Süleyman Demirel Üniversitesi
Fen Bilimleri Enstitüsü Dergisi
Cilt 27, Sayı 3, 417-425, 2023

Süleyman Demirel University
Journal of Natural and Applied Sciences
Volume 27, Issue 3, 417-425, 2023

DOI: 10.19113/sdufenbed.1263561

The Effects of Milk Feeding Frequency on the Growth and Behaviour of the Calves

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(Alınış / Received: 11.03.2023, Kabul / Accepted: 15.05.2023, Online Yayınlanma / Published Online: 25.12.2023)

Keywords
Milk feeding frequency,
Growth,
Behaviour,
Health,
Calves

Abstract: In this study, it was aimed to examine the effects of milk feeding frequency on the growth, behaviour and health of calves during the suckling period. The Holstein calves (5 in each group) at the age of 5-day-old were used in the study. Computer controlled feeder (CCF) was used in the study. First group calves were given 4 lt/day of milk replacer feed (G1), in the morning and evening. In the second group (G2), a maximum of 12 lt/day of milk, which is natural suckling behaviour, in the morning (05:00-08:00), midday (10:00-13:00)i evening (16:00-20:00) were allowed to consume substitute feed. The time spent for rumination by both groups was close to each other. Cross-sucking and vocalization behaviour was more common in G1, but decreased with age. Tongue Rolling behaviour was more common in G2, but decreased with age. The results showed that the milk feeding frequency did not have a significant effect on the behavioural patterns of the calves.

Süt İçirme Sıklığının Buzağıların Davranışları Üzerine Etkileri

Anahtar Kelimeler
Süt içme sıklığı,
Gelişim,
Davranış,
Sağlık,
Buzağı

Öz: Yapılan bu çalışmada, süt içme sıklığının süt içme dönemindeki buzağıların davranış özellikleri üzerine etkilerinin incelenmesi amaçlanmıştır. Çalışmada 5 günlük yaşta 10 adet (her grupta 5 buzağı) Holstein buzağı kullanılmıştır. Çalışmada bilgisayar kontrollü besleyici (BKB) kullanılmıştır. Birinci grup buzağılara, sabah-akşam olmak üzere 4 lt/gün süt ikame yemi (G1) verilmiştir. İkinci gruba (G2) ise doğal emzirme davranışı olan sabah (05:00-08:00), öğlen (10:00-13:00), akşam (16:00-20:00) olmak üzere azami 12 lt/gün süt ikame yemi tüketmelerine müsaade edilmiştir. Her iki grubun ruminasyon için harcadıkları zaman birbirine yakın olmuştur. Çapraz emme davranışı ve bağırma G1'de fazla görülmüştür ancak yaşla beraber azalma gözlenmiştir. Dil çevirme davranışı G2'de fazlaca görülmüş ancak yaşla beraber azalmıştır. Elde edilen sonuçlar, süt içme sıklığının buzağıların davranış kalıpları üzerine önemli etkisinin olmadığını göstermiştir.

1. Introduction

The study was approved by the Animal Experiments Local Ethics Committee Isparta University of Applied Sciences with its decision date 27.05.2021 and numbered 002.

In recent years, there has been concern and pressure from conscious consumers about the welfare of livestock. This affects the preferences of consumers of animal products and increases the pressure to introduce animal welfare legislation. The legislation on animal welfare in the European Union countries is one of the strongest in the world, and the import of animal products that do not comply with this legislation is limited [1, 2].

Calves, which are the future of the herd, should be fed as high-yielding dairy cows or fast-growing livestock in the future. For this reason, great care must be taken in the rearing of calves. The amount of milk and the methods of feeding with milk can affect behaviour and welfare. Raising in individual boxes, deprivation of sucking behaviour and restricted milk intake are considered factors that can reduce calf welfare [3].

In modern dairy farms, most calves are separated from their dams within the first 24 hours after birth. This type of herd management does not allow adequate bonding between the dam and the calf and prevents the natural sucking behaviour of the calves.

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Various methods have been used and tried to give milk to calves for many years. Undesirable sucking behaviours have emerged due to insufficient sucking behaviour in feeding milk calves with bottles [4].

In the traditional calf rearing method, the amount of milk intake is restricted and 8-10% of the live weight of milk [5] or 500 grams of powdered milk per day per calf [6] is recommended. However, when calves are reared by the dam, the lactation process takes place in three periods of the day; early morning (05:00-08:00), midday (10:00-13:00) and afternoon (16:00-20:00) [7, 8].

Calves born in dairy cattle are separated immediately after birth and are fed a restricted of milk twice a day, usually with bottled or bucket-nipple. This situation increases the milk sucking desire of the calves [9] and they can perform a large number of non-nutritive sucking actions; they suck the materials of the boxes where they are reared, suck them with close neighbour calves, this is called cross-sucking [3, 10]. Cross-sucking can lead to inter-sucking, i.e. between heifers and cows [11, 12, 13]. It was defined by [14] that the calf's desire to suckle is a need because the animal must perform the suckling behaviour in order to intake milk and satisfy its hunger.

As stated above, the difference in milk feeding methods has an impact on the performance, behaviour and welfare of the calves. The difference of milk feeding methods affects the level of stress to which it is exposed and thıs the behaviour of the calf. However, the amount of milk and the frequency of feeding the calves also affect the calves' behaviour. This study contributes to the understanding of the effects of the frequency of giving milk replacer to the calves with computer-controlled automatic feeders on the growth, behaviour and health of the calves.

The aim of this study is to examine the effects of milk feeding frequency on the growth, behaviour, feed intake and health of calves during the suckling period. The study sought and answers to the following questions:

- How does the amount and frequency of milk given to calves fed with a computer- controlled automatic milk feeder affect the growth and feed intake?
- How does this affect the growth of calves' oral behaviour?
- How does this affect the oxidative stress level in calves during the suckling period?
- How does this affect the antioxidative defense mechanism and the immune response?

2. Material and Method

2.1. Animal material

In the study, 10 Holstein calves born in Isparta University of Applied Sciences, Faculty of Agriculture, Education, Research and Application Farm were used. The power analysis method was used to determine the number of animals, and according to the frequency of diarrhoea cases, the highest value average was 17, the lowest value average was 3, and the standard deviation was 0.35, and it was found that 5 animals in each group were required for 95% power.

2.2. Feed material

In the study, commercially starter and milk replacer used on the farm were used.

2.3. Method

Calves with similar live weights at an average 5-old-day were divided into 2 groups. The first group (G1) was fed with traditional method. This group includes milk replacer (Pro Milk, Interchem Limited, Dublin, Ireland) with a total of 4 lt/day computer-controlled automatic feeder (I-Mom, ITech Robotic Automation Ltd. Sti., Isparta, Turkiye). The second group (G2) was fed with a computer-controlled automatic feeder in the morning (05:00-08:00), midday (10:00-13:00), evening (16:00-20:00), which is natural sucking behaviour [7, 8]. The G2 was allowed to intake a maximum of 12 lt/day of milk replacer. The milk replacer was prepared in a computer controlled automatic feeder according to the daily limits of the calves during suckling. For 1 litre of milk replacer, an average of 125 grams of powder was mixed with water at 38-40 ^{0}C and fed to the calves.

2.4. Calf behaviour

Calves were recorded with Everest QC.Q1.F1 digital camera (Segment Computer Inc. Ltd., Istanbul, Turkiye). Behaviours of calves were recorded between 06:00-09:00, 13:00-16:00, 19:00-22:00 and 22:00-24:00. The observed behaviour of the calves is shown below:

Table 1. Behaviours observed in calves and their description

Behaviour	Definition
Eating starter	Calf having starter in its mouth or head in the concentrate trough
Ruminating	Repetitive movements of lower jaw in the lateral plane
Sucking	The time when the calf had a teat in its mouth
Licking itself	Calf licking any part of itself
Licking penmate	Calf's tongue touching any part of another calf
Licking structures	Calf's tongue touching any part of pen structures or teat buckets
Biting structures	Calf holding any part of the pen structures between jaws
Cross-sucking	Calf sucking any part of another calf
Tongue rolling	Calf rolling its tongue in a repetitive way outside the mouth
Vocalization	Calf keeping its head stretched upwards and mouth open

When the calves reached the 2-month-old, milk feeding was reduced to one meal, and the amount of milk intake was given by decreasing every day, and the calves were weaned at the end of 7 days. The experiment was terminated when the calves were reduced to a single meal.

2.5. Statistical analyses

T_Test was used in the analysis of behavioural data obtained from the study, and repeated measurements analysis of variance technique was used in the analysis of computer-controlled automatic feeder and feeder visits. Differences between groups were examined with the Tukey test. Minitab 20 (Minitab, LLC, 2020, Penn State, USA) package program was used in the analysis of the data.

3. Results

3.1. CCF visit

As seen in Figure 1, G1 spent more time in CCF in the first days. After 40-day-old, G2 spent more time in CCF.

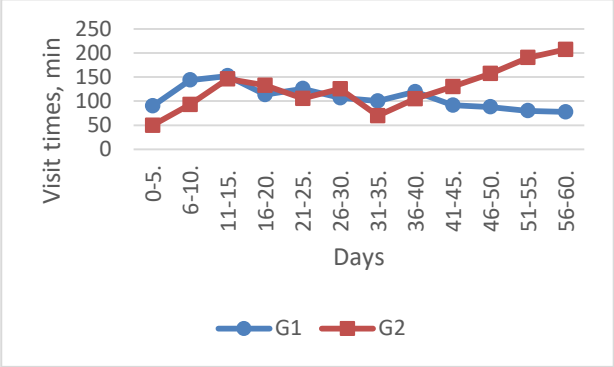

Figure 1. Total time spent by calves in CCF

The awarded visit times of the calves in CCF are shown in Figure 2. Naturally, G2 spent more time in CCF while milk intake. The time used by both groups for milk intake in CCF increased at first, but decreased over time.

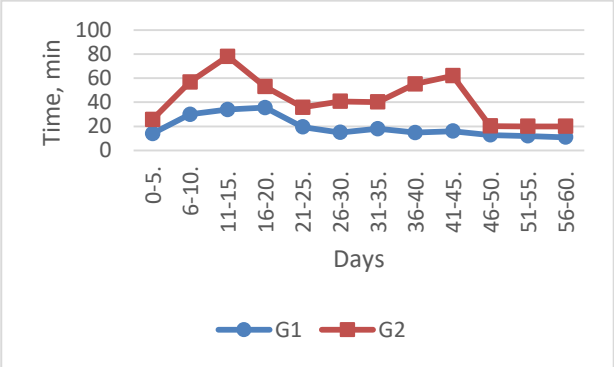

Figure 2. Awarded visit times of calves in CCF

The unrewarded visit times of the calves in the CCF are shown in Figure 3. G1 spent more time without milk intake in the first days. However, after 45-day-old, G2's unrewarded visit time has increased.

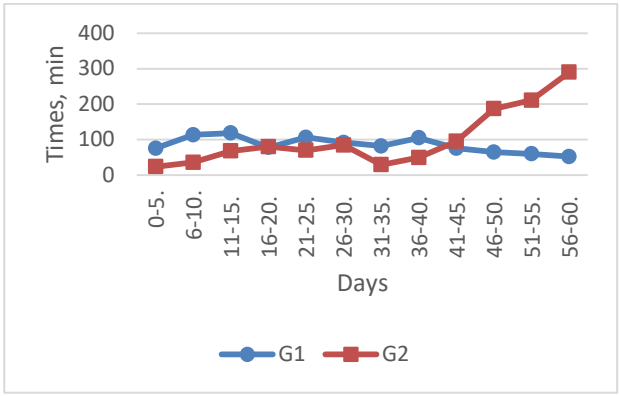

Figure 3. Unrewarded visit times of calves in CCF

3.2. Starter Feeder visit

In the first weeks of life, calves are fed with liquid feed because their rumen is undeveloped. As seen Figure 4, the number of feeder visits in the first days of their lives was similar for both groups. Feeder visits have increased in parallel with the age of the calves. However, G1 made more feeder visits than G2.

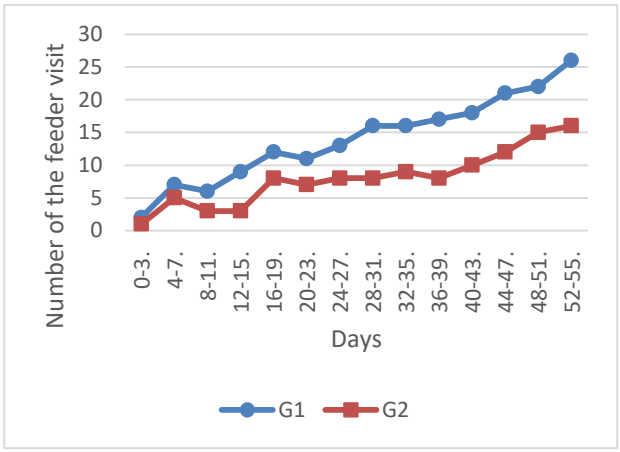

Figure 4. Daily starter feeder visits of calves

Feeder visits of calves in the morning, midday, evening and night hours are shown in Figure 5. After morning milk feeding, G1 visited the feeder, while G2 did not. Feeder visits of G1 remained almost the same as morning visits at midday, while G2 increased until midday milk feeding. After midday feeding, feeder visits of G2 decreased while G1 increased. After the evening milk feeding was finished, G1 increased their feeder visits, while the G2 decreased compared to midday, however, increased compared to morning. The night feeder visits of both groups were close to each other.

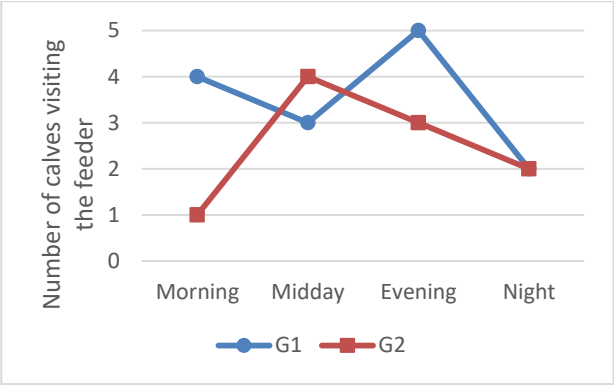

Figure 5. Starter Feeder visits of calves at meals

3.3. Ruminating

Rumination times of calves increased with age (Figure 6). Calves that spent less time ruminating in the early lives spent more time ruminating as they got older. However, G1 spent more time ın the rumination than G2.

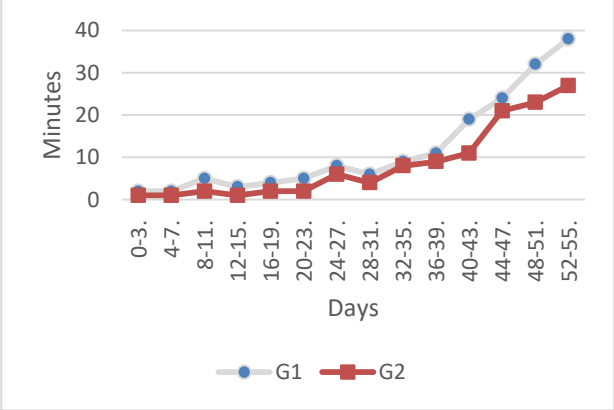

Figure 6. Time spent rumination

While G1 started to ruminate in the morning, this situation decreased at midday, but increased in the evening (Figure 7). In addition, while G2 calves did not ruminate much in the morning, rumination increased at midday and remained the same at night.

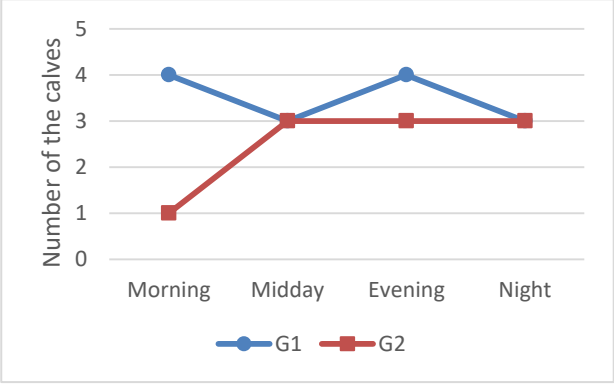

Figure 7. Preferred time period of calves for rumination

3.4. Cross-sucking and tongue rolling

Undesirable behaviour such as cross-sucking was observed in G1 more than in G2 (Figure 8).

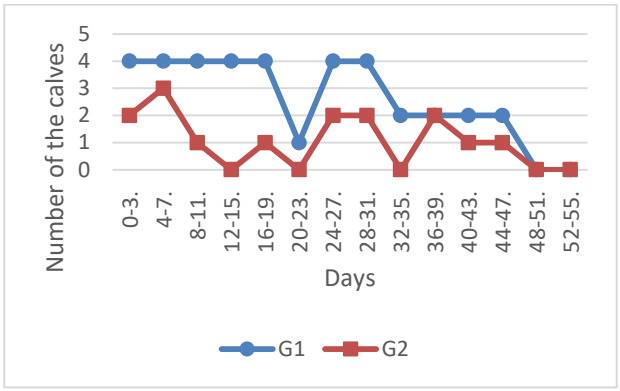

Figure 8. Calves with cross-sucking behaviour

Tongue rolling behaviour was higher in G2 than G1 (Figure 9).

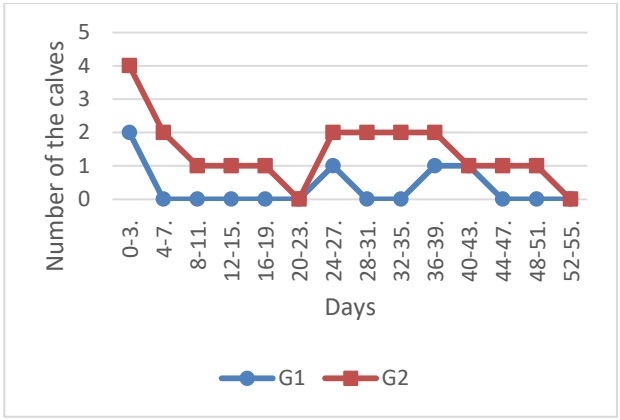

Figure 9. Calves with tongue rolling behaviour

3.5. Vocalization

Vocalization behaviour was observed more in G1 (Figure 10). More vocalization in absence of milk.

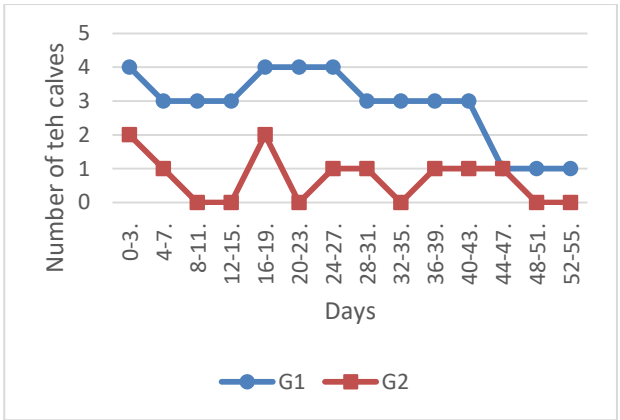

Figure 10. Vocalization behaviour

3.6. Licking itself

Group 1 (G1) performed more self-licking behaviour than G2 (Figure 11). However, this behaviour decreased with age.

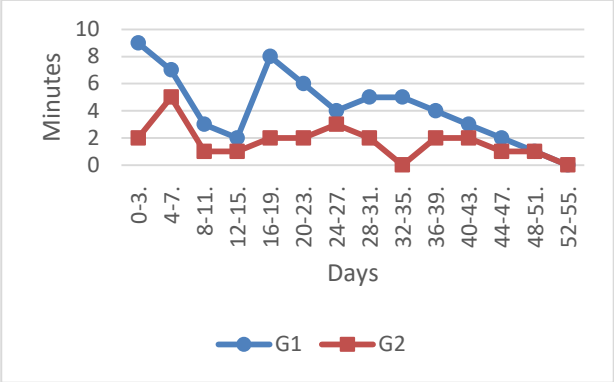

Figure 11. Self-licking behaviour

3.7. Licking and biting structures

Behaviours such as licking and biting structures were almost absent in the both groups (figure 12). Although there behaviours were higher in G1 in the first days, a decrease In these behaviours was observed in the other periods of their lives.

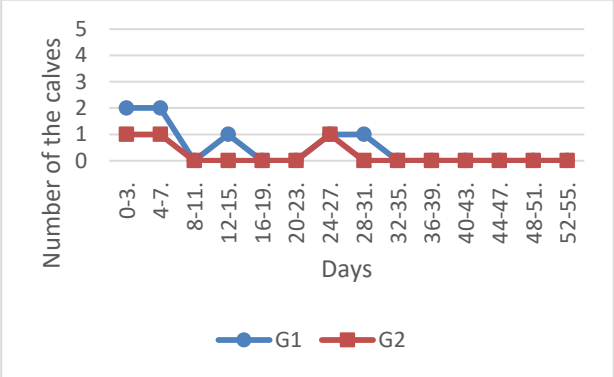

Figure 12. Licking and biting structure behaviours

3.8. Licking penmate

Licking penmate behaviour was observed more in G1 than in G2 (Figure 13). Licking penmate behaviour decreased with age.

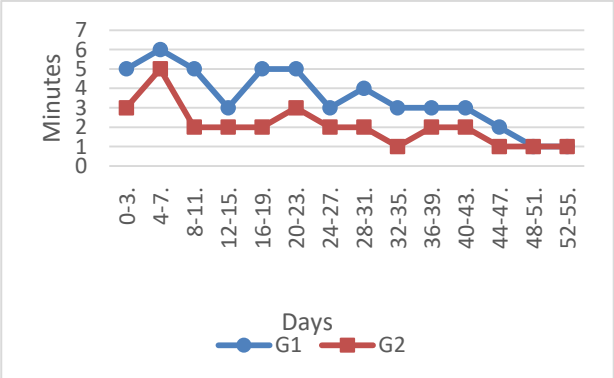

Figure 13. Licking penmate

4. Discussion and Conclusion

4.1. CCF visit

Calves fed a high percentage of milk or milk replacer reduce their visits to automatic feeding systems [15, 16]. However, calves fed with restricted milk frequently visit the feeder, although they do not receive milk during these visits [17]. Calves fed with restricted milk exhibit more frequent but shorter visits to the feeder [18]. Similar results were observed in our study. However, while this visits of the calves fed with restricted milk (G1) to the feeder decreased with age, the visits of the other group (G2) increased. It is thought that the reason for the increase in feeder visits of calves is hunger [19] and hunger increases the desire to suckle in calves [20].

4.2. Starter Feeder visit

In the first weeks of life, calves are fed with liquid foods because their rumen is underdeveloped, and the number of feeder visits in the first days of their lives was similar for both groups. Feeder visits have increased in parallel with the age of the calves. Since the rumen of newborn calves in underdeveloped and the main food sources are milk and/or milk replacer in the first weeks of their lives, they restricted their starter consumption [21]. Therefore, CCF visits are increase and feeder visits are decrease in the first weeks of their lives.

Feeding calves with 4-6 liters of milk daily is not sufficient for hunger [22]. Feeding high amounts of milk reduced the calves' hunger and increased the calves welfare [18, 23]. Calves fed with restricted liquid feed during the sucking period increase solid feed intake and therefore feeder visits increase [24].

4.3. Ruminating

In this study, it was observed that calves fed with high amount milk spare less time for rumination compared to calves fed with restricted milk. The reason for this may be the small amount of starter intake of the calves fed with high amount milk during the suckling period. This may be an indication that the rumen of calves fed with high amount milk is not well developed compared to those fed with restricted milk [25]. It has been reported that feeding with high amounts of milk suppresses metabolic and physical rumen development [26, 27, 28]. Hepola [25] reported that calves fed with restricted milk spend more time the rumination than calves fed *ad* libitum. It has been reported that calves fed with hgih amounts of milk spend less time for rumination [19]. After the calves start solid feed intake, they start to ruminate at 3-wk-age and increase the time they spend for rumination in parallel with solid feed intake [21].

4.4. Cross-sucking and tongue rolling

Cross-sucking behaviour is observed in calves suckling their dams [29]. In addition, this undesirable behaviour is more common in bucket-fed calves than in bottle-fed calves [30]. Cross-sucking can cause inflammation and hair loss in the absorbed body part [10, 31]. This behaviour can also cause mutual sucking, which means heifers and cows suck each other [11, 12, 13]. It has been reported that cross-sucking usually occurs within the first 10 min after milk feeding [31, 32] and this is related to the method of milk feeding [10]. As a matter of fact, cross-sucking behaviour was observed in restricted milk feeding group after morning and evening.

Studies have shown that calves housed in group's exhibit more cross-sucking behaviour than calves housed individually [33, 34]. Increasing the daily amount of milk reduces the occurrence of cross-sucking in calves [35].

It has been reported that stereotypical tongue-rolling behaviour occurs very rarely in calves fed with restricted milk [25]. Our study supports this result. Tongue-rolling behaviour rarely occurs in calves fed with restricted milk, probably because they have free access to solid forage [36]. Low solid feed intake improves tongue-rolling behaviour [37].

It has been reported that tongue-rolling behaviour is observed in calves fed a*d* libitum after morning meals [25]. As matter of fact, tongue-rolling behaviour was higher in G2 after morning meals. Intake of large amounts of milk reduces solid feed intake, which may tongue-rolling behaviour, [38] reported.

4.5. Vocalization

Calves' sense of hunger probably encourages them to vocalization [39]. Calves may vocalise loudly with the frustration of not milk feeding. They may also react to separation from the milk feeder [40]. Vocalization levels of calves with their dams are much lower than those of calves fed with restricted milk [41].

4.6. Licking itself

Calves with natural suckling behaviour spend less time licking themselves than calves fed with restricted milk [42, 43]. In addition, it has been reported by [44] that bottle-fed calves exhibit significantly more licking-self behaviour than calves suckle their dams.

4.7. Licking and biting structures

Behaviours such as material licking and biting have been observed in bucket-fed calves after a milk-feeding meal [31, 45, 46].

4.8. Licking pen-mate

No literature on this behaviour was found, so discussion with previous studies was not possible.

4.9. Conclusion

Calves fed with restricted milk spent more time at the feeder in the early days. However, the duration of visits to the feeder increase in groups that intake high amounts milk as they got older. As expected, visits with awards were higher in the group that intake high amount milk. Unrewarded visits were performed by calves fed with restricted milk. In addition, calves fed with restricted milk visited the starter feeder greater numbers.

The time spent for rumination was low in younger calves, but increased time spent ruminating as calves got older. Calves with restricted milk had more rumination time compared to calves fed with high amount milk. While calves fed with restricted milk preferred rumination after morning and evening meals, calves fed with high amount milk did not prefer rumination after morning meal.

Licking-self behaviour patterns were similar in both groups. Although the calves frequently preferred the licking-self behaviour pattern in the first period of their lives, they did not prefer this behaviour pattern with age. Licking pattern of roommate also showed similarity with licking-self behaviour pattern.

In the first period of their lives, the calves of both groups had more licking and biting structures behaviours. However, calves fed with restricted milk exhibited these behavioural patterns more than calves fed with high amount milk. This pattern of behaviour disappears with age.

Cross-sucking, which is one of the undesirable behaviour patterns in calves, was more common in calves' intake restricted milk. However, this behaviour pattern decreased with age in both groups. The tongue-rolling behaviour after was observed in calves fed with high amount milk. Although this behaviour pattern has decreased and increased over time, the calves have moved away from the behaviour pattern with age.

The pattern of vocalization behaviour, which is tough to be a sign of hunger, was observed more frequently in calves fed with restricted milk. However, with age, calves have moved away from this behaviour.

In this study, it has been to explain the changes in the behavioural patterns of calves by feeding different amounts and frequency of milk replacer during the suckling period. However, it also drew attention to some questions. Some of the issues to be explored in the future are:

1) Can the cross-sucking behaviour pattern, which is an undesirable behaviour that occurs during the suckling period, be prevented or how can it be prevented? For this, different strategies should be tried.

2) The effects of different feeding strategies on the undesirable behaviour of calves should be investigated in computer controlled feeders. For example, feeding with restricted milk at first, increasing the amount of milk in parallel with increasing age, and decreasing the amount of milk as weaning approaches.

3) How does the division of calves into male and female groups during the milk drinking period affect their behaviour?

Acknowledgment

We would like to thank the Isparta University of Applied Sciences Scientific Research Projects Management Unit, which financially supported the the study with Project no 2020-YL1-0107.

Declaration of Ethical Code

In this study, we undertake that all the rules required to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with, and that none of the actions stated under the heading "Actions against Scientific Research and Publication Ethics" are not carried out.

The study was approved by the Animal Experiments Local Ethics Committee Isparta University of Applied Sciences with its decision date 27.05.2021 and numbered 002.

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