agriculture

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Effect of Different Rearing during the Milk-Feeding Period on Growth of Dairy Calves

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Received: 14 June 2020; Accepted: 7 August 2020; Published: 10 August 2020

Abstract: The objective was to determine the impact of calves' rearing, gender, and the sire lineage on the growth and health. One hundred-and-five Holstein calves were assigned to one of three treatments: single suckling (SS), multiple suckling (MS), and artificially rearing in hutches (H). All calves received a comparable amount of milk/milk replacer (MR) across treatments. All calves were weaned at the 84th day. After weaning, all calves were separated by sex in age-balanced groups. At weaning, the highest body weight was in MS and the lowest in H (SS 94.97 kg, MS 109.85 kg, H 80.80 kg, $p < 0.001$). The average gains from the birth to weaning were 0.67 kg (SS), 0.81 kg (MS), 0.48 kg (H), ($p < 0.001$). A difference ($p < 0.01$) was found for the period from birth to 180th day of life (SS 0.75 kg, MS 0.82 kg, H 0.67 kg). We did not notice a gender differences ($p > 0.05$). The Sire 1 progeny showed a lower body weight at 180 days ($p < 0.01$) and 360 days ($p < 0.05$). The results indicate that the method used to rear calves and sire lines had a significant impact on their later performance.

Keywords: calves; feeding; housing; weaning; animal welfare

1. Introduction

The early separation of the calf from the cow is common in the dairy industry and is deemed by some to be essential to maximum production [1,2]. However, it is expected that the delayed separation of calf from mother may improve welfare and growth of dairy calves. Under ecological or organic conditions, cow and calf remain together until weaning at 6–8 months [1]. In contrast, on many commercial dairy farms, calves are abruptly separated from cows within a few hours of birth [3–5]. Dams return to the milking herd while calves are artificially reared in isolation or in groups. Calves are fed rationed quantities of milk or milk replacer (MR) until weaning from milk nutrition, approximately 4–12 weeks [6].

In past years, a number of authors have explored different ways of keeping dairy cows and calves together [1,2,5]. They found possible benefits of these manners as calf growth and behavioural development. The suckling systems can be divided into more different categories depending on the farming type purpose and duration of the suckling period [7,8].

Some suckling systems restrict the contact between mother and young to half the day or to short periods after milking, only; others allow 24 h/d contact. Restricted suckling means that the calf is allowed to suckle its own dam during short periods daily. Cow and calf may stay together for 2 × 15 min [9,10] or 2 × 30 min [11,12]. For the rest of the day, cow and calf are separated [8,9]. The cow calf contact system implies that 2–4 calves are kept together and suckle one nursing cow [1,13,14]. The ratio of nurse/foster cows to calves should be adjusted so that each calf receives at least 4–6 kg/day

of milk. All calves should be matched for age and body weight [8,14–16]. Calves may be with wiped amniotic fluid or transfer odour prior to discharge to a cow [15,17].

For many years, ad libitum (ADL) whole milk or MR feeding is propagated in calf rearing [1,7,18]. Authors found the large discrepancy between the low amount of milk usually fed to calves on farms and the large amount of milk that the calves will drink when allowed to suckle ADL from their dam or nurse cow [8,19–21]. Restrictive suckling calves often consumed less milk than those reared artificially by the automatic milk-feeder or in the nipple buckets Consumption of milk in calves which are allowed to suckle depends on milking, time suckling, and whether there is more than one calf [22].

Compared with calves provided ADL milk, calves fed restricted amounts of milk have greater rates of concentrate mixture (CM) intake [23,24]. On the contrary, the CM intake was higher in the calves receiving milk than those fed MR [25]. Also, calves fed high amounts of MR usually present low CM intake [26–28]. Calves artificially reared ate more CM than those under restrictive suckling [18,29].

Generally, calves on a low milk allowance had a significantly lower growth than the calves on high milk allowance [30–32]. Also, the prolonged period of nursing increased calf average daily gains (ADG) during the milk-feeding period [33–35].

A number of articles report a higher ADG in ADL fed calves or restricted-suckling (2 × 30 min after milking) than in artificial reared calves (nipple bottles or buckets at the same time) [11,19,27,35–37]. It is important, how much MR given to artificially reared calves. However, some authors found no difference or lower ADG [12,38–40].

The objective was to determine the impact of the calves rearing, gender, and the sire lineage on the growth and health. We tested a hypothesis that dairy calves' growth and health are influenced by the rearing manner (Single suckling, SS; Multiple suckling, MS; Artificial rearing by nipple of bucket sucking, hutches, H), gender, and the sire lineage.

2. Materials and Methods

The study was performed in Nitra, Slovakia. The experimental period lasted for 360 days, but the whole experiment lasted 16 months. Each calf was evaluated for 360 days. We could not include all animals in the experiment at once, so the whole experiment was extended to 16 months. Males and females were 360 days in the experiment.

2.1. Animals and Treatments

At the birth, 105 Holstein calves (53 males and 52 females, descended from 4 sires) were consecutively assigned into the three treatments groups, balancing for gender but not sire or birth weight.

Group SS (n = 36, 18 males, 18 females) were housed separately in a common individual pen with the mother (milked from 2nd day at 05:00 and 16:00) until the 21st day; suckled their mother's udder 10 min 3 times per day (8:00, 13:00, 18:00), then let loose in a housing pen from the 22nd day (6 kg any cow milk per day, 2 × daily 3 kg, bucket with nipple). The health condition of SS cows was checked precisely. Disease occurrence was recorded by researchers (each day) and the project veterinarian who examined the animals clinically (every second morning). Group MS (n = 34, 17 males, 17 females), after 3 days kept with their own mother in individual pens, were then put in pens with non-milked nursing cows from the 4th day; calves could suckle at any time, usually 3–5 times per day. A total of 14 cows were used, of which 5 for 2nd parity, 7 for 3rd parity and 2 for 4th parity. Ten cows were in the mid lactation stage and 4 in the late lactation stage. Nursing cows were selected from milking cows of the herd. Their health and udder health status were checked before the start of the experiment, they had to be perfectly healthy and their temperament had to be mild. During the experiment, their health and udder health status were checked once a week. They had no health problems.

Group H (n = 35, 18 males, 17 females), after having nursed their dams in individual pens for 24 h in hutches from the 2nd to 56th day (bucket with nipple, MR, 2nd day 3 × 0.5 kg, 3rd day 3 × 1.0 kg, 4th day 3 × 1.5 kg, from 5th day 6 kg/day, to 21st day 3 × daily), were then kept in loose housing pens to wean from the 57th day (bucket with nipple, MR, 6 kg/day, 2 × daily).

Experimental calves originated from four sires (S1, S2, S3 and S4). The distribution was as follows: SS (S1 = 8, S2 = 5, S3 = 14, S4 = 9); MS (S1 = 3, S2 = 10, S3 = 15, S4 = 6) and H (S1 = 5, S2 = 9, S3 = 12, S4 = 9). By gender, this represented: males (S1 = 9, S2 = 10, S3 = 20, S4 = 14) and females (S1 = 7, S2 = 14, S3 = 21, S4 = 10). All animals were weaned abruptly at the age of 12 weeks and moved to a group housing pen, where equal conditions of nutrition were ensured. The transfer was made at the exact age of 84 days. Each treatment group separate pens for males and females, also pens were differentiated by age, so that the age difference in one pen was not higher than 21 days. Approximately 10–15 calves were kept in a pen of 9 × 4.5 m.

2.2. Feeding Managements and Experimental Procedures

Calves in all groups were kept in individual pen with mother and received colostrum for the first 24 h by suckling ad libitum. If some calves did not want to suckle, they were fed with a teat-bottle (two hours after the birth).

From the 2nd day until weaning the calves were offered starter concentrate mixture (SCM) and alfalfa hay ADL.

Consumed amounts of milk, MR, and other feeds were taken from 4th to 84th day. Suckling time a mother's udder (10 min) of SS calves was determined during preparation on experiment according to [41]. We wanted to know how much milk will be available to the calf during suckling. The calves were weighed immediately before and after each suckling to assess milk intake. For 3 × 10 min, the calf should receive 6 kg of milk from the average herd cow. At current experiment, these SS calves were also weighted before and after each suckling.

Number of MS calves per nursing cow was determined according to milk yield of selected cows, so that 6 kg of milk per calf and day should be available. All designated calves were well adopted by the cows. The adoption criterion was when the cow allowed the calf to suckle in the inverse parallel position and licked it. No amniotic liquid had to be used. Milk yield controls were performed on the last day before moving to the experiment and then weekly thereafter. It was not possible to measure milk consumption at MS calves at every suckling event.

Milk replacer (Lactavit12, MILKP Slovakia) consumption in H group calves was taught by weighing at every individual drink (to 21st day 3 × daily, hutch; from 22nd day 2 × daily, hutch and then group housing from 57th day to weaning at 84th day, 2 × daily).

The SS and MS calves could eat SCM and alfalfa hay from a special feeder ADL, the calves had no access to feed the cows from the trough. Cows could not eat from the calves' feeder. The H group calves received SCM from a bucket and alfalfa hay from crib feeder. Feed refusals were removed and weighed each morning before feeding throughout the whole milk-feeding period. All calves offered the same SCM and forage.

After weaning, feed was available throughout the 24 h periods. Calves were fed alfalfa hay and corn silage ADL and 1.5 kg/day of SCM (TKS, PZa Slovakia) from a group feeder, but the intake was not recorded.

From 181 days, the bulls and heifers in all three groups were fed the same total mixed feed ration (TMR) throughout the study. The CM (used from 181 to 360 days, 1.5 kg/day) was fed separately. The consumption was not recorded. Drinking water was available at all times throughout the study.

The cows' SS and MS groups were fed the TMR. The Feed ration contained 16.5 kg of dry matter (DM), 104.1 MJ net energy content for lactation (NEL), 1.44 kg of protein digestible in the small intestine (PDI) and 2.32 kg of crude protein. The TMR was administered to troughs by a feeding wagon. Feed troughs were raised 0.68 m above ground. The cows did not receive concentrates separately. Feeding was allowed throughout the 24 h period. Automatic watering troughs were located next to feed bunks. The total mixed ration was calculated according to Slovakian nutrient requirements of dairy cattle [42].

The methods of Larson et al. [43] and Slavik et al. [44] for the daily evaluation of the health (e.g., diarrhoea, respiratory condition, mastitis, laminitis) was used. For the expression of diarrhoea, colour and consistency of faeces (i.e., yellow, code 0; green, code 1; white, code 2; red, code 3; pink, code 4;

brown, code 5; dark or black, code 6) and consistency (i.e., liquid, code 0; normal, code 1; firm, code 2) was used.

Live body weight (LBW) of the calves was recorded at birth. All calves were weighed every week and then every month after weaning. The ADG is the rate of live weight gain per day over some period of time. It was calculated as the average change in live body weight during a specified period. The calves were weighed on the plate scale with LCD display (Soehnle, Germany), load capacity up to 200 kg and weighing accuracy +/− 0.1 kg. The live body weight of young cattle was determined to mobile livestock scale (DVM, Soehnle, Germany), load capacity up to 2000 kg and weighing accuracy +/− 0.2 kg.

2.3. Housing of Animals

Group SS was kept in individual pens of 4.5 × 4.5 m, one cow, one calf. A small part of the pen was separated for calf (1.2 × 4.5). The cow and the calf were loose.

Group MS was housed in a pen of 9 × 4.5 m (3 nursing cows and 10–12 calves). Cows were tied in the pen, and the calves were loose.

Hutches (group H) were made from fibreglass (white colour), used from the second day of life to relocation to group housing at the age of 8 weeks. Each hutch (1.8 × 1.2 m) had an outside fenced yard of 1.8 × 1.2 m, bedded with straw. Hutches were arranged in rows, 0.8 m apart.

The calves could see and touch each other through the openings in the upper part of the pen wall or fenced yard of the hutch. Each calf had free access to clean drinking water in a plastic bucket or automatic drinker throughout the study.

After weaning from milk feeding, all calves were separated by sex in age-balanced groups in loose housing bedded pens with the same ration. The calves had no visual contact with the dam or nursing mother, only acoustic.

The SS cows were milked twice a day at 05:00 and 16:00 after being driven by the herdsman a short distance within the barn to a holding area, which measured 13.5 m × 4.5 m, adjacent to the milking parlour. Cows entered the parlour individually once a milking stall was available. Upon exiting the parlour, cows remained in a separate holding area until all other cows in the group were milked.

2.4. Chemical Analyses

The MR (Lactavit12), SCM (TKS) and CM (KSJ) were analysed in the PZa Slovakia. Cow milk, alfalfa hay, corn silage, also feeds for TMR were analysed in the Nutrition laboratory of National Agricultural and Food Centre, Luzianky, Slovakia. Samples feeds were examined for DM (at 105 °C) and crude protein (Kjeldahl N) using Kjeltec Unit. Ether extract (using a Soxtec System, Tecator, Sweden) and ash (using at 550 °C) were determined according to AOAC (2000) while determination of crude fibre, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) was carried out using a Fibertec 1010 (Tecator, Hilleroed, Denkmark). Starch was determined on polarimeter ADP 220. For macro and micro elements analysis sample were burned at 550 °C, the ash was dissolved in 10 mL of HCl (1:3) and minerals were determined by Unicam AAS spectrometer iCE 3000 (Thermo Fisher Scientific, Waltham, USA), phosphorus content was determined by molybdate-vanadate reagent on CamSpec 501 (Spectronic CamSpec Ltd., Leeds, UK). Value of pH was determined using electrometric method, lactic acid and volatile fatty acids (acetic, propionic and butyric acid) content was determined by gas chromatography and alcohol content by micro-diffusion method.

Chemical composition of the solids in cow milk was crude protein 278.6 g/kg DM, crude fat 323.6 g/kg DM, lactose 342.6 g/kg DM, and ash 57.6 g/kg DM. The MR (DM 94.7%), was composed of dry whey, dry buttermilk, dry skimmed milk, animal fat, whey dried with vegetable oil, and wheat gluten (crude protein 226 g/kg DM, crude fat 196 g/kg DM, ash 87 g/kg DM and crude fibre 6.0 g/kg DM). The SCM (DM 89.3%) contained barley, wheat, soybean meal, oats, corn and mineral mixture (crude protein 214 g/kg DM, crude fat 32 g/kg DM and ash 81 g/kg DM). The CM (DM 90.1%) contained

sunflower cake, cotton seed cake, corn, wheat bran, mineral mixture, salt (crude protein 183 g/kg DM, crude fat 35 g/kg DM, and ash 92 g/kg DM).

Composition of alfalfa hay (DM 88.8%) was crude protein 212 g/kg DM, total digestible nutrients 595 g/kg DM, acid detergent fibre 294 g/kg DM, neutral detergent fibre 351 g/kg DM, Ca 13.8 g/kg DM, and P 2.6 g/kg DM. Composition of corn silage (DM 43.21%, pH 4.06) represented crude protein 68.6 g/kg DM, starch 406 g/kg DM, non-fibrous carbohydrates 518 g/kg DM, sugar 12.0 g/kg DM, crude fat 33.4 g/kg DM, acid detergent fibre 232.8 g/kg DM, neutral detergent fibre 345.1 g/kg DM, ash 51.8 g/kg DM, Ca 2.2 g/kg DM, P 2.3 g/kg DM, Mg 1.5 g/kg DM, K 9.3 g/kg DM and S 1.3 g/kg DM).

2.5. Statistical Analyses

The data were analysed using a general linear model ANOVA (AOV/AOCV) by the statistical package STATISTIX, Version 10.0. The dependent variables were LBW, ADG, consumption of feed to weaning, colour and consistency of faeces and the independent variables were treatment group (T), gender (G) and sire lineage (S).

The normality of data distribution was evaluated by the Wilk–Shapiro/Rankin Plot procedure. The homogeneity of variance of the observed variables in groups was calculated by preliminary variance tests which determined whether the variabilities were equal. The Bartlett's test for the equality of variance tests was used for an unequal size of samples. Differences among groups were tested by comparisons of mean ranks. Significant differences among means were tested by Bonferroni's test.

All values are reported as means ± standard deviation. The interactions among observed factors (treatment, gender and sire lineage) were also computed.

The following model of general AOV/AOCV on observed factors (treatment and sire lineage) was used:

$$Yijk = \mu + Ti + Gj + Sk + \alpha ij + \beta ik + \gamma jk + \varepsilon ijk$$

where Yijk is a dependent variable, μ is the overall mean, Ti is the effect of factor treatment on the level i, Gj is the effect of factor gender on the level j, Sk is the effect of factor sire lineage on the level k, αij is the interaction between factor T on the level i and factor G on the level j, βik is the interaction between factor T on the level i and factor S on the level k, γjk is the interaction between factor G on the level j and factor S on the level k and εijk is the residual error.

3. Results and Discussion

3.1. Feed Consumption and Health Condition

The calves of the SS group received from 4th to 84th day 406.4 ± 48.23 kg (5.08 kg/day) milk, MS group 412.52 ± 42.93 kg (5.16 kg/day) milk and the calves of H group 408.44 ± 32.65 kg (5.11 kg/day) of MR. Differences were not significant ($p > 0.05$).

The highest intake of SCM until weaning was recorded in group MS and the lowest in group SS (SS 34.25 ± 7.11 kg, 0.43 kg/day, MS 39.18 ± 9.20 kg, 0.49 kg/day, H 35.42 ± 7.67 kg, 0.44 kg/day, $p < 0.05$). No significant differences were found in alfalfa hay consumption (SS 28.91 ± 5.52 kg, 0.36 kg/day; MS 26.33 ± 6.18 kg, 0.33 kg/day; H 27.44 ± 6.24 kg, 0.34 kg/day).

Many studies show that the more milk calves drink, the lower is their SCM intake [23,24,26–28]. Based on the relatively similar amount of milk/MR drunk by the calves of the three treatment groups, we had expected that the calves' intake of solid feed and growth rate would not differ much. So, it is necessary to explain first, why the calves of the MS group consumed significantly the most SCM.

It has been reported that milk feeding level affects the feed intake of dairy calves [5,7,12,39]. It may be stated that normally suckled calves ingest more milk and then eat less concentrate [20,27,30]. At the present study, solid feed intake was the highest in the free suckled calves (MS) than in MR (H) fed or restrictive suckled (SS) calves. However, the latest research has indicated that reduced milk drink volume can encourage intake of solid feed [5,20,45,46] and when calves drink ad libitum, they usually eat less concentrates [23]. Reduced intake of solid feed is one of the disadvantages of increased milk

feeding [45]. In the present study, all calves drank a similar amount of milk, and SS calves ate less SCM. We can conclude that the reason for eating less concentrate is not the ingestion of high amounts of milk. Probably, MS calves ate more SCM the more contact they had with other cattle [1,13,24]. This group of calves was in loose housing for 80 days, without access to cows' feed. According to Costa et al. [47], social housing improves solid feed intakes and calf weight before and after calves are weaned from milk to solid feed.

The fact that SS calves ate less SCM to weaning than those that were bucket-fed (group H) may be disadvantageous for rumen development [30,48].

There is little published information on the solid feed intake of multiple suckling calves. As Loberg [49] points out, calves suckled by nursing cows and their mothers were likely to be highly motivated to consume any feed, especially when they were socially stimulated by eating adult animals. There were no differences among treatment groups in the colour and consistency of faeces. Colour showed a steadily trend from yellow to green and consistency changed smoothly from liquid to normal. No calf was sick. Calves neither died nor were culled for bad health.

3.2. Live Body Weight Growth

At birth, the LBW was not statistically different (SS 38.72 ± 6.32 kg, MS 41.59 ± 4.68 kg, H 40.31 ± 3.66 kg). At the weaning, the highest LBW was recorded in the MS group and the lowest in group H (SS 94.97 ± 16.69 kg, MS 109.85 ± 13.94 kg, H 80.80 ± 10.87 kg, $p < 0.001$) (Table 1). No significant interactions were found among the observed factors.

Table 1. The live body weight of calves and young cattle (kg).

Group	*N*	Mean	SD	Factor		
				Group	Sex	Sire
			Birth			
SS	36	38.72	6.32	NS	NS	NS
MS	34	41.59	4.68			
H	35	40.31	3.66			
			Day 84			
SS	36	94.97	16.69	0.0000	NS	NS
MS	34	109.85	13.94	SS:MS,H, ***		
H	35	80.80	10.87	MS:H ***		
			Day 180			
SS	36	173.00	26.56	0.0009	NS	0.0091
MS	34	190.24	27.86	MS:H ***		1:2 **
H	35	161.37	25.82			
			Day 360			
SS	35	335.89	41.72	0.0155	NS	0.0131
MS	34	361.85	46.51	MS:H *		1:2,3,4 *
H	34	328.03	40.78			

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; SS = single suckling group; MS = multiple suckling group; H = hutch group; *N* = number of animals; SD = standard deviation.

At the weaning from milk–liquid nutrition, the highest live weight of the MS group was recorded. It is possible that the MS calves consumed a higher amount of milk than the 6 kg/d estimated by milk yield control. A cow which is stimulated by frequent suckling produces more milk, as confirmed by the results in Reference [50]. However, we do not have the data to confirm or disprove whether they drank

more. However, suckling does not automatically increase milk production. In free suckling with only one calf, milk production can even decline, as the udder is not emptied properly. However, suckling of several calves empties the udder properly and, more often, can increase the milk production. Feeding high levels of milk may improve calf health and performance [21,34,51–53].

Perhaps, the long period spent with the nursing cow (MS group) before the weaning made the calves eat enough solid food to compensate for the loss of milk at weaning [14]. A lower weight gain in SS group can be explained as an effect of lower milk and SCM intake [1,7,11,20].

However, a high daily gain obtained through a high milk intake is not necessarily beneficial, because it results in a decreased intake of roughage, and hence delayed rumen development and increases the difficulties associated with weaning–separation [4,7]. Previous experiments showed that calves that suckled their dams or nursing cows during the milk-feeding period achieved a higher ADG than calves separated from their dams at birth, probably due to the higher milk intake of these naturally reared calves [29]. These results support our explanation that the increased ADGs in MS calves were a result of a greater milk intake than we had planned for. In foster cow rearing systems (as MS) calves have to compete with other calves, and this can have an effect on milk intake. Moreover, if the calves were allowed to suckle over the whole day, this frequent udder stimulation and udder emptying might have increased the milk secretion, even if the milk production before the start of the experiment fulfilled the determined necessary yield. It is believed that the calculated 6 kg/day was not reached by some calves as well as that some calves might have ingested much more than the calculated amount. Undoubtedly, the significantly increased growth observed in the calves' MS group involved the need for the increased intake of SCM. Also, increased energy intake, as a consequence of increased DM intake, could be an explanation for higher live weight gain.

According to Uys [19], the calves receiving an unlimited volume of milk during feeding time drank 72% more milk than restricted calves fed conventionally during the milk-fed stage. At the present study, probably as a result of the much higher intake of milk, the MS calves gained more weight than the SS and H calves before weaning. Also, Miller-Cushon et al. [54] pointed out that calves fed ADL consumed 2.6 times more milk, had greater weight gain and consumed less solid feed during the milk feeding period than did calves fed restrictive.

Intensive growth in free suckling calves (MS) has been attributed to a higher fat content in the consumed residual milk [48]. However, suckled calves drink milk with higher fat content, if the mother is being milked (SS group, not in MS). If the cow has milk ejection problems the milk with high fat content remains in the udder and can be drunk by the calf. It has been found that suckling calves had a higher level of growth hormone than calves that were fed milk from buckets [11,55]. However, calves suckled also other cows. It may have resulted in higher variability in individual milk intake and different live weight gain in MS calves.

There was also a significantly higher LBW in the SS group compared to group H. According to Asheim et al. [21], restricted amounts of milk result in impaired growth. But they compared suckling the dam for a few or more weeks with conventional restricted milk feeding (separation, single pen, 6 kg/d). However, our results are consistent with the findings of References [7,56] that the ADG of suckling calves are higher than that of calves reared without the dam in the milk allowance of 10–13% of LBW per day. In the present study these differences were probably the result of higher milk consumption by suckling (SS) versus bucket-fed (H) calves. Despite milking SS cows twice daily, the calves can obtain sufficient milk for a satisfying ADG.

The daily gain of suckling calves depends mainly on the amount of milk available per calf [7]. Authors have [6,57,58] reported that calves allowed to suckle cows for several weeks after birth also achieve greater daily weight gains probably because they suckle more frequently and drink more milk. The animals in the SS group probably received more valuable liquid nutrition from udders than the animals in group H. We used the generally fed MR in practical conditions. Also, maternal care and social contact also played an important role. On the other hand, SS calves were separated from their

dam after a few weeks and then had to get used to bucket feeding. This will have caused a relevant level of stress in the calves that affected also the feed intake and the weight gain during this change.

The ADG from the birth to weaning were 0.67 ± 0.17 kg (SS), 0.81 ± 0.16 kg (MS) and 0.48 ± 0.12 kg (H), ($p < 0.001$). The lowest ADG in group H was due to the lower MR energy content compared to whole milk. The quality of solid feeds was the same in all groups. A significant difference ($p < 0.01$) were found also for the period from birth to 180th day (SS 0.75 ± 0.14 kg, MS 0.82 ± 0.15 kg, H 0.67 ± 0.14 kg, $p < 0.001$) and for the period from birth to the 360th day of life (SS 0.82 ± 0.11 kg, MS 0.89 ± 0.13 kg, H 0.80 ± 0.11 kg, $p < 0.05$) (Table 2). In our opinion, the higher growth in MS calves was caused by the suckling of more milk than was calculated but also the higher solid feed intake by social facilitation.

Table 2. The average daily gains of calves and young cattle (kg).

Group	*N*	Mean	SD	Factor		
				Group	Sex	Sire
From the birth to weaning (84th day)						
SS	36	0.67	0.17	0.0000	NS	NS
MS	34	0.81	0.16	MS:SS, H ***		
H	35	0.48	0.12	SS:H **		
From the birth to the 180th day						
SS	36	0.75	0.14	0.0012	NS	0.0269
MS	34	0.82	0.15	MS:H **		1:2 *
H	35	0.67	0.14	SS:H *		
From the birth to the 360th day						
SS	35	0.82	0.11	0.0227	NS	0.0212
MS	34	0.89	0.13	MS:H *		1:2,3 *
H	34	0.80	0.11			
From the weaning to the 360th day						
SS	35	0.87	0.12	NS	NS	0.0046
MS	34	0.91	0.15			1:3,4 **
H	34	0.89	0.14			

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; SS = single suckling group; MS = multiple suckling group; H = hutch group; *N* = number of animals; SD = standard deviation.

No significant interactions were found among the observed factors.

The most intense growth of the MS group was maintained until the end of the experiment. The differences between MS and H were highly significant at the 180th and the 360th days (Tables 1 and 2).

A similar course of faster MS calves' growth was recorded also after weaning. Their ADG were found the highest in periods from birth to 180th day and to 360th day.

Some studies report reduced growth in suckled calves, particularly in the weeks immediately after weaning. This result was likely due to the challenge of weaning calves from high volumes of milk, while most artificially reared calves in these studies were fed restricted volumes [19,59]. The separation and weaning can be concurrent. Study [56] showed that if calves can be separated and weaned in time, the growth dip is reduced. According to Conneely et al. [60], poor weight gain following weaning in calves fed higher quantities of milk before weaning occurs because the high milk intake depresses SCM consumption.

Another important factor that can promote rearing with nursing cows is even faster habitude of calves to solid feed. Group housing may also stimulate appetite [61–63].

The majority of studies have reported that the benefits for growth during the suckling period, compared to calves that do not suckle milk, were maintained for weeks or months after separation [5,53,54,58,64,65]. These authors reported that calves provided with milk for longer time showed higher LBW.

Generally, when calves eat less concentrates this can lead to post-weaning delay in growth. However, there is little published information on the different concentrate mixture intake and post-weaning performance of multiple suckling calves. From our results it is clear that depending on the daily milk creation and the number of suckling calves, the calves in long-term suckling systems can obtain a better daily gain than restrictive or artificial fed calves.

3.3. Influence of Gender and Father Origin

We did not notice any gender differences, only sire lineage (Tables 1 and 2). Calves after father S1 tended to have the lowest LBW at birth and weaning (37.35 ± 6.84 kg; 87.56 ± 18.99 kg; $p < 0.05$) and the ADG from the birth to weaning (0.59 ± 0.19 kg). It is obvious that the offspring of the S1 bull showed significantly lower LBW and ADG. The most significant differences in ADG were determined for the period from birth to age 360 days and from weaning to 360 days (S1 0.72 ± 0.14 kg, S2 0.84 ± 0.14 kg, S3 0.85 ± 0.09 kg, and S4 0.87 ± 0.11kg, p <0.05; S1 0.76 ± 0.17 kg, S2 0.89 ± 0.15 kg, S3 0.91 ± 0.09 kg, S4 0.94 ± 0.11kg, $p < 0.01$).

The effect of paternal origin has been proven in the assessment of calf growth. This hypothesis was also confirmed. However, the calves were not evenly divided into treatment groups according to the fathers. We were unable to secure this. This influence of the father is important because the bull acts on a large part of the population in a relatively short period of time [66]. There were no significant differences between bulls and heifers. No significant interactions between the observed factors were calculated.

4. Conclusions

At the present study, three rearing treatments of calves with weaning at the 84 days were compared: (1) single (restricted) suckling of dam, (2) unrestricted (multiple) suckling of nursing cow, (3) artificially rearing in hutches. All calves should receive 6 kg milk or milk replacer per day.

The average daily gains from the birth to weaning, from birth to 180th and 360th day of life were the highest in calves from multiple suckling system. Advantages of the multiple suckling systems include calves having contact with adult dairy cows and performing natural behaviour.

Restrictive milk allowances can lead to poor growth before and after weaning. The single suckling calves ate less starter mixture to weaning than those bucket-fed from hutches. The results indicate that the feeding method used to rear calves may have a significant impact on their later performance.

Author Contributions: J.B. and M.U. conceived and designed the experiments; P.K. and A.H. performed the experiments; J.B. and M.U. analysed the data; J.B. wrote the manuscript. J.B. and M.U. conceived and designed the experiments; P.K. and A.H. performed the experiments; J.B. and M.U. analysed the data; J.B. wrote the manuscript. Each author participated equally in the study. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: This article was written based on data project APVV-15-0060 of the SRDA, Slovakia, and CEGEZ 26220120073, supported by the Operational Programme Research and Development funded from the European Regional Development Fund.

Conflicts of Interest: The authors declare that they have no conflict of interest.

Disclosure Statement: The authors declare that the research was conducted in the absence of any commercial, financial or other relationships that could be construed as a potential conflict of interest.

Ethical Approval: The authors declare that the experiments comply with the current laws of the Slovakia Republic. The treatment of the animals was approved by the Ministry of Agriculture and Rural Development of the Slovak Republic, no. 115/1995 Z.z. and 377/2012 Z.z. The experiments were carried out in accordance with the Code of Ethics of the EU Directive 2010/63/EU for animal experiments.

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