vpliva na njihovo rast in obnašanje. Namen raziskave je bil oceniti spremembe v rasti in obnašanju zgodaj odstavljenih jagnjet, ki so bila pred odstavitevijo rejena po dveh različnih tehnologijah (sesanje pri materi ali vzreja z mlečnim nadomestkom). Poskus je bil izveden s 24 jagnjeti pasme assaf, razdeljenimi v dve skupini (12 živali na skupino). Kontrolna skupina je do odstavitev sesala pri materah (NR), poskusna skupina pa je bila napajana z mlečnim nadomestkom (AR). Po odstavitev so jagnjeta AR hitreje pridobivala telesno maso kot jagnjeta iz kontrolne skupine (NR), kar je povzročilo, da sta se telesni masi med skupinama po odstavitev skoraj izenačili. Prvi dan po odstavitev so jagnjeta NR porabila manj kot 1 % časa za zauživanje koncentrata in manj kot 2,5 % časa za zauživanje lucerninega sena, kar je pomenilo 34,4 % manj poskusov hranjenja kot pri jagnjetih AR ($p < 0,01$). V času poskusa so jagnjeta NR, v primerjavi z jagnjeti AR, prezivela več časa stoje in v gibanju ($p < 0,05$) ter manj časa leže, pri igri ($p < 0,05$) in zauživanju krme. To kaže, da ima tehnologija reje pred odstavitevijo pomemben vpliv na obnašanje jagnjet po odstavitev in upravičuje nadaljnje raziskave dejavnikov, ki vplivajo na oblike obnašanja zgodaj odstavljenih jagnjet.

Ključne besede: drobnica, ovce, jagnjeta, prehrana živali, odstavitev, obnašanje živali, dobrobit živali

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1 INTRODUCTION

The artificial rearing of lambs is a subject in which the quality of animals' life is discussed and is focused on the physical and emotional health of the animals so that they can display their normal behaviour in the environment in which they are housed. The desire of humans to achieve higher productivity from animals has led to the development of intensive livestock farming. Intensive livestock farming can result in consumers concerns for the welfare of farm animals. These concerns may also be related to the early weaning of lambs, which is described as physical separation of the lambs from their mothers. This is a common practise to increase the economic efficiency of the farm, described, as forcibly terminating sucking of maternal milk by the offspring, which may affect animal welfare (González-Martínez et al., 2023). Napolitano et al. (2008) pointed out that weaning is a critical time for lambs due to the involvement of social, nutritional and environmental changes.

The use of milk replacer (MR) in lamb feeding is a common practice in dairy sheep farming with the aim of increasing physical milk yield (Caroprese et al., 2005; David et al., 2014). At the same time, MR is also used in artificial breeding of lambs, in the presence of insufficient milk secretion of ewes, mastitis, and other factors that prevent lambs from suckling (McCoard et al., 2020, Mialon et al., 2021). Depriving lambs of their mothers and feeding them MR has a negative psychological effect (Gaudin et al., 2018). This is a challenge for young lambs because they receive MR that is different from their mother's milk, which affects growth and microbial colonization (Belanche et al., 2019). According to Toral et al. (2015) MR is not easily influenced by the external environment, unlike mother's milk, and improves lamb growth (Ocak and Cankaya, 2013; Zhang et al., 2019), immunity and reduces stress due to dietary changes (Amdi et al., 2021).

Different lamb rearing methods are implemented worldwide, but the goal is the same, namely to reduce farming costs without compromising lamb welfare and growth (Heaney et al., 1982). According to Simitzis et al. (2012) early weaning is associated with stress, which can reduce feed consumption and affect average daily gains (Demir, 1995). Wang et al. (2019) point out that stress can be minimized if lambs are separated from their mothers at an early age, and acclimatised to eat dry food, which will encourage the development of the forestomach. Already in the last century, Selye (1936) defined stress as a state of the organism where homeostasis is threatened by the stressor. Etim et al. (2013) described stress as a reflex reaction resulting from

the animal's inability to adapt to the new environment. In this case, early weaning of lambs leads to changes in the physical and social environment of the animals (de Melo et al., 2022).

The development of a suitable system for rearing and weaning lambs to reduce stress and improve welfare serves as the basis for this study. The aim of the present study was to evaluate the change in growth, and behaviour of early weaned lambs subjected to two rearing methods (natural and artificial) prior to weaning.

2 MATERIAL AND METHODS

The experiment was conducted in January 2023 with 24 lambs of the Assaf breed, raised on a private livestock farm, Kostelevo Village, Vratsa Municipality, Bulgaria (43.21659°N, 23.61234°E).

2.1 EXPERIMENTAL DESIGN

The animals were divided into two groups (until the 24th hour after birth), each of which was equalized in terms of body weight, age, sex, and birth type (singles and twins). The animals were abruptly weaned at 23 days of age. Until weaning, the lambs in the control group were naturally reared with their mothers (NR, n = 12) in an indoor facility without air currents. In the treatment group, the lambs were artificially reared in a separate room where the temperature was maintained at 16 to 18 °C and without air current (AR, n = 12). The AR lambs were separated from their mothers within 24 hours after birth. Up to three days of age, each lamb received colostrum, after which (from 4 days of age) they received MR (Capragno 62, SERVAL, France, containing 62% skimmed milk powder) *ad libitum* via an automatic feeder (height-adjustable on four teat), according to the following scheme (Table 1).

From the age of 4 days until weaning, the lambs in both groups had free access to dry feed (protein concentrate with 33% crude protein, maize and alfalfa hay, Table 2), lukewarm water to drink and a rock salt to lick. For the control group (NR lambs), the aforementioned

Table 1: Scheme of feeding the lambs with milk replacer

Age of lambs, day	Nutrition
until the 2 nd day after birth	Colostrum
from the 3 rd to the 14 th day	milkk replacer (190 g/L of water)
from the 15 th to the 18 th day	milkk replacer (120 g/L of water)
from the 19 th to the 22 nd day	milkk replacer (80 g/L of water)

Table 2: Component and chemical composition of feed used

Ingredient, %	PPC ¹	Maize	Alfalfa hay
Sunflower meal	37.4		
Soybean meal	30.2		
Peas (grain)	19.4		
Molasses	5		
Calcium carbonate	2.5		
Vitamins and minerals	2.5		
Sodium chloride	1.5		
Sodium bicarbonate	1.5		
Nutrient Analyses, g kg ⁻¹			
Dry matter	918	897	893
Feed units for growth ²	1.04	1.49	0.62
Crude protein	311.4	87.6	198.4
Digestible protein in the intestine	140.4	91.2	74.2
Balance of the protein in the rumen	123.5	-33	51.4
Crude fats	14.6	36.4	27.2
Calcium	17.1	0.27	16.6
Phosphorus	8.7	3.1	2.5
Vitamin A, IU/kg	43		
Vitamin D, IU/kg	8529		
Vitamin E, mg/kg	261		

¹ PPC – pelleted protein concentrate; ² Feed units for growth is = 6 MJ N

feeds were provided in a “creep” (with a total area of 15 m²) to which the lambs had free access (Alcock, 2006). During the experiment lambs were weighed at birth, on day 14 after birth, and daily from day 21 to 29 using an electronic scale to determine body weight (BW).

2.2 ANIMAL BEHAVIOR

The behaviour of the lambs was recorded for six lambs from each group (NR lambs, n = 6; AR lambs, n = 6) for 9 days (2 days before weaning and 7 days after weaning). The following behaviour was recorded, considering definitions by Broekman (2015): standing (the time when the lamb is on all fours and not moving); movement (the time the lamb is on all fours and moving, forwards or backwards); lying (when the lamb's belly is in direct contact with the ground); playing (building social interactions between lambs in the form of running, jumping, stroking, hanging). Intake of concentrate feed and alfalfa hay was assessed in NR lambs (n = 6) and AR lambs (n = 6). Each of the behavioural parameters was recorded if its duration was not less than 5 s.

The remaining number of animals (NR lambs, n = 6 and AR lambs, n = 6) were divided into six subgroups (3 from NR and 3 from AR) with 2 lambs in each subgroup, which were housed in pens with dimensions of 3 m × 1.5 m, where they had free access to dry feed (Table 2), luke-warm drinking water and rock salt. This made it possible to determine the feeding behaviour and feed consumption of the lambs for 7 days after weaning. During this period, the following indicators were determined: number of meals (per 24 h), feeding duration (min/24 h), time to consume 1 kg dry matter (DM)/min (this is the recorded time for the animal to consume an average of 1 kg of dry matter (DM) in 24 hours, calculated by dividing the time spent feeding by the amount of feed DM consumed), intake rate (g DM/min) and duration of meal (min).

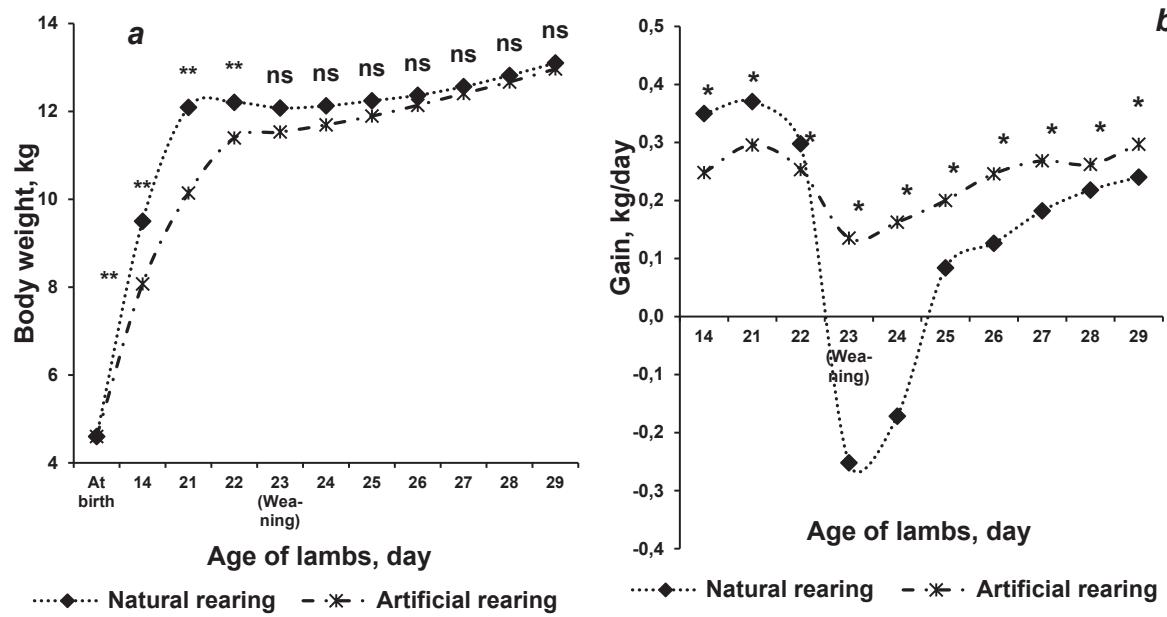
To achieve the above objectives, animal behaviour was recorded with XMART WI-FI cameras with built-in BC202 batteries (Langshixing Electronic Shenzhen Co. Ltd, China) installed at 4 m above the floor. The lambs were marked with a red spray (OVI-line, Ukal Eschbach, France) to make it easier to identify individual

behaviors. During the experiment, protein concentrate and maize were placed together in the feeder at a 60/40 ratio, separated from the alfalfa hay. The chemical content of feeds (Table 2) was determined by standard methods AOAC (2007), as described by Todorov et al. (2010).

A total of 54 recordings were made during the experiment, 42 of which were used for determining the feeding behaviour of the lambs. Each recording covered a period of 24 hours, which allowed the following actions to be recorded: standing (min); movement (min); lying (min); playing (min); feeding attempts (number) and feeding duration (min).

2.3 STATISTICAL ANALYSIS

All statistical analyses were performed using Statistica for Windows, version 6.0 (StatSoft Inc., 2006). The General Linear Model (GLM) was used in the calculation of least squares analysis of variance. Animal behaviour was considered as a quantitative variable and the calculation measured the mean time (minutes per 24 hours) spent by the lambs standing, moving, lying



* $p < 0.01$; ** $p < 0.05$, ns (non significant)

Figure 1: BW (a) and ADG (b) in the lambs depending on the rearing method before weaning (LSM \pm SE)

down, playing and feeding. The level of statistical significance was set at $p < 0.05$ and $p < 0.01$.

3 RESULTS

From birth to weaning, NR lambs maintained significantly higher BW ($p < 0.05$) and average daily gain (ADG, $p < 0.01$) compared to AR lambs (Figure 1a). In the first two days after weaning, growth was positive in the AR lambs, while it was negative in the NR lambs (Figure 1). The reported low ADG in NR lambs after weaning ($p < 0.01$, Figure 1b) allowed the animals artificially reared at 23 days of age to reach the body weight of animals from the control group (Figure 1a).

On the first day after weaning, consumption time decreased in both groups of lambs, being most noticeable in the NR lambs (Figure 2). Lambs that were NR before weaning spent less than 1% of their time consuming concentrate (Figure 2a) and less than 2.5% of their time consuming alfalfa hay, compared to the AR animals (Figure 2b). After this day, the time spent on feed intake increased in both groups of animals (Figure 2ab).

The feeding behaviour of the lambs in the first week after weaning in Table 3 shows that after weaning, NR lambs made 34.4% fewer feeding attempts and used 27% less time feeding compared to AR lambs ($p < 0.01$). The average duration of a meal for NR lambs was 1.8 minutes, which was 11.1% longer than the average du-

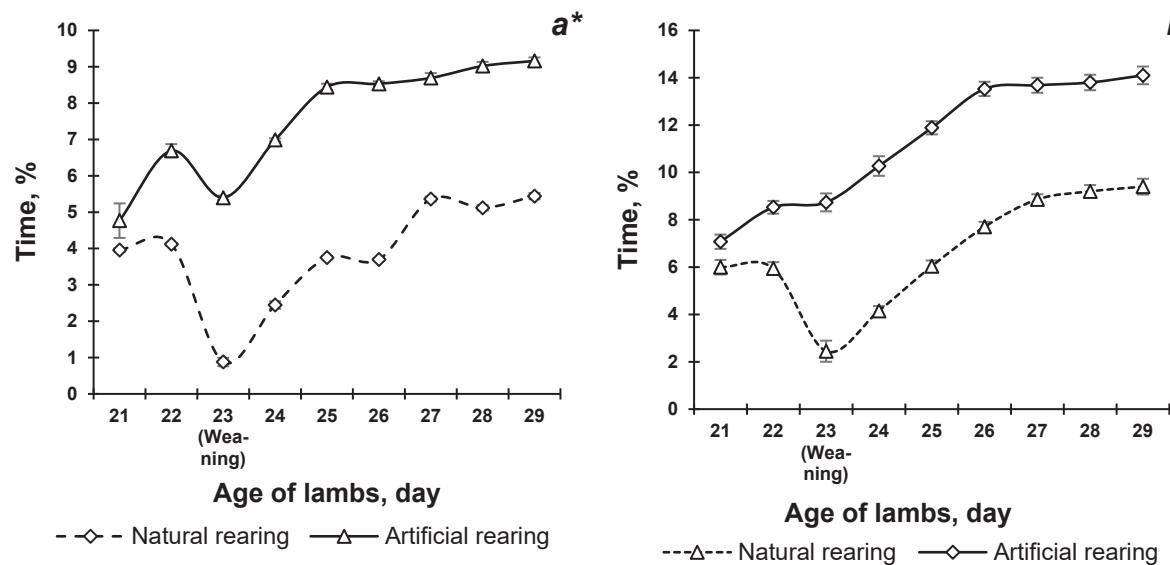
ration for AR lambs ($p < 0.05$). The study found no significant differences in the time and speed of intake of 1 kg of DM.

The behaviour of the lambs during the study period (Figure 3) shows, significant differences in the behaviour of the animals (standing, moving, lying and playing), even before weaning ($p < 0.05$). On the first day after weaning, NR lambs increased standing and moving time to 32% and 35%, but decreased lying and playing time to 29% and 0.4% (Figure 3). Such large behavioural change were not observed in AR lambs (Figure 3).

The effects of weaning on the behaviour of the lambs is described in Table 1. During the study period, NR lambs spent 60% more time standing and 32.8% more time moving compared to AR animals ($p < 0.01$). The time spent lying, playing and eating was higher ($p < 0.01$) in the AR lambs, 11.6%, 42.2% and 47.4%, respectively (Table 4).

4 DISCUSSION

In the present study, the NR lambs had higher BW and ADG compared to AR lambs before weaning ($p < 0.05$). After weaning at 23 days of age, the NR lambs showed a sharp drop in BW in the first two days after weaning, indicating acute stress. A decrease in body weight and negative growth during the first day after weaning was also reported in the study by Mo-



* Combination of protein concentrate + maize (60/40)

Figure 2: Time spent for intake of concentrates (a*) and alfalfa hay (b) in lambs depending on the rearing method before and after weaning (average per 24h)

hapatra et al. (2021) in lambs weaned at 60 days of age. According to Kuhn et al. (1990), the separation of neonates from the mother leads to a sharp decrease in growth hormone secretion, while the increase in corticosterone levels occurs with a considerable delay, and only starts several hours after the stressful event or the reduced amount of feed intake (Dantzer & Mormede, 1979). Although AR lambs reduced their growth in the first two days after weaning, it remained positive and did not reach the negative values observed in NR lambs ($p < 0.01$, Figure 1b). This may be an indication of a greater weaning stress in NR lambs. According to Mora-Medina et al. (2015), the disruption of the ewe-lamb relationship, the lack of milk in combination with the changes occurring in endocrine and behavioural responses reduce the growth of the animals.

After weaning, the NR lambs received the same dry feed as they received in the creep and during the

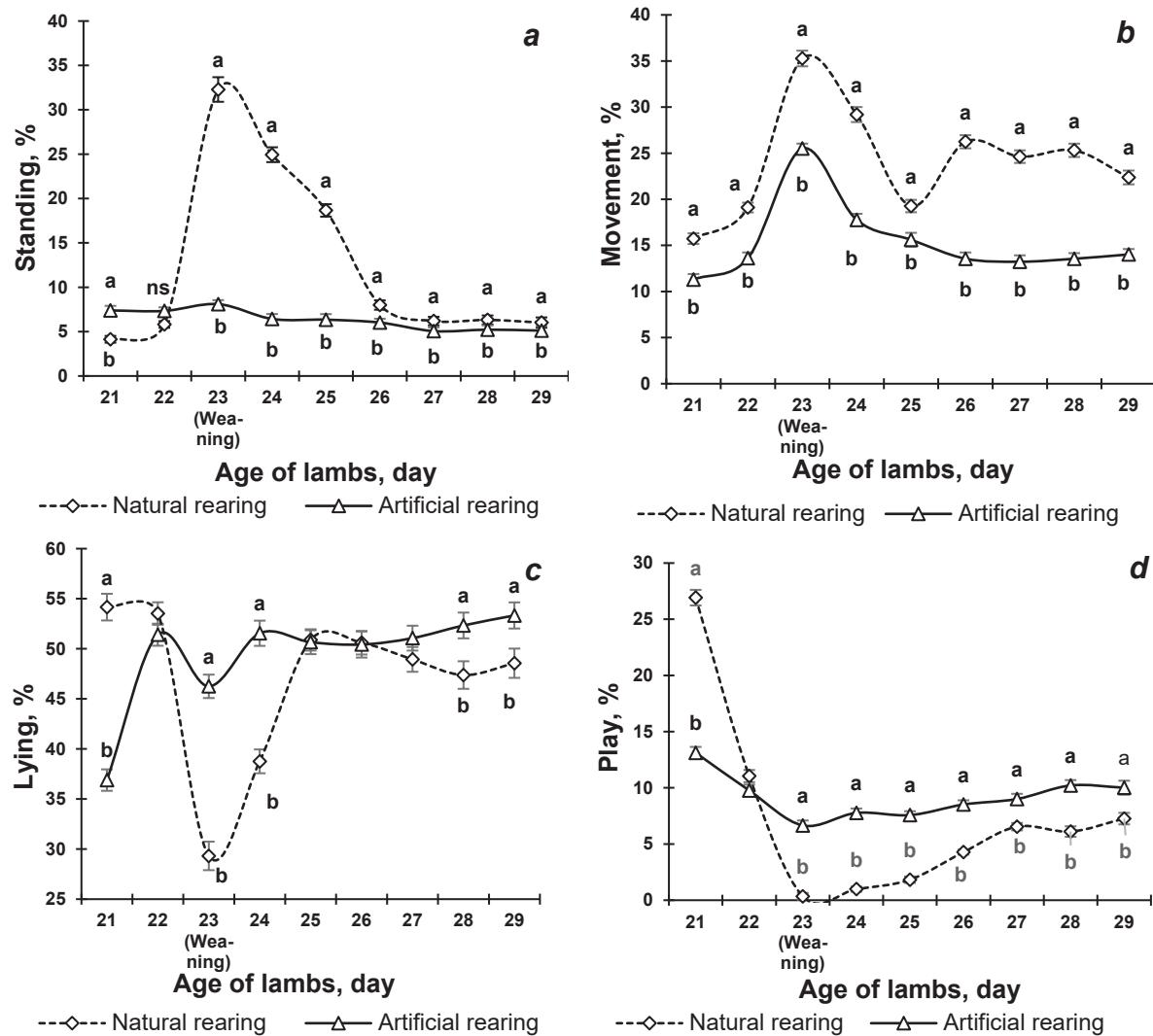
suckling period. However, they spent less time feeding (Figure 2) and made fewer feeding attempts ($p < 0.01$), which affected the duration of a meal ($p < 0.01$). The possible cause is the adaptation of the digestive system to the sudden change in diet, which according to de Melo et al. (2022) lead to altered behavioral responses in NR lambs. This can be explained by the fact that, the amount of MR was gradually reduced in the AR lambs from 15 days of age (Table 1). Consequently, the lambs could not fully meet their nutritional requirements through the MR and switched to consuming dry feed (concentrate and hay). In contrast, NR lambs primarily relied on their mother's milk, which adequately met their requirements. When lambs are raised with their mothers, there is a strong bond between them that is associated with several neurochemicals involved in neuronal activity, which act in synergy for affection and care. In this context, Lynch et al. (2019), who studied

Table 3: Feeding behaviour of lambs during the first week after weaning

Indicators	NR	AR	SEM	p-value
Number of meals per 24 h	39.2	59.8	1.96	*
Time spent feeding, min/24 h	69.38	95.01	2.54	*
Time to intake of 1 kg DM, min [#]	189.1	181.0	3.60	ns
Rate of intake, g DM/min	5.3	5.5	0.09	ns
Duration of meal, min	1.8	1.6	0.04	**

* $p < 0.01$; ** $p < 0.05$; ns (non significantly)

[#] This is the recorded time in which the animal consumes an average of 1 kg of dry matter (DM) in 24 hours.



^{a,b} Differences between groups were significant at $p < 0.05$

Figure 3: Behaviour of the lambs during the study period

cattle, allow for the possibility that cow's milk contains opiate-like substances that play a key role in the calf's attachment to the mother.

At weaning, the NR lambs were subjected to both psychological (separation from the mother) and physical stress (the introduction of a new type of feeding and husbandry). These lambs spent more time standing and moving and less time lying down, playing and eating compared to the AR lambs (Figure 3), suggesting that the rearing method before weaning affects behaviour ($p < 0.01$). According to Pascual-Alonso et al. (2015) artificial rearing before weaning creates a positive human-animal relationship reducing stress and improving lamb welfare. In this case, when lambs are artificially reared, human is accepted as a social substitute, which relieves the stress of weaning (Boivin et al., 2000).

De et al. (2017) describes lying down as a factor of rest and as an indicator of good animal welfare. This could support our results, namely the AR lambs

Table 4: Behaviour of the naturally (NR) versus the artificially reared (AR) lambs after weaning

Behavior, min/h	NR	AR	SEM	p-value
Standing	10.56	4.23	0.534	*
Movement	15.31	10.28	0.435	*
Lying	26.52	30.01	0.433	*
Play	2.17	5.14	0.193	*
Meal	5.44	10.34	0.341	*

* $p < 0.01$

spent 12% more time lying down after weaning than NR lambs (Table 4). The possible reason for this is that during the first days after weaning, the NR lambs await their social behaviour in the first days after weaning and spend much of their time standing or moving (Figure 3ab).

Play behaviour is an indicator of animal welfare in which the individual behaves in a spontaneous and flexible manner (Burghardt, 2005). It is an indicator of animal welfare (Oliveira et al., 2010), evident when they are healthy, fed and stress-free (Burghardt, 2005). Abrupt weaning, lack of milk and loss of social patterns are stressful for animals (Damián et al., 2013; de Melo et al., 2022). In calves, the change in behaviour may last several weeks (Veissier & Le Neindre, 1989). In our study, play behaviour in NR lambs completely stopped on the first day after weaning, and gradually increased thereafter (Figure 3d). This shows that the change in behaviour and the occurrence of anxiety in the animals in our study happens in the first 24 hours after weaning, while in other studies it lasted up to few days after weaning in lambs and calves (Veissier & Le Neindre, 1989; Boland et al., 2008; Norouzian, 2015).

In our study, abrupt weaning further increased emotional stress in the NR lambs, which was also confirmed in the study by Norouzian (2015), where the animals were weaned at 6 weeks of age. The author found that the lambs that were weaned by withdrawing part of the milk for a week showed lower arousal, which lead to less stress, compared to quickly weaned animals. The reason for this according to de Melo & Ungerfeld (2016), is that social, emotional, and nutritional changes occur that increase cortisol levels (Mohapatra et al., 2021). This is described as a physiological response to stress, in which cortisol levels rise (Mears & Brown, 1997) and energy expenditure increases in the animals' not yet stabilised physiological state to the new living environment (de Melo et al., 2022).

Yau & Potenza (2013) indicated that emotional stress increases the animals' appetite, which was not the case in our study, in which the NR lambs spent less time feeding (Figure 2, Table 3). In our study, abrupt weaning of NR lambs not only affected body weight and growth, but also dramatically increased locomotor activity and standing at the expense of resting, eating, and play time. This indicates a change in behaviour and the onset of anxiety associated with weaning and separation from the dam. This requires further research and in-depth studies on the behavioural responses associated with separation from the dam and how we can mitigate its negative effects in early-weaned lambs.

5 CONCLUSION

In the study, AR lambs were found to have a higher ADG after weaning at 23 days of age, indicating that stress on this indicator is lower in AR lambs.

Natural rearing of lambs prior to weaning and early weaning (23 days of age), resulted in lambs spending less time and making fewer attempts to consume dry feed.

Early weaning of NR lambs was found to cause psychological and physical stress due to anticipation of their social model, where they spend a large part of the time standing and moving, and less time lying down and playing, compared with AR lambs. This shows that the method of rearing before weaning has a significant influence on the behaviour of NR lambs. This warrants further research into factors that influence behaviour and its control in early weaned lambs.

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