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Effects of Different Weaning Age and Housing System on the Growth Performances of Holstein-Friesian Calves

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Abstract

Early life of the cattle is very critical; they require intensive care and this period is probably the most expensive period in their life. By understanding the principles of growth, nutrition, health and behavior of calves, a farmer can develop successful calf rearing system on his/her farm. In this study, different weaning age (5 weeks and 8 weeks) and housing systems (individual calf hutch, group barn and combination of these two systems) of Holstein-Friesian calves were investigated. The study repeated twice in winter calving and spring calving and totally 36 calves were used in the study. During and after calving, some behaviors of cows and calves were observed in addition to determine the quality of the colostrum. The body weight of the calves at birth and weakly ages up to the weaning were determined, too. After the weaning the measurements were conducted monthly up to the 6 months of calves' age. The averages of colostrum quality, standing up time of calf from birth, separation of calf from the cow after birth and time of placenta drop from birth were found to be 95.44±3.74 mg/mL, 101.3±10.30 min, 170.56±8.57 min and 345.3±75.60 min, respectively. The average birth weight of calves for the 5th and 8th weeks weaning groups were 43.14±0.90 kg and 41.75±0.91 kg (P>0.05), and the body weight at the 6th month of age were found to be 108.99±2.14 kg and 106.60±1.89 kg (P>0.05), respectively. The average calf birth weight in winter calving is 3.09 kg higher than that of spring calving (P<0.05), but the body weight at the 6th month of age in winter calving group was 15.93 kg lower than that of spring calving group (P<0.01). The statistically significant birth weight differences among the housing groups were disappeared at the second month of age and the average body weights at the 6th month of age were found to be 105.77±2.35 kg, 107.94±2.56 kg and 109.69±2.52 kg (P>0.05), respectively. In conclusion due to the quality of the colostrum varies significantly, before feeding the calves with colostrum, the quality of it should be determined. Early weaning (5 weeks) of the calves did not have a significant effect on the later performances of the calves. For animal welfare concern, instead of housing the claves in individual calf hutches, the combined system could be an important practice for dairy farms.

Key words: Early Weaning, Colostrum Quality, Calf Housing, Birth Weight, Weight Gain, Season

Introduction

Early life of cattle is very critical and probably the most expensive period in their life. By understanding the principles of the growth, nutrition, health and behaviors of calves, farmer can develop a successful calf rearing system on the farm. The mortality rate and diseases especially scours and pneumonia is very high at the early life of calves. Due to undeveloped digestive tracts, calves need feeding with high quality and easily digestible form of nutrients, like whole milk or milk substitutes. As whole milk is more expensive than the concentrates, weaning the calves as early as possible will decrease the cost of calf rearing (Moran, 2005).

Immunoglobulin content of colostrum is the criterion of the colostrum quality. Before feeding the calf with colostrum, the quality of it should be determined and newborn calves should not be fed with low quality colostrums. Moran (2005) reported that high quality colostrum contains 80 mg/mL or higher immunoglobulin, but 40 mg/mL or less immunoglobulin content is an indicator of the poor

quality of colostrum. It was reported that a newborn calf needs to consume 3-4 L high quality colostrum (Moran, 2005).

In a study, in Kahramanmaraş State Farm, colostrum samples from 60 heads Holstein-Friesian (HF) cows were determined and indicated that 27% of the samples had good quality, but 20% of the samples had low quality colostrum (Tümer, 2006). In another study Hoyraz et al. (2014) in 51 heads HF cows found the average quality of colostrum was 107.16±3.36 mg/mL and added that lactation number effect on colostrum quality was statistically insignificant.

Weaning age of calves can be changed depending on the farms and production systems. In dairy herds weaning criterion of a calf depends on concentrate consumption (Quigley and ark., 1991) and rumen development (Keleş, 2010). Quigley and ark. (1991) reported that consumption of 600-700 g/day concentrate for three consecutive days could be a criterion for calf weaning.

There is a trend to wean calf as early as possible in dairy cattle production due to decreasing the feeding cost, time and labor. It was reported that calves can be weaned as early as they are 8.4 days old (NRC, 2001; USDA, 2002). In a study Uğur (1999) weaned the HF calves at 21 days and 30 days old and reported insignificant differences in the daily weight gain and live weights at different time up to the 6th month of age.

In another study, Uğur et al. (1999) weaned the HF and Brown Swiss heifer calves at 30 days, 45 days and 60 days, and reported that the live weight differences among the groups at 12 months and at 18 months were statistically insignificant.

Çelik (2006), under same milk feeding system, weaned the HF calves in 1.5 month and 2.5 months and observed the growth performances of these calves until 6 months of age and found that the calves weaned at 1.5 month had better growth performances than those calves weaned at 2.5 months.

In a study conducted by Kehoe et al. (2007) to determine the effects of feeding frequency and weaning age on the growth, health and rumen development of HF calves and they found insignificant differences among the three, four, five and six weeks weaning age groups.

In another early weaning study, Koçak and Güneş (2004) fed the HF male newborn calves for 60 days and gave fodder to one group when they were 4 days old, and gave fodder to another group when they were 35 days old, and other group was not fed with fodder until they were 60 days old. They weaned all calves when they were 35 days old and concluded that there was not any significant differences among the groups for birth weights, weaning weights, 60 day live weight, total weight gain and feed consumption.

In this study in addition to determine some maternal and calf behaviors at birth and colostrum quality, the effects of different weaning age (5 weeks and 8 weeks) and housing systems (individual calf hutch, group barn and combination of these two systems) on the performances of HF calves were investigated.

Materials and Methods

In this study, 36 heads HF calves (13 female, 23 male) born on a private farm in Aydin province were used. Whole milk, fodder and concentrates were obtained from the farm. Fifteen of these calves were born with the assistance of veterinary (41.67%) and 13 of the cows gave birth as they were standing (36.11%). Thirty five calves were dried by their mother, but one cow did not lick her calf and this calf was dried by another cow.

Some of the data during and after parturition collected about cows were dry period, gestation length, colostrum quality, time from birth to start of cow licking to calf and time from placenta drop from parturition. The data collected for calves during and after parturition were time from birth to colostrum feeding, time from birth to first attempt of calf standing, time from birth to calf standing and time from birth to calf separation from mother. Calves stayed with their mother for about three hours after birth and then they separated from their mother without being allowed to suckle their mother.

The quality of colostrum produced by the mother of these calves was determined by a Colostrometer (BIOGENICS-1980 COLOSTROMETER^{TM}) at room temperature. Only high quality colostrum that contain 80 mg/mL or higher immunoglobulin contents were used to fed calves in this study. Low quality colostrum that is lower than 80 mg/mL, produced by seven cows was not fed their calves. These calves were fed with high quality stored colosrtum. Calves were not allowed to suckle their mother, colostrum was milked and fed to the calves with a feeding bottle. So, all the claves were fed with high quality colostrum. Every calf was fed with 3 L high quality colostum at the first feeding. After that any additional colostrum was not given to the calves. It means that every calf had at least 240 g immunoglobulin at the first feeding.

After separation of the calf from its mother, the calves were randomly put in an individual calf

hutch, group barn or combination of these two systems. In the last housing system the calves were put in individual calf hutches and during the day the calves were allowed to go out from the hutches and make contacts with other calves in this group. When the calf was sick and at feeding time or at night, the calves were not allowed to go out from the individual calf hutches. In each group three calves were housed during milk feeding time until weaning. After weaning, the calves were housed in a group barn. The dimension of the individual calf hutches were 125x140x100 cm and the dimension of the group barn was 250x250x120 cm. The study was done in winter born calves in 2011-2012 and it was repeated with spring born calves in 2012, too.

When the calves were three days old, they were started to be given concentrates, fodder (Crude protein 7.71%, NDF 67.60%, ADF 38.07%) and fresh water. Their mangers cleaned daily and unconsumed feed were removed and then, fresh concentrates and fodder was given.

During milk feeding time, all the calves were fed with 4 L/day whole milk and this amount was given in two feeding time in the morning and in the evening. In the last week of milk feeding time, the daily amount of whole milk was reduced to 2 L/day.

Two weaning times were practiced in this study. One group was weaned at five weeks and the other group was weaned at eight weeks.

The birth weights and weekly weights of calves until weaning were determined. After the weaning, monthly weights of them were determined until 6 months of age. The weights of calves were weighed with a 500 kg weighing scales.

The data were analyzed using GLM procedure of SAS. The differences between the means were considered to be statistically significant at $P<0.05$ (2-tailed) based on Tukey's adjustment type I error rate. The statistical model used for the analysis is as follows.

$$y_{ijklm} = \mu + a_i + b_j + c_k + d_l + (bc)_{jk} + e_{ijklm}$$

where y_{ijklm}; is the observation of the trait, μ is the overall mean, a_i is birth season effects, (i= winter, spring), b_j is weaning time effects (j= five weeks or eight weeks weaning), c_k is housing system effects (k= individual calf hutch, group barn or combination of these two systems), d_l is the effects of sex (l= female, male), $(bc)_{jk}$ is weaning time x housing system interaction effects, e_{ijklm} is random error.

Results and Discussion

Means of some traits during and after parturition for cow and calf are given in Table 1. Dry period, gestation length and colostrums quality means were found to be 72.78±1.30 days, 280.28±0.73 days and 95.44±3.74 mg/mL, respectively. Colostrum quality of two cows could not be determined, because of one cow not producing any colostrum and another cow being mastitis.

Dry period of cows was found to be between 61 d and 89 d. The ideal dry period in dairy cows should be 60-d for normal mammary epithelial cell turnover to occur (Collier et al., 2012). Longer dry period found in this herd shows some fertility and managerial problems. However, longer dry period could have also a positive effect on the increase of colostrums quality (Collier et al., 2012).

The average colostrum quality found in this study could be accepted as high and is in agreement with good colostrum quality class reported by Özhan et al. (2001) and Moran (2005). However, the quality of colostrum was changed between 50 mg/mL and 140 mg/mL and seven cows' colostrum quality were found to be below the criterion of Moran (2005).

Table 1. Descriptive statistics of some traits for cow and calf during and after parturition

Traits	n	$\overline{X} \pm S_{\overline{X}}$	Min	Max
Dry period (day)	32	72.78±1.30	61	89
Gestation length (day)	36	280.28±0.73	272	288
Colostrum quality (mg/mL)	34	95.44±3.74	50	140
Time from birth to colostrum feeding (min)	36	35.25±2.42	15	105
Time from birth to start of cow liking to calf (min)	35	13.71±2.09	5	60
Time from birth to first attempt of calf standing (min)	36	48.61±6.37	15	225
Time from birth to calf standing (min)	36	101.3±10.30	40	270
Time from birth to calf separation from mother (min)	36	170.56±8.57	30	270
Time from parturition to placenta drop (min)	34	345.3±75.60	45	1590

The time from birth to colostrum feeding was changed from 15 min to 105 min and the average was found to be 35.25±2.42 min (Table 1). This result shows that all calves were fed with colostrum in the first two hours of their life and most of them fed with colostrum about 30 min after birth.

The averages of time from birth to start of cow liking to calf and time from birth to first attempt of calf standing were determined to be 13.71±2.09 min and 48.61±6.37 min, respectively.

The placenta drop time from parturition was changed between 45 min to 26.5 hours and the average was found to be 345.3±75.60 min. It can be noticed that, there is a huge variation among the cows for placenta drop time. It was reported that so many factors have effects of placenta drop time of cows such as early parturition, lower uterus contractions, deficiencies of vitamin-A, β carotene and iodine and improper body condition scores at dry period and parturition (Koç, 2013).

The calves were allowed to stay with their mother for about three hours (170.56±8.57 min) and then separated from their mother. Due to higher suckling instinct of calf after standing up, the calves were not allowed to stay with their mother longer after being dried. Because of higher suckling instinct during this time, some microorganisms from the mother to her calf could be transferred and this may cause significant health problems of calves.

The average time of calf standing was determined to be 101.3±10.30 min. This average was longer than the results reported dairy cows and heifers by Albright and Arave (1997). Albright and Arave (1997) reported that beef calves had shorter standing up time (35±15 min) from birth than those of dairy calves (58±21 min) and added that because of longer licking of beef cows to their calves, time of standing up of beef calves were shorter than those of dairy calves.

Birth weight, weights and daily weight gains (DWG) means at different age periods of calves are given in Table 2 and Table 3. Average birth weight of male calves (45.76±0.78 kg) had 6.64 kg higher than that of female calves (39.12±1.06 kg) (P<0.01). Male calves had also 10.2 kg higher total weight gain than those of female calves at 6th month of age (P<0.05).

Similar to body weight, male calves had also higher DWG than those of female calves almost for every age periods until the 6th months of age. The average DWG of male calves (0.39±0.01 kg) until the six months age had higher than that of female calves (0.33±0.01 kg; P<0.01). As calf age increased, the differences of DWG between the sexes were become more distinct as seen in Table 3.

A statistically significant difference was also determined between winter and spring born calves. Calves born in winter had 3.09 kg higher birth weight than that of spring born calves (P<0.05). These seasonal differences between the weights of calves were disappeared in the first and third week's weights. For later age periods the calves born in spring had higher body weight than those calves born in winter (P<0.05). At 6th month age, the spring born calves had 15.93 kg higher body weight than those calves born in winter (P<0.01). Total weight gain between the seasons was also found to be different (P<0.05). The spring born calves had 19.1 kg higher total weight gain than those calves born in winter (Table 2).

Although 5 weeks weaning group (5WWG) had 1.39 kg higher birth weight than that of 8 weeks weaning group (8WWG), this difference was not determined to be statistically significant (P>0.05). 5WWG had higher body weights only at the first and third weeks than those of 8WWG, but at other age periods the differences between the weaning groups were similar (P>0.05). For DWG, between the weaning groups, the weight gains at the first week and second month DWGs were determined to be statistically significant (P<0.05). Other differences between the groups at different age periods were found to be statistically insignificant (P>0.05). At the first week the calves at the 5WWG had higher DWG (0.34±0.06 kg) than that of 8WWG (0.15±0.06 kg), but the DWG mean of 8WWG from 5 weeks to second month (0.58±0.05 kg) was higher than that of 5WWG (0.33±0.05 kg). The higher DWG found for 8WWG from 5 weeks to 8 weeks than that of 5WWG shows that the calves in the 5WWG had a reduced performance after weaning but then the performances until the 6th month of age for both groups were similar. The average DWG of the weaning groups from birth to 6th month of age were the same (0.36±0.01 kg). Statistically insignificant differences found for body weights and DWGs between third and sixth month of ages shows that instead of weaning the calves at 8 weeks, weaning at 5 weeks cannot cause any significant inconveniences in the later performances of calves. In other words, early weaning cannot cause any significant prolong reducing performances compared to calves weaned at 8 weeks. This result is consistent with the results of Winter (1985), Hopkins (1997), Uğur (1999), Koçak and Güneş (2004), Çelik (2005) and Kehoe et al. (2007). Winter (1985) found an insignificant weaning

weight age effects on DGW of three, five and seven weeks weaning weights of calves. Hopkins (1997) also reported insignificant body weight and height at withers differences between the early weaning and late weaning.

For weaning group, the DWG of 5WWG in the second month (0.33±) was 0.25 kg lower than those of the 8WWG (P<0.05), but this difference was disappeared at later ages and the average DWG until the 6th month of age was found to be same (0.36±0.01) for both groups. The insignificant differences between the weaning groups found at later ages in this study are in agreement with the results of Yung and Chung (1985), Ulutas et al. (1996), Uğur (1999), Koçak and Güneş (2004), Çelik (2005) and Kehoe et al. (2007).

DWG found in early (5WWG) and late (8WWG) weaning groups in this study were found to be lower than the results detected for HF by Kaya et al. (1999).

For housing group, the third group (individual+group housing) had higher birth weight than those of the individual and group housing (P>0.01). The third group continued this advantage until the second month of age, then there were not any significant differences among the groups were exist from second month to the 6th month of age. The total daily weight gains of the housing groups were also found to be similar (P>0.05) from birth to 6 months of age. The DWG differences among the housing groups at all ages were also determined to be statistically insignificant (Table 3).

As seen in Table 2, weaning group x housing system interaction was found to be statistically significant from birth to third weeks of age (P<0.05), but at later ages among the groups the interaction was determined to be statistically insignificant (P>0.05). The interaction for DWG was also statistically insignificant (P>0.05) for all age periods (Table 3).

As seen in Table 3, for every age periods, spring born calves had higher DWG than those calves born in winter and the differences between the seasons were also statistically significant (P<0.05) except for fourth and sixth months of age. Similarly, average DWG from birth to the 6th months of age for spring born calves (0.41±0.01 kg) were determined to be higher than those of winter born calves (0.31±0.01 kg) (P<0.01).

Conclusion

In conclusion, because of every cow not produce high quality colostrums, determining the quality of colostrum determination could be an important practice in calf rearing program on the cattle farms. Only high quality colostrum should be used for feeding newborn calves. If a cow produce lower quality of colostrum, then high quality stored colostrum should be used for feeding her calf.

After the birth, allowing the calf dried by its mother, the calf should be separated from its mother as soon as possible to protect it from the possible transfer of pathogens from its mother.

Weaning the calves at 5 weeks instead of 8 weeks did not have any significant effect on the later performances of calves. Therefore, by practicing 5 weeks weaning program in the dairy herds, the farmers, without having any inconveniences, could save additional three weeks milk fed to each calf in addition to save of labour.

The lower growth performances and higher diarrhea obtained from winter born calves than those of spring born calves in this study shows the importance to give more care to these calves in cold and rainy winter months in the herds in this region. Another solution to this problem could be arranging the calving in spring months by synchronizing the heats of cows.

In this study, instead of using only individual cage during milk feeding period of calves, using individual cage + free housing give opportunity to calves to get socialize with other calves and could also get rid of the stress at group housing after weaning.

Table 2. Mean weights (kg) of calves at birth and different age periods and total weight gain (kg)

Factor	n	Birth Weight kg	1.Week BW, kg	3. Week BW, kg	5. Week BW, kg	2. Month BW, kg	3. Month BW, kg	4. Month BW, kg	5. Month BW, kg	6. Month BW, kg	Total Weigh Gain, kg
Season		*	NS	NS	*	**	**	**	**	**	*
Winter	18	43.99±0.89^{Aa}	44.53±0.90	50.19±1.05	54.68±1.65^{Aa}	63.98±2.06^{Aa}	71.29±2.09^{Aa}	80.28±1.96^{Aa}	89.62±2.01^{Aa}	99.83±2.07^{Aa}	55.1±1.91^{Aa}
Spring	18	40.90±0.91^{Ab}	43.78±0.92	51.15±1.08	60.61±1.69^{Ab}	73.14±1.96^{Bb}	82.16±1.99^{Bb}	92.03±1.8^{Bb}	104.11±1.9^{Bb}	115.76±1.9^{Bb}	74.2±1.81^{Ab}
Weaning group		NS	*	*	NS	NS	NS	NS	NS	NS	NS
5. Weeks	18	43.14±0.90	45.49±0.90^{Aa}	52.43±1.06^{Aa}	59.22±1.67	68.91±2.13	77.63±2.16	87.57±2.03	98.32±2.08	108.99±2.14	64.3±1.97
8. Weeks	18	41.75±0.91	42.81±0.91^{Ab}	48.92±1.07^{Bb}	56.07±1.69	68.21±1.88	75.81±1.91	84.74±1.79	95.41±1.84	106.60±1.89	65.0±1.74
Housing group		**	**	**	*	NS	NS	NS	NS	NS	NS
Individual	12	40.46±1.10^{Aa}	42.59±1.11^{Aa}	48.94±1.30^{Aa}	56.41±2.04^{Aab}	66.29±2.34	75.02±2.38	84.97±2.23	95.56±2.28	105.77±2.35	65.5±2.17
Group	12	40.86±1.13^{Aa}	42.39±1.14^{Aa}	48.09±1.33^{Aa}	53.78±2.10^{Aa}	67.85±2.55	75.32±2.58	84.53±2.42	96.06±2.48	107.94±2.56	65.7±2.36
Individual+Group	12	46.01±1.07^{Bb}	47.48±1.08^{Bb}	54.99±1.26^{Bb}	62.74±1.99^{Ab}	71.54±2.51	79.82±2.54	88.97±2.38	98.98±2.44	109.69±2.52	62.8±2.32
Sex		**	**	**	NS	NS	NS	NS	NS	NS	**
Female	13	39.12±1.06^{Aa}	40.75±1.07^{Aa}	46.46±1.25^{Aa}	53.56±1.97	63.15±2.30	70.78±2.34	79.46±2.19	89.48±2.25	99.09±2.31	59.5±2.13^{Aa}
Male	23	45.76±0.78^{Bb}	47.55±0.78^{Bb}	54.88±0.92^{Bb}	61.73±1.44	73.98±1.78	82.66±1.80	92.86±1.69	104.25±1.73	116.51±1.79	69.7±1.65^{Bb}
WeanGr xHouGr		*	*	*	NS	NS	NS	NS	NS	NS	NS
5W Individual	6	38.89±1.44^{Aa}	41.87±1.45^{Aa}	48.60±1.70^{Aa}	55.02±2.67	62.40±3.23	72.12±3.28	83.39±3.08	95.15±3.15	106.17±3.25	67.4±3.00
5WGroup	6	41.75±1.75^{ABa}	43.25±1.75^{ABa}	49.25±2.06^{Aa}	55.50±3.23	69.33±4.20	77.46±4.25	87.52±3.99	98.24±4.09	109.89±4.21	65.2±3.88
5WIndiv+Group	6	48.78±1.44^{Bb}	51.37±1.45^{Bb}	59.43±1.70^{Bb}	67.14±2.67	75.00±3.72	83.31±3.78	91.81±3.54	101.56±3.63	110.91±3.74	60.2±3.44
8W Individual	6	42.02±1.62^{ABa}	43.30±1.62^{ABa}	49.29±1.91^{Ab}	57.80±2.10	70.19±3.34	77.92±3.39	86.55±3.18	95.96±3.26	105.37±3.36	63.5±3.09
8WGroup	6	39.98±1.44^{Aa}	41.53±1.45^{Ab}	46.93±1.70^{Ab}	52.05±2.67	66.36±2.97	73.19±3.01	81.53±2.82	93.87±2.89	105.98±2.98	66.1±2.75
8W Indiv+Group	6	43.24±1.57^{ABab}	43.59±1.58^{Aab}	50.54±1.85^{ABa}	58.35±2.91	68.08±3.23	76.32±3.28	86.13±3.08	96.39±3.15	108.47±3.25	65.3±3.00

*: Significant for P<0.05, **: Significant for P<0.01. NS: Not significant, A,B,C: Different letter shows the significance between the means for P<0.01, Different letter shows the significance between the means for P<0.05

Table 3. Mean average daily weight gains (DWG) at different age periods

Factor	n	1.Week DWG, kg	3. Week DWG, kg	5. Week DWG, kg	2. Month DWG, kg	3. Month DWG, kg	4. Month DWG, kg	5. Month DWG, kg	6. Month DWG, kg	Average DWG, kg
Season		**	*	**	*	*	NS	*	NS	**
Winter	18	0.08±0.05^{Aa}	0.40±0.03^{Aa}	0.32±0.07^{Aa}	0.38±0.05^{Aa}	0.24±0.02^{Aa}	0.30±0.02	0.31±0.03^{Aa}	0.34±0.02	0.31±0.01^{Aa}
Spring	18	0.41±0.06^{Bb}	0.53±0.03^{Ab}	0.68±0.07^{Bb}	0.54±0.05^{Ab}	0.30±0.02^{Ab}	0.33±0.02	0.40±0.03^{Ab}	0.39±0.02	0.41±0.01^{Bb}
Weaning group		*	NS	NS	**	NS	NS	NS	NS	NS
5. Weeks	18	0.34±0.06^{Aa}	0.50±0.03	0.49±0.07	0.33±0.05^{Aa}	0.29±0.02	0.33±0.02	0.36±0.03	0.36±0.02	0.36±0.01
8. Weeks	18	0.15±0.06^{Ab}	0.44±0.03	0.51±0.07	0.58±0.05^{Bb}	0.25±0.02	0.30±0.02	0.36±0.03	0.37±0.02	0.36±0.01
Housing group		NS	NS	NS	NS	NS	NS	NS	NS	NS
Individual	12	0.30±0.07	0.45±0.04	0.53±0.08	0.47±0.06	0.29±0.02	0.33±0.02	0.35±0.03	0.34±0.02	0.36±0.01
Group	12	0.22±0.07	0.41±0.04	0.41±0.08	0.55±0.07	0.25±0.02	0.31±0.02	0.38±0.04	0.40±0.02	0.37±0.01
Individual+Group	12	0.21±0.07	0.54±0.04	0.55±0.08	0.36±0.06	0.28±0.02	0.31±0.02	0.33±0.04	0.36±0.02	0.35±0.01
Sex		NS	*	NS	NS	NS	*	NS	**	**
Female	13	0.23±0.06	0.41±0.04^{Aa}	0.51±0.08	0.41±0.06	0.25±0.02	0.29±0.02^{Aa}	0.33±0.03	0.32±0.02^{Aa}	0.33±0.01^{Aa}
Male	23	0.26±0.05	0.52±0.03^{Ab}	0.49±0.06	0.51±0.05	0.29±0.02	0.34±0.01^{Ab}	0.38±0.03	0.41±0.02^{Bb}	0.39±0.01^{Ab}
WeanGr xHouGr		NS	NS	NS	NS	NS	NS	NS	NS	NS
5W Individual	6	0.43±0.09	0.48±0.05	0.46±0.11	0.33±0.08	0.32±0.03	0.38±0.03	0.39±0.05	0.37±0.03	0.38±0.02
5WGroup	6	0.22±0.11	0.43±0.06	0.45±0.13	0.42±0.11	0.27±0.04	0.34±0.03	0.36±0.06	0.39±0.04	0.36±0.02
5WIndiv+Group	6	0.37±0.09	0.58±0.05	0.55±0.11	0.25±0.10	0.28±0.04	0.28±0.03	0.33±0.05	0.31±0.04	0.34±0.02
8W Individual	6	0.18±0.10	0.43±0.06	0.61±0.12	0.60±0.09	0.26±0.03	0.29±0.03	0.31±0.05	0.31±0.03	0.35±0.02
8WGroup	6	0.22±0.09	0.39±0.05	0.37±0.11	0.69±0.08	0.23±0.03	0.28±0.02	0.41±0.04	0.40±0.03	0.37±0.02
8W Indiv+Group	6	0.05±0.10	0.50±0.06	0.56±0.12	0.47±0.08	0.27±0.03	0.33±0.03	0.34±0.05	0.40±0.03	0.36±0.02

*: Significant for P<0.05, **: Significant for P<0.01. NS: Not significant, A,B,C: Different letter shows the significance between the means for P<0.01, Different letter shows the significance between the means for P<0.05

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