The Effect of Different Calf Hutch Material on Calf Behavior and Physiologic Parameters in Summer Season

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Abstract

The present study was carried out to investigate the effect of different calf hutches on behavior and physiologic parameters of Holstein calves. Twenty five female calves born from May to June 2009 in Agricultural Faculty Farm were used in the experiment. All calves were kept together with their mothers for the first 3 days after calving and then were housed in individual pens in calf hutches. The results obtained in the experiment showed that there were differences in behavioral pattern and physiologic parameters of calves (P>0.01). Fiberglas calf hutches behavior and physiologic performances were better than the other groups.

Key words: Calf Hutch Material, Calf Behavior, Physiologic Parameters

Yaz Aylarında Farklı Tip Buzağı Kulübelerinin Buzağı Davranış ve Fizyolojik Parametreleri Üzerine Etkisi

Özet

Bu çalışma yaz aylarında farklı tip buzağı kulübelerinin buzağı davranış ve fizyolojik parametreleri üzerine etkisini ortaya koymak amacıyla yürütlmüştür. Çalışmada, Ziraat Fakültesi Araştırma Uygulama Çiftliği'nde Mayıs-Haziran 2009 doğumlu yirmi beş dişi buzağıya ait veri değerlendirilmiştir. Denemeye alınan buzağılar buzağılama sonrası ilk 3 gün anneleriyle birlikte tutulmuş daha sonra sütten kesilinceye kadar farklı materyalden yapılmış kulübelerde tutulmuşlardır. Deneme sonucunda elde edilen bulgular, buzağıların davranış özelikleri ile fizyolojik parametreleri (P> 0.01) arasında fiberglass malzemeden yapılan kulübler lehine farklılık olduğu tespoit edilmiştir.

Anahtar kelimeler: Buzağı kulübesi, Davranış, Fizyolojik Parametreler

Introduction

Calf hutches widely used in calf rearing operations in intensive dairy farms. Selecting the appropriate housing to maximize calf health and performance is an important consideration on any farming operation. It’s especially important when rearing valuable animals such as replacement dairy heifers. A number of research studies have shown that the type of housing can affect performance (Lago et al. 2006). Modern dairy housing systems have been designed to reduce the magnitude of stress and to improve performance of cows (Roman et al. 1977). Calf hutches have been used successfully for calf rearing, given the potential problems in calf barns of elevated ammonia concentrations, inadequate air movement, and residual disease (Appleman and Owen 1975). Several studies (Goodger and Theodore 1986; James et al. 1984, Jenny et al.1981; Spain and Spier, 1996) reported no differences attributable to housing between calf hutches and other housing systems. Lance et al. (1992) noted that producers using calf hutches had lower death rates for preweaned calves than did those using other housing types; however, calves housed in hutches could be exposed to significant heat stress during summer months. Especially hot climates conditions required more comfortable hutch material to provide less stressful environment. Practical studies on calf barn design, material and its impact on calf health and growth are scarce. Especially alternative hutch material subject is

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very strictly researched. The same type and designed hutches suggested as a solution for all climate and season. Dairy farmers would like to get healthy and economic calf raising program for their specific conditions. Uncomfortable specific conditions causes stress for animal performances. Stress is important to the dairy producer, since the longer term effects influences the ability of the calf to mature and reproduction performances (Quigley, 2009). Cold or heat stress can affect younger or sick animals much more severely than mature, healthy cattle. Thermal comfort may be quantified as the thermal neutral zone. In the calf, the range is 50º F to 85ºF in still air. This optimal thermal environment promotes maximum performance and provides the least stress for the calf. Within this thermal neutral zone, the calf can maintain body temperature, or homeothermy, by constriction or dilation of the blood vessels, changing postures or behavior, changes in hair, or by sweating and panting (Roy, 1990; Stull, 1997; Yousef, 1985). Under thermoneutral environmental conditions most of the large domestic animals are able to maintain an equilibrium between the heat production and heat loss. But in stressful conditions, the number of physiological and behavioral responses vary in intensity and duration in relation to the animal genetic make-up and environmental factors. The purpose of these research was to investigate the effect of different hutch materials on calf performances, behavior and physiologic parameters of Black and White calves under summer stress.

Material and Method

Twenty five Black and White female calves born within the months of February and April in Research and Production Unit of Agricultural Faculty Farm, University of Çukurova, were used in this study. All calves were kept together with their mothers for the first 3 days after calving. After three days, calves were fed colostrum as soon as possible after birth during the 3 days period. Between day 4 and 70, calves were fed whole milk via pail twice a day according to the feeding program, in which each calve received 245 L milk during 10 weeks period in total. After colostrum feeding all calves were placed in experimental calf hutches. The calf hutches types which were made from tin-plate, fiberglas and wood were used. The hutches that are made from tinplate were construct by using two-layer of tin-plate that are generally used in making tins and straphor were filled between two layer tin plate. Each type of hutch has same paddocks which was made of iron bond which used in concrete floor built. Hutches were aligned in rows oriented east to west to minimize exposure to solar heating. Twenty five calves were assigned to calf hutches group randomly. In addition, they were received a calf starter, good quality alfalfa straw ad libitum. Water was available to all calves at all times. Water was provided in the bucket used for the milk feeding.

The chemical composition of calf starter and alfalfa straw which are used in this experiment is presented in Table 1. The dry matter, crude protein, ash, ether extract and crude fiber contents of feeds were determined according to the standard AOAC procedures (1998). NDF and ADF were analyzed using the methods of Van Soest et al. (1991) with ANKOM fiber analyzer.

Table 1. The chemical composition of calf starter and alfalfa straw

Feeding substances	Calf starter (%)	Alfalfa straw(%)
Dry matter	87.7	89.7
Crude protein	16.5	15.0
Crude cellulose	9.7	26.0
Crude fat	3.2	3.4
Ash	5.9	8.4

This study was done from June to September (temp: 27.90 °C; RH: 28.21%, and THI:72.50).

Behavioral observation

Behavioral observation was done using focal sampling techniques. 3 observer trained for these observation study before experiment. At this method observer focused on a single calf for a period between 9:00 am 17:00 pm and recording all instances of its behavior. The observation calf chosen (randomly) prior to observations. During this observation period all occurrences of behavior and tries to keep an exact record of behavior. But especially feeding, lying standing, drinking, vocalization, urination and defecation numbers and duration is calculated as total time for a daytime. This evaluation showed frequencies, durations and latencies of these behavior patterns.

Physiological Measurements

Rectal temperature was recorded using a digital thermometer (HI92704, Hanna Instruments - Bedfordshire, UK) with the probe being inserted to a depth of 9cm, heart rate was measured by means of an oscillometric apparatus (Argus TM7, Schiller-Barr,Switzerland), and respiration rate (RR) of animals (breaths per minute) was recorded by counting the flank movement, one inward and one outward movement as one breath. Pulsation Rate (Beats per minutes). The environment temperature and the relative humidity were determined by the climatic data recording machines which were place into the calf hutches (HOBO).

Statistical analyses

Hutch types and measurement hours were taken as a main factors. The main factors and interactions were analysed using SPSS statistical package programs in randomize factorial design.

Results and Discussion

Performances

There was significant difference in the birth weight of calves between the treatment groups (Table 2). However, calves reared in fiber hutch material showed significantly higher average daily live weight gains than the calves reared in other hutch material over the 70 days preweaning period (Table 2).

Table 2. The growth performances of the experimental groups during pre-weanig period

	Fiber	Wood	Tinplate
Birthweight (kg)	35.34±3.05	34.54±4.20	33.75±3.78
Daily Weight gain (g)	0.509±0.041 ^{a}	0.443±0.054^{b}	0.408±0,076^{b}
Weaning weight (kg)	69.53±4.04^{a}	63.80±5.65^{b}	59.93±7.33 ^{c}

Values with different superscripts within a row differ significantly (p≤0.01).

The variance analyses results show that season growth performances at different hutch types of the calves were statistically significant. These results show big similarity with our previous study. Göncü and Özkütük (1998) indicated that calves reared in the hutches made from fiberglas material gave the best result (0.613), while those reared double layer tin-plate was the worst (0.511). Karakök Göncü and Gökçe (2004) reported that daily weight gain averages from birth to 2 months of age were 367.55; 319.11 and 253.83 g. and the differences between the groups were not statistically significant ($P<0.05$) for calf hutches groups. In disagreement with previous studies (de Wilt, 1985; Smits and de Wilt, 1991; Andrighetto et al, 1999), which reported that the daily gain values of calves was not significantly affected by the housing system. Behavioral satisfaction of calves in open environment hutches in our studies might have contributed to a better growth rate than calves housed in confined crates (Heinrichs et al, 2005).

Physiological parameters The mean values of physiological parameters considered together with their standard errors (SEM) and with the statistical significances obtained during the experiment were given at Table 3. Rectal temperature values of the groups were between 38.63±0.07 (for wood material at morning measurement) to 39.39±0.07 (for tin-plate material at 16:00 measurement). Differences between the hutches groups were determined statistically significant ($P\leq0.01$). The time of the day is also important factor for the physiologic parameters of the groups which in the morning hour showed lower rectal temperature. During the p.m. period, when heat stress was highest, calves housed in a tin-plate hutch had highest physiological parameters than the others.

The normal rectal temperature of cattle is between 38 and 39 ºC, and this may go up a degree or so for some animals, especially during the heat of the day in summer (Johnson, 1980; Hahn, 1999; Hansen and Arechiga, 1999; West, 1999; Regan and Richardson 1938;Piccione et al, 2003).

Table 3. The mean values of physiological parameters considered together with their standard errors (SEM) and with the statistical significances obtained during the experiment.

Hutch types	**Hours**	**Rectal temperature. (ºC)**	**Respiration rate (breaths per minute)**	**Pulsation rate (Beats per minutes)**
Fiber	07:00	38.73±0.07	80.78±2.37	40.78±1.69
	13:00	38.95±0.07	84.63±2.37	48.03±1.69
	16:00	39.14±0.07	83.99±2.37	50.77±1.69
Total		**38.94±0.07**	**83.13±2.37**	**46.53±1.69**
Tin-plate	07:00	38.83±0.07	80.57±2.51	41.40±1.79
	13:00	39.05±0.07	86.76±2.51	52.45±1.79
	16:00	39.39±0.07	84.87±2.51	53.80±1.79
Total		**39.09±0.07**	**84.07±2.51**	**49.22±1.79**
Wood	07:00	38.63±0.07	81.30±2.28	40.15±1.63
	13:00	38.92±0.07	83.89±2.28	47.46±1.63
	16:00	39.14±0.07	82.43±2.28	50.74±1.63
Total		38.89±0.07	82.54±2.28	46.11±1.63
Sign.	Hutch	**0.002**	0.736	**0.06**
	Hours	**0.000**	**0.088**	1.4
	Interaction	0.791	0.946	0.8

The mean level of calf body temperature was 38.64 ± 0.02°C for days 1–10 and 38.34 ± 0.02°C for days 52–61 (Piccione et al. 2003) . The normal respiration rate in cattle is about 30 breaths per minute (one every two seconds). In this experiment calves rectal temperatures rise above the normal values afternoon hours especially tin-plate group averages higher than the others. Wood hutch material show the lowest physiologic parameters than the others. A rise of 1 ºC or less in rectal temperature is enough to reduce performance in livestock species (McDowell, 1976), which makes body a sensitive indicator of physiological response to heat stress in the cow because it is nearly constant under normal conditions. In this study respiration rate and pulsation rate values were not determined statistically significant. But there is small tendency to be significant higher pulsation rate values at tinplate hutch groups. This can be accepted as calf comfort were not affected negatively at this condition or climatic condition were between acceptable stress level. Because under thermal stress, cattle increase evaporative heat loss by both panting and sweating, with sweating being quantitatively superior to panting (McLean, 1963). Clearly, the availability of shade improved the performance of the calves and protect negative effects on this groups in this study. For example, heifers in shaded pens had about 13% decrease in respiration rates, though rectal temperatures were unaffected (Quigley, 2009). The results of the Matarazzo et al. (2010) which reported that rectal temperature did not differ (P>0.05) among animals from different treatments are show big similarity with this study results. Researcher also reported that the the respiratory frequency and skin temperature were higher during the afternoon in calves kept in individual cage as in this case. Spain and Spiers (1996) reported that the outer and inner surface temperatures of the hutch were lower under supplemental shade. Bianca (1958) shown that, under severe heat stress, the respiratory rate at first rapidly rose from 88 to a maximum of 218 respirations/min. and then fell to 167 respirations/min., while breathing at first became shallower and then deeper. During the phase in which breathing became faster and shallower (panting), the heart rate rose at a mean rate of 13 beats/min. for each degree centigrade increase in rectal temperature. During the phase in which breathing became slower and deeper (‘second-phase breathing’) the mean rate of rise in heart rate was 50 beats/min. for each degree increase in rectal temperature. The changes in respiratory rate and in heart rate occurred at mean rectal temperatures of $40{\cdot}6^0$ C and $41{\cdot}0°$ C., respectively, and, on average, the change in respiratory rate preceded that in heart rate by 8 min.

Behaviour

The mean values of behavioral observation results considered together with their standard errors (SEM) and with the statistical significances obtained during the experiment were given at Table 4. Hutch types were determined statistically significant for feeding duration durng the day time of the groups. The lowest feeding time were determined at wood hutch group while highest feeding duration were determined at fiber hutch group. The herd’s day involves maintenance behaviour: standing, walking, lying, feeding, drinking, self-grooming, allogrooming, agonistic behavior and ruminating (Mitlohner et al., 2001). The other parameters were not determined statistically significant during this study.

Feeding behavior is affected by climate, condition of teeth, age of cattle, and nature and kind of feed. In general, feed consumption (in a controlled climate laboratory) is depressed by increasing environmental temperature (Albright, 1993). Domesticated ruminants are mainly diurnal in their habits, being active during the day and resting at night. (Finch, 1984; Silanikove, 2000). If shade is not available, an animal will change its posture to the vertical position in respect to the sun in order to reduce the effective area for heat exchange (Hafez, 1968). Sheep tend to crowd, and to stand intimately side by side for the same purpose. Under severe heat stress, animals moisten their body surface with water saliva, or nose secretions. This range of behavioral response affects the heat exchange between the animal and its environment by reducing heat gain from radiation, and increasing heat loss via convection and conduction (Hafez, 1968). Vocalization is an indicator of stress (Grandin, 1980). Cattle vocalize when they are forced away from the rest of the herd. Young animals vocalize if disturbed, distressed, or hungry (Taylor and Field, 1998; Shahhosseini, 2013)

Table 4. The mean values of physiological parameters considered together with their standard errors (SEM) and with the statistical significances obtained during the experiment.

	Fiber	**Wood**	**Tinplate**	Sign.
Feeding	24.17±2.46	8.37±1.95	6.65±2.06	**.000**
Drinking	11.83±3.26	15.21±2.59	17.41±2.74	.430
Lying in hutch	182.58±23.12	211.79±18.37	201.18±19.42	.616
Lying out hutch	29.83±12.75	36.68±10.13	45.76±10.71	.625
Standing in hutch	49.92±11.50	40.05±9.14	36.65±9.66	.669
Standing out hutch	12.33±2.70	9.89±2.15	8.53±2.27	.562
Vocalization	0.08±0.18	0.27±0.14	0.47±0.15	.192
Defecation	0.83±0.21	0.95±0.17	1.00±0.18	.835
Urination	1.17±0.29	1.16±0.23	1.53±0.25	.492

Conclusion

The differences in the growth rates, behavioral and physiological data analyses of calves in three types of hutch types indicated that in fiber hutch type provide to more comfortable environment than the others during summer months also. But many new materials also is found on the market for more comfortable calf barn. It is needed more research for new material and hutch design for hot climate conditions.

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