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EFFECTS OF PHOTOPERIOD AND HOUSING SYSTEM ON GROWTH PERFORMANCE AND SOME BLOOD PARAMETERS DURING FATTENING PERIOD IN SHEEP

(With 6 Tables)

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تأثيرات فترات الإضاءة ونظام الإيواء على كفاءة النمو وبعض مقاييس الدم أثناء فترة تسمين الأغنام

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فى هذه التجربة تم دراسة تأثير فترة الإضاءة لمدة ١٦ ساعه أو ٨ ساعات وأنظمة الإيواء سواء فى مجاميع أو حظائر مفرده على كفاءة نمو الحملان وبعض مقاييس الدم فى ٢٤ حمل أوسيمى متوسط أوزانها ٣٩ كجم. تناولت الحملان التى تم تعريضها لفترات الإضاءة الطويله بنسب أعلى من المادة الجافة ١٠ % و ٥,١٢ % من مخلوط العلف المركز و١١ % من الماء مقارنة بالحملان التى تعرضت لفترات الإضاءة القصيره. أيضا الحملان التى عرضت لفترات الإضاءة الطويله وكانت فى مجاميع كانت أكثر كفاءة فى تحويل الغذاء الى عائد فى الوزن اليومى. ونمت الحملان المرباه فى مجاميع بمعدل أسرع عن الحملان المفردة بالنسبة لكل من فترات الإضاءة الطويله والقصيره. وزاد المتوسط العام لتركيز جلوكوز البلازما ونيتروجين اليوريا بينما إنخفض تركيز الكورتيزول فى البلازما فى الحملان المرباه فى مجاميع وعرضت لفترات الإضاءة الطويله. وتدل هذه النتائج على أنه بمكن أن تكون فترة الإضاءة من وسائل الرعاية المفيدة فى إنتاج الأغنام وكذلك نظام الإيواء. حيث أن معدل النمو والكفاءة التحويلية للغذاء وتركيز كلا من الجلوكوز ونيتوجين اليوريا قد إرتفعت بينما تناقص تركيز الكورتيزول فى البلازما عندما تم تعريض الحملان لفترات الإضاة الطويلة وتمت تربيتها فى الحظائر بصورة جماعيه.

SUMMARY

The effect of photoperiod either 16 hours or 8 hours light and two housing systems (group or individual pens) on growth performance and some blood parameters in twenty four Ossimi (39 kg live body weight) were studied. Lambs exposed to long photoperiod consumed more 10% dry matter, 12.5% concentrate mixture and 11% water than short photoperiod ones. Long photoperiood grouped lambs were more efficient in converting feed to gain. Grouped lambs grew faster than individual ones in both long and short photoperiods. The overall mean of plasma glucose and urea-N concentrations increased but the plasma cortisol concentration decreased in grouped long photoperiod lambs. In conclusion, the results revealed that photoperiod may be useful management tool in sheep production, as well as housing system. Growth rate and feed efficiency, plasma glucose and urea-N concentrations increased and plasma cortisol concentration decreased when lambs were exposed to long photoperiod and raised in group pens.

Key words: *Lambs, Housing system, photoperiod, growth performance.*

INTRODUCTION

The present and anticipated world shortage of food and of animal origin might not be overcome but could certainly be considerably reduced by wider application of established techniques of good animal husbandry (Barrett and Larkin 1979). Inadequate animal protein resources and the inflation in the Egyptian population, as well as the increased demand on animal products necessitate a corresponding increase of animal production. One of the most important factors that improve animal production is managerial factors, specially photoperiod (day length) and housing system. Sheep like many other species, are sensitive to changes in their photoperiod environment. In fact photoperiod (day length) appears to be the primary environmental cue that regulates seasonal breeding activity in sheep (Ortavant. 1977).

Also Housing system is an important managerial factor. Kung *et al.* (1997) recommended that raising calves in an individual pens minimizes the spread of disease and prevents the calves from suckling each other also allows the precise measurement of feed intake and the monitoring of fecal consistency (LeBlanc, 1981). As well as, feed

intake, daily gain and feed efficiency were improved by raising calves in groups (Warnick *et al.*, 1977 and Andrighetto *et al.*, 1999). Similarly, in sheep. Kali *et al.* (1984) revealed that group pens ewes ate about 9% more dry matter than those in individual pens ones.

The objective of this study was to investigate the effect of photoperiod and housing system on growth performance and some blood parameters in Ossimi sheep under Upper Egypt conditions during fattening.

MATERIALS and METHODS.

The present study was carried out at the Experimental Farm of Animal and Poultry Production Department, Faculty of Agriculture, Assiut University. Assiut, Egypt.

Animals and experimental design:

Twenty four Ossimi lambs of approximately 9 months of age weighing about 39 kg. Lambs were assigned to one of four treatments (6 lambs/ treatment) according to their initial body weight. The experiment was designed as 2×2 factorial design, to study the effect of photoperiods of 16 h of light (L): 8 h of dark (D) or 8L: 16D and two housing systems; group pens or individual pens. The animals were exposed to 16L: 8D (Light switched on from 08.00 to 00.00 hr) or 8L: 16D (light switched on from 08.00 to 16.00 hr) throughout the entire trial (13 weeks). Lighting consisted of one 60 watt bulb per 8 m^2 suspended 2 m above floor level, (Forbes *et al*,. 1979); light density inside pen was equal to the normal daylight (outside pen). Lambs were housed in group pens (1.94 m^2 /head) or individual pens 1.4 × 1.4 m (1.96 m^2 /head). All lambs were fed on *ad libitum basis* bean straw and concentrate mixture (30%, Wheat bran; 42%, Maize; 25 %, Decorticated cotton meal; 2 %, Limestone and 1 %, Sodium chloride). Fresh water and mineralized salt blocks were freely available all times. The approximate chemical analysis of concentrate mixture and bean straw are shown in Table (1).

Growth performance:

All lambs were fasted 14 hours and weighed weekly. Feed intake and water consumption were measured daily throughout the experimental period (13 weeks). Daily weight gain and feed conversion were calculated.

Table 1: Chemical analysis of concentrate mixture and bean straw (Dry matter basis).

Items	Concentrate mixture	Bear straw
Crude protein	17.89	4.95
Crude fat	1.08	2.23
Nitrogen free extract	57.54	37.87
Crude fiber	8.21	45.83
Ash	15.28	9.12

Blood analysis:

Blood samples were collected just before morning feeding biweekly in heparinized tubes. Plasma was separated by centrifugation at 3000 r.p.m. for 15 minutes and stored at –20 C° until subsequent analysis. Glucose was measured using kit supplied by Biocon Diagnostics. Urea nitrogen was measured using kit supplied by Diamond Diagnostics. Cortisol was measured by radioimmunoassay; the assay is a solid phase competitive enzyme linked immunosorbent assay (ELISA). The wells are coated with cortisol igG. The samples, control and standard are incubated simultaneously with cortisol conjugated to enzyme horseradish peroxidase. After incubation, a sandwich complex is found on the well and unbound materials are removed by washing step. Upon addition of chromogen substrate, the intensity of the color developed is proportional to the amount of enzyme activity, which in turn is inversely proportional to the amount of cortisol in the samples.

Statistical analysis:

All data were statistically analyzed using the general linear model (GLM) procedure of SAS (1996). The following model was applied:-

$$Y_{ijk} = \mu + T_i + P_j + TP_{ij} + E_{ijk}$$

Where;

Y_{ijk} = the observation. μ = General mean. T_i = Effect due to photoperiod.
P_j = Effect due to housing system.
TP_{ij} =Effect of interaction between photoperiod and housing system.
E_{ijk} = the error related to individual observation.

RESULTS and DISCUSSION

Animal performance :

Feed intake, water consumption final body weight , daily gain and feed conversion of lambs exposed to long (16L: 8D) or short (8L: 16D) photoperiod and kept under two housing systems (individual or group) for 13 weeks are presented in Table (2). There was a highly significant ($P<0.01$) effect of photoperiod on average daily intake of both concentrate mixture and dry mater, for the entire experiment. Lambs exposed to long photoperiod tended to consume 10% more dry matter, 12.5% concentrate mixture and 11% water compared with lambs exposed to short photoperiod. There was no significant effect of photoperiod on roughage intake by lambs. These results are in agreement with those reported by Schanbacher and Crouse (1980) in lambs and Guertin *et al.*,(1995) in calves. The increase in feed intake associated with long photoperiod may be requisite to increase nutritional requirements of the rabidly growing animals exposed to long photoperiod (Schanbacher and Crouse, 1980). Changing day length modifies the sensitivity of the hypothalamo-pituitary axis to feedback gonadal steroid. Irrespective of photoperiod treatment, the presence of testosterone apparently imporin stimulating food consumption (Gettys *et al.*, 1989).

Lambs exposed to long photoperiod consumed more ($P<0.01$) water than those exposed to short photoperiod. These results may be attributed to high dry matter intake, since more water intake was associated with more dry matter intake (Koes and Pfonder, 1975).

There was a significant effect of housing system on average daily intake ($n =6$) of bean straw, concentrate mixture and water consumption during the experimental period (Table 2). Lambs housed in group pen tended to consume more concentrate mixture, and water by 9% and 20%, respectively, compared with lambs housed in individual pens. Individual pens raising system, under long or short photoperiod, was significantly high associated with more bean straw and water intakes than those kept in group pen. The increase of feed intake for lambs housed in group pen may be reduced the stress by permitting the animals to move freely, thus enabling animals to better assimilate nutrients (Warnick *et al.*, 1977). Similarly, Lalande *et al.* (1979) reported that calves housed in group pen tended to consume more ($P<0.05$) feed than those calves housed in

individual pens. However, high feed intake that associated with concentrate mixture, dry matter intake by lambs kept in group pen when exposed to 16L: 8D may be due to increased growth rate of lambs exposed to long photoperiod (Table 3).

Data in Table (2) revealed that, there was no significant interaction effect between photoperiod and housing system on intake of concentrate mixture, bean straw and dry matter. However, there was a high significant ($P<0.01$) interaction effect between photoperiods and housing systems on water intake. Lambs exposed to long photoperiod and individually housed consumed more water than others exposed to long photoperiod and housed in group, as well as the short and either individually or grouped housed lambs. Also, the individually housed lambs exposed to either long or short photoperiod tended to consume more bean straw and consequently more water. In contrast to this behavioral feeding habit, it noticed that the group housed ones preferred to have more concentrate mixture than individually housed lambs either exposed to long or short photoperiods with lesser amount of water. This behavior can be explained on the basis that lambs in group compete with each other to consume the concentrate mixture rather than bean straw.

By reviewing the entire period of 0-13 wk of the experiment, lambs exposed to long photoperiod gained more significant ($P<0.05$) in weight by 23.8% (164.6 vs. 132.9 g/day $P<0.05$) than lambs exposed to short photoperiod. In general, the entire 13 wk experimental period, animals kept in group pens grew faster than those kept in individual pens in both long and short photoperiods (Table 2). The values were 176.9, 152.4, 136.6 and 129.3 g/day in group's long × group, long × individual, short × group and short × individual, respectively (Table 3). These results are in agreement with those reported by Warnick *et al.* (1977), Lalande *et al.* (1979) Maatje *et al.* (1991) and Andrighetto *et al.* (1999) who found that average daily gain was higher for calves raised in group as compared to those raised individually. This may be due to increase in GH, stimulated by long photoperiod, which had a role in mediating supplemental light – induce increases in growth (Peter and Tucker, 1978). In addition, lambs had a greater weight gain in long day length may be due to greater gut-fill, which stimulated by long photoperiod. Schanbacher and Crouse (1980) suggested that long photoperiod stimulates growth rate of lambs by stimulating prolactine concentration, which may be a triggering factor of growth. Forbes *et al.* (1979) reported that long photoperiod significantly stimulated weight gain of lambs fed

ad libtum. . Similarly, Schanbacher *et al.* (1982) found that growth rate for lambs exposed to 16-h photoperiod (269 g/d) was about 15% greater than those exposed to only 8 h of light / day (228 g/d). There was no significant (P>0.05) differences in final body weight between the four groups, although lambs housed in group pen and exposed to long photoperiod had higher final body weight than the other three groups (Table 2).

Neither photoperiod nor housing system had significant effect on feed conversion ratio (kg feed /kg gain) and dry matter in lambs (Table 2). Forbes *et al.* (1975) reported no significant difference in feed efficiency between lambs exposed to long photoperiod (16hr light) and those exposed to short photoperiod (8 hr light). In respect to housing system effect, Lalande *et al.* (1979) reported that housing system did not affect feed efficiency when calves raised in group pen or in an individual pen, (2.26 vs. 1.6 TDN/ kg wt gain). Similar results were found by Barnett *et al.* (1984) in pig.

However, lambs exposed to long photoperiod and raised in group pen are more efficient in converting feed to gain than those exposed to short photoperiod and raised in individual pens. This improvement in feed conversion ratio may be due to high growth rate of lambs and high concentrate mixture intake by lambs exposed to long photoperiod and raised in group pens as shown in Tables (2 and 3). Higher concentrate intake resulted in higher propionate concentration; propionate is a major source of glucose (Riis, 1983). Higher blood glucose increased plasma insulin concentration (Hadly, 1984) and the end results increasing of feed conversion ratio. Feed conversion ratios were 8.6, 10.7, 10.5 and 14.6 kg dry matter/ kg gain, and for groups; long × group, long × individual, short × group and short × individual, respectively, as shown in Table (2).

Daily gain:

Table (3) summarize the effect of photoperiod and housing system on live weight gain throughout the experiment (13 weeks). Over the first 2-wk period, animals of 16L: 8D gained significantly more than those of 8L: 16D (123 vs. 61.8, g/day; $p<0.05$). Although this trend was remained high at 4, 6, 8 and 10 weeks, the differences were not significant (Table, 3). As well as, the first 2-weeks period. lambs kept in group pens gained more weight (128.4 vs. 57.19 g/day, $p<0.01$) than

those kept in individual pens. This trend continued at 4, 6, 8, 10 and 13 weeks of experiment but the differences were not significant (Table 3).

In the first 2-weeks period, lambs kept in group pen and exposed to long or short photoperiods gained more than those kept in individual pens (Table 3). The values were 152, 95, 105 and 19 g /day for long photoperiod × group pens, long photoperiod × individual pens, short photoperiod × group pens and short photoperiod × individual pens, respectively. Low live weight gain (19 g/day) in lambs exposed to short photoperiod and kept in individual pens is due to that four animals lost their weight during the first 2-wk of experiment.

The present study showed that long photoperiod and group pen raising systems improved lambs growth rate through the experiment. The increase in live weight gain was associated with increased intake of concentrate mixture and dry matter for lambs exposed to long photoperiod and kept in group.

Plasma glucose concentrations:

At the second week of experimental period plasma glucose concentration was significantly decreased in lambs exposed to short photoperiod compared with those exposed to long photoperiod. In spite of plasma glucose concentration, on fourth, eighth and twelfth week, were lower in lambs exposed to short photoperiod than those exposed to long photoperiod, such decrease was not significant (Table 4). The overall mean of plasma glucose concentration in lambs exposed to long photoperiod was significantly ($P<0.01$) increased by (82 vs. 86.7 mg /dl) than those exposed to short photoperiod. These results are in agreement with Bocquier *et al* (1990) observation that lambs exposed to long photoperiod had higher concentration of plasma glucose than those exposed to short photoperiod. Also, Forbes *et al.* (1979) reported that plasma glucose concentration was higher in lambs exposed to long photoperiod than those exposed to short photoperiod. Increasing glucose concentration by increasing photoperiod may be due to, stimulating growth hormone secretion by long photoperiod (Terqui *et al.*, 1984). Growth hormone decreases carbohydrate utilization from the blood (antagonizing insulin action, John *et al.*, 1986).

The overall mean of glucose concentration in lambs raised in group pen was higher ($P<0.05$) than those lambs raised in individual pens. This increasing of plasma glucose may be due to high concentrate mixture intake as shown in (Table 2).

Generally, lambs raised in group pen and exposed to long photoperiod (16L: 8D) had higher plasma glucose concentration than those lambs raised in an individual pens and exposed to either long or short photoperiods (Table 4). On the other hand, after the first two weeks of the experiment, lambs raised in individual pen and exposed to short photoperiod reached to minimum value of plasma glucose concentration compared with the other groups.

Plasma urea-N concentration:

At fourth, eighth and twelfth week of experimental period, plasma urea-N concentration was significant higher in lambs exposed to long photoperiod compared with those exposed to short photoperiod (Table 5). As well as, lambs raised in group pen had higher plasma urea concentration than those lambs raised in individual pens through the experimental period. Such increase of plasma urea concentration may be due to high concentrate mixture intake andconsequently protein intake as shown in Table (2). Cole and Hulcheson (1990) showed that plasma urea nitrogen concentration increased with increasing level of protein intake in calves. In contrast, Madsen (1983) stated that when amino acids are utilized in the liver for gliconeogenesis, the amino groups are converted into urea. The highest levels of urea-N production are found in the fast growing animals with higher protein intake.

The present study showed that lambs raised in group pen and exposed to long photoperiod had higher plasma urea-N concentration than those raised in an individual pens and exposed to either long or short photoperiod during experiment period (Table 5).

Plasma cortisol concentration:

Plasma cortisol concentration was significantly higher at weeks 4, 8 and 12 in lambs exposed to short photoperiod than those exposed to long photoperiod As well as, overall mean of cortisol concentration for whole the experimental period was significantly higher in lambs exposed to short photoperiod compared with lambs exposed to long photoperiod. These results are in agreement with (Brinklow and Forbes; 1984 Brinklow *et al.*, 1984) who found that serum cortisol concentration decreased with increasing photoperiod, also, Lunow and Zerobin, (1987) found similar result in non pregnant ewes. Similarly, Leining *et al.* (1979) reported that concentration of glucocorticoids decreased ($P<0.05$) by 29% and 39% within 2 to 3 weeks after increasing daily light from 8 to 16 and 20 hr, respectively, in bulls.

After the first two weeks, lambs raised in an individual pens had significantly higher plasma cortisol concentration than those raised in group pen. Following 8 to 12 week of the experimental period, plasma cortisol concentration was remained higher but not significant.

In general, lambs housed in group pen and exposed to long photoperiod had significant lower plasma cortisol concentration than those housed in individual pens and exposed to short photoperiod (Table 5)

In conclusin:

Our results revealed that photoperiod may be useful management tool in sheep production, as well as housing system. Growth rate and feed efficiency are increased when animals exposed to 16 h of light daily and raised in group pen. The overall mean of plasma glucose and urea-N concentrations increased and plasma cortisol concentration decreased in animal exposed to long photoperiod and raised in group pens compared with those animals exposed to short photoperiod and raised in individual pens. The increase values were associated with high intake of concentrate mixture and protein.

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Table (2). Feed intake, water consumption and feed conversion of lambs exposed to long (16L: 8D) or short photoperiods (8L: 16D) and kept under two housing systems (individual vs. group pens) for 13 weeks (mean ± SE).

Factors	Bean straw (kg)	Concentrates mixture (kg)	Dry matter (kg)	Water (kg)	Final Body weight (Kg)	Daily Gain (g)	Feed conversion Kg (Feed / gain)
Photoperiod	NS	**	**	**		*	
Long	1.13±0.09	8.72±0.19^{a}	9.02±0.17^{a}	33.64±1.22^{a}	54.23±1.65	164.66±6^{a}	9.65±0.45
Short	1.22±0.09	7.75±0.18^{b}	8.19±0.16^{b}	30.24±0.84^{b}	51.47±1.10	132.94±6^{b}	12.56±2.01
Housing system	**	**	NS	**		*	
Group	0.93±0.05^{b}	8.59±0.18^{a}	8.72±0.15	28.99±0.97^{b}	53.52±1.65	156.76±5^{a}	9.55± 0.31
Individual	1.415±0.09^{a}	7.88±0.22^{b}	8.49±0.21	34.88±0.88^{a}	52.18±1.22	140.84±7^{a}	12.66±2.02
Photo. × House.				**			
Long × group	0.85±0.03^{b}	8.98±0.18^{a}	9.02±0.15^{a}	28.96±1.29^{b}	55.40±2.68	176.91±7^{a}	8.62±0.32
Long × individual	1.41±0.13^{a}	8.46±0.33^{ab}	9.02±0.30^{a}	38.31±0.92^{a}	53.07±2.06	152.41±8^{a}	10.69±0.75
Short × group	1.01±0.08^{b}	8.19±0.25^{b}	8.42±0.24^{ab}	29.02±1.49^{b}	51.63±1.83	136.60±6^{bc}	10.48±0.39
Short × individual	1.42±0.14^{a}	7.31±0.21^{c}	7.96±0.21^{b}	31.46±0.68^{b}	51.30±1.42	129.27±11^{c}	14.63±0.39

a, b and c means in the same column with different superscript for each factor differ at (p<0.05) of all pairwise tests of treatment differences for interaction (PDIFF).

* significant at (P<0.05)

** significant at (P<0.01)

Table (3): Daily gain (g) of lambs exposed to long (16L: 8D) or short photoperiods (8L: 16D) and kept under two housing systems (individual vs. group) for 13 weeks (Means ± SE).

Factors	week 0-2	week 3-4	Week 5-6	week 7-8	week 9-10	week 11-13
Photoperiod						
Long	123.75±17^{a}	134.42±17	147.67±20	191.67±19	204.83±21	223.83±18
Short	61.75±31^{b}	120.33±13	116.83±11	158.25±19	171.33±25	137.91±17
Housing system						
Group	128.42±12	144.08±17^{a}	154.83±14	177.33±19	190.50±20	195.25±13^{a}
Individual	57.08±32	110.67±11^{b}	109.67±16	172.58±20	185.67±24	166.50±27^{b}
Photo. × House.						
Long × group	152.17±20^{a}	178.50±13^{a}	181.00±24^{a}	197.67±30	219.166±38	224.00±20^{a}
Long × individual	95.33±24^{a}	90.33±18^{b}	114.33±28^{ab}	185.67±27	190.50±23	223.67±32^{a}
Short × group	104.67±6^{a}	109.67±27^{ab}	128.67±9^{ab}	157.00±25	161.83±28	166.50±9^{ab}
Short × individual	18.83±5^{b}	131.00±5^{ab}	105.00±19^{b}	159.50±33	180.83±45	109.33±29^{b}

a, b and c means in the same column with different superscript for each factor differ ($p<0.05$) of all pairwise tests of treatment differences for interaction (PDIFF).

* Significant at ($P<0.05$)

Table (4): Effect of photoperiod (short vs. long) and housing system (individual vs. group pen) on blood glucose concentration (mg/dl) of lambs for 13 weeks (means ± SE).

Factors	At the beginning	2nd week	4th week	8th week	12th week	Allover-mean
Photoperiod						**
Long	86.04±1.86	85.93±2.64	88.10±2.77	87.88±2.98	85.497±2.68	86.69±1.11[a]
Short	80.63±1.20	77.38±1.54	83.66±2.61	83.66±2.61	80.844±2.76	81.97±0.98[b]
Housing system						*
Group	84.41±1.59	82.14±2.38	88.10±3.51	88.31±2.49	87.121±1.20	86.02±0.90[a]
Individual	82.25±2.38	81.17±3.30	83.66±3.51	85.39±1.93	80.74±3.16	82.64±1.24[b]
Photo. ×House.						
Long ×group	86.79±2.63	86.36±2.34[a]	88.53±3.19[a]	91.56±3.89	88.53±1.15[a]	88.36±1.16[a]
Long ×individual	85.28±3.14	85.49±5.41[ab]	87.66±5.29[ab]	84.20±3.97	82.47±5.04[ab]	85.02±1.82[ab]
Short ×group	82.03±0.43	77.92±2.24[ab]	87.66±0.65[ab]	85.06±2.34	85.72±1.98[ab]	83.68±1.12[bc]
Short ×individual	79.22±2.25	76.84±2.55[b]	79.654±4.180[b]	86.58±1.20	79.01±4.78[b]	80.26±1.52[c]

[a, b and c] means in the same column with different superscript for each factor differ (p<0.05) of all pairwise tests of treatment differences for interaction (PDIFF) .

* significant at (P<0.05)

** significant at (P<0.01)

Table (5): Effect of photoperiod (short vs. long) and housing system (individual vs. group pen) on blood urea-N concentrations (mg/dl) of lambs for 13 weeks (means ± SE).

Factors	At the beginning	2nd week	4th week	8th week	12th week	Week 0-week 13
Photoperiod						**
Long	36.13±0.64	39.14±1.14	43.46±1.12^{a}	42.56±1.30^{a}	44.14±1.14^{a}	41.09±0.72^{a}
Short	36.39±0.86	37.98±1.57	36.39±1.41^{b}	39.08±1.21^{b}	38.50±1.02^{b}	37.67±0.55^{b}
Housing system						**
Group	36.55±0.79	41.24±0.25^{a}	40.77±1.96	42.25±1.16	42.83±1.56^{a}	40.73±0.66^{a}
individual	35.97±0.70	35.86±0.89^{b}	39.08±2.01	39.40±1.50	39.82±1.47^{b}	38.03±0.67^{b}
Photo. × House.						
Long ×group	36.08±1.11	41.03±0.38^{ab}	44.62±1.20^{a}	44.62±0.80^{a}	45.89±150^{a}	42.45±1.04^{a}
Long ×individual	36.18±0.90	37.24±1.66^{b}	42.30±1.88^{a}	40.51±1.90^{b}	42.41±1.10^{ab}	39.73±0.90^{b}
Short ×group	37.03±1.32	41.46±0.36^{a}	36.92±1.74^{b}	39.88±0.66^{b}	39.77±0.76^{bc}	39.01±0.63^{b}
Short ×individual	35.76±1.27	34.50±0.18^{b}	35.87±2.57^{b}	38.29±2.51^{b}	37.24±1.73^{c}	36.33±0.79^{c}

a, b and c means in the same column with different superscript for each factor differ ($p<0.05$) of all pairwise tests of treatment differences for interaction (PDIFF)
** significant at ($P<0.01$)

Table (6). Effect of photoperiod (short vs. long) and housing system (individual vs. group pen) on blood cortisol concentration (μ g/dl) of lambs for 13 weeks (means ± SE).

Factors	At the beginning	4th week	8th week	12th week	Week 0-week13
Photoperiod					**
Long	1.63±0.28	2.92±0.48[b]	3.23±0.56[b]	4.38±0.49[b]	3.04±0.27[b]
Short	2.19±0.49		8.09±0.92[a]	8.90±0.96[a]	6.66±0.58[a]
Housing system					**
Group	1.25±0.31	4.25±0.97[b]	5.25±0.86	6.55±0.89	4.32±0.50[b]
Individual	2.57±0.38	6.03±1.015[a]	6.07±1.30	6.82±1.24	5.37±0.57[a]
Photo. ×House.					
Long ×group	1.40±0.54	2.20±0.51[b]	3.40±0.81[b]	4.60±0.64[b]	2.90±0.43[c]
Long ×individual	1.85±0.20	3.65±0.71[b]	3.05±0.87[b]	4.15±0.81[b]	3.18±0.38[c]
Short ×group	1.10±0.34	6.30±1.36[a]	7.10±0.99[a]	8.50±1.13[a]	5.75±0.80[b]
Short ×individual	3.29±0.60	8.14±1.14[a]	9.09±1.52[a]	9.49±1.65[a]	7.57±0.82[a]

[a, b and c] means in the same column with different superscript for each factor differ ($p<0.05$) of all pairwise tests of treatment differences for interaction (PDIFF).

** significant at ($P<0.01$)