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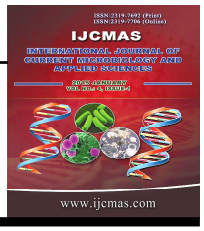

Original Research Article

Effect of housing system on lamb puberty

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K e y w o r d s

Housing system, lamb puberty, testosterone

A B S T R A C T

This study was to investigate the influence of housing system on lamb puberty. Forty- eight Farafra ram lambs with an average weight of 19 kg and 4-5 months of age were used during summer. Ram lambs were randomly divided into six groups and housed under six housing systems, they are differed mainly in the type and height of roofs, as follow: 1) Semi open type house shaded with asbestos sheets (AS); 2) Semi open type house shaded with straw earth floors (S); 3) a close type shaded with single asbestos roof at 3 m height (single low type, SL); 4) a close type shaded with single asbestos roof at 5 m height (single high type, SH); 5) a close type shaded with double asbestos roofs at 3 and 3.5 m height for two roofs, respectively (double low type, DL); 6) a close type shaded with double asbestos roofs at 5 and 5.5 m height for two roofs, respectively (double high type, DH).. The experiment period lasted for 5-6 months. Ram lambs were tested for libido (first mounting without erection, first mounting with erection and first collected ejaculate containing motile sperm, puberty) at 8:00 am to 9:00 am daily until puberty. Testis measurements, scrotal circumference, testis length, and volume of the testes were recorded monthly during the experimental period. Age and weight at first mounting without erection, first mounting with erection and age at first collected ejaculate containing motile sperm (puberty) was recorded. Blood samples were collected for determination of serum testosterone**.** All results were analyzed using GLM procedure of SAS**.** Average age and weight of growing ram lambs at first mounting without erection, at first mounting with erection and at first ejaculation with spermatozoa (puberty) were (199.08 days and 26.42 kg), (250.92 days and 33.00 kg) and (288.00 days and 37.29 kg), respectively. Among puberty stages, ram lambs in closed houses (DL and DH) had significantly lower age at first mounting without erection than that in semi open types (AS and S). Also, ram lambs in closed houses had significantly lower age at first mounting with erection and age at puberty than those in semi open one. Ram lambs in closed houses had significantly higher testicular volume, right and left testis length and scrotal circumference means than those in semi open one. With the advancement of age, ram lambs in closed houses had significantly higher testicular volume, right and left testis length and scrotal circumference means than those in semi open one. Serum testosterone levels of ram lambs increased gradually with advancing of age until attainment of puberty (369.56 ng/dl). Ram lambs in closed houses had higher average serum testosterone levels than that in semi open houses (AS and S). Among puberty stages, housing systems had no significant effect on serum testosterone levels of ram lambs in the first mounting stage. Whereas, in the first mounting with erection stage, and in the first ejaculation (puberty) serum testosterone levels of ram lambs were significantly higher in closed houses than those in semi open one. In conclusion, closed houses, particularly that with high and double roof during hot months may enhance puberty of ram lambs

Introduction

Housing and management practices particularly during hot seasons can be a source of stress for sheep and domestic animals. Also, climatic conditions have direct and indirect effects on production and reproduction of ram lambs. Environmental temperature influences reproductive function in the male by altering spermatogenesis and reducing semen quality, leading to decreased male fertility (Curtis 1983 and Casu et al. 1991). Mickelsen et al. (1981) showed that season and breed had more effect on scrotal circumference than did body weight. Marai et al. (2006) found that scrotal circumference and testis length in Suffolk rams were significantly lower ($P < 0.05$) in summer than in winter (23.33 and 11.75 cm vs. 30.33 and 12.25 cm, respectively). Housing, months of the year or season had a significant ($P < 0.01$) effect on the serum testosterone levels, (Field et al. 1989; Delgadillo et al. 2002; Malfatti et al. 2006; Gundogan, 2007 and Todini et al. 2007) .In fact such effects are mainly attributed to air temperature and humidity which are closely related to housing system. So, the present study was carried out to evaluate and assess the impact and different housing systems on Farafra lamb puberty, under Upper Egypt hot conditions.

Materials and Methods

The present study was carried out during the period from May to October at Mallawi Animal Production Research Station on a total of 48 growing ram lambs approximately 5 month of age and had an initial weight of 19 kg.

Animals were assigned to six groups raised under six housing system as follow. 1, Semi open type house roofed with asbestos sheets (AS); 2, Semi open type house roofed with straw earth floors (S); 3, a close type roofed with single asbestos roof at 3 m height (single low type, SL); 4, a close type roofed with single asbestos roof at 5 m height (single high type, SH); 5, a close type roofed with double asbestos roofs at 3 and 3.5 m height for two roofs, respectively (double low type, DL); 6, a close type roofed with double asbestos roofs at 5 and 5.5 m height for two roofs, respectively (double high type, DH).

All animals were fed *ad libitum* wheat straw and concentrate mixture (Table, 1) containing 140 g crude protein per kg diet. Fresh water and mineral mixture blocks were freely available day and night.

Ram lambs were tested daily for libido at 8:00 am to 9:00 am until puberty. Libido test for each animal was measured by introducing ram lambs to a teaser ewe, which was randomly selected. All ram lambs were allowed to go out the collection area without restraint to observation the sexual activity toward the ewe and considering the following, first mounting with erection is the first penile protrusion. While puberty is the age at first collected ejaculate containing motile sperm. After first mounting with erection, ram lambs were trained for semen collection using an artificial vagina. During semen collection, the ram lamb was stimulated sexually by allowing it to mount the ewe.

Testis measurements; scrotal circumference, testis length, and volume of the testes were recorded monthly during the experimental period according to *Salhab et al. (2001).* Plasma testosterone level was determined at first mounting; erection and ejaculation, using kits supplied by Diagnostic Products Corporation (USA).

All results were subjected to an analysis of variance procedure using general linear procedure (GLM) using *SAS (1995).* Ambient temperature, relative humidity, reproductive traits as well as blood testosterone were dependent variables. Main effects in the model were housing system, weeks or periods. The model used for statistical analysis of reproductive performance and blood testosterone was:

$$Y_{ijk} = \mu + T_i + W_j + TW_{ij} + E_{ijk}$$

where, Y = Experimental observation., μ = General mean, T_i = The effect of housing system, W_j = The effects of week., TW_{ij} = The effect of interaction between housing system and week. And E_{ijk} = Experimental error of ijk observation.

Result and Discussion

Housing and environmental condition

Table (2) illustrate the environmental conditions of different lamb's houses. Results indicate that daily average AT was the lowest in both (DL) and (DH) houses compared with the other housing types. Also, THI values at closed houses were lower (P< 0.05) than that in semi open types. Also, the double roof houses (DH and DL) show lower (P< 0.05) values than that in semi open types (AS and S).

Effect of housing system on sexual behavior development, age and weight at puberty

Table (3) illustrates that the average values of age and weight of growing ram lambs at first mounting without erection were 199.08 days and 26.42 kg, at first mounting with erection were 250.92 days and 33.00 kg and at first ejaculation with spermatozoa (puberty) were 288.00 days and 37.29 kg. Similar results were recorded by *Hamdon (2005)* who found that average age and weight of Farafra ram lambs at first mounting without erection, at first mounting with erection, and at first ejaculation with spermatozoa were 215.80 days and 28.76 kg, 274.35 days and 34.76kg and 329.17 days and 36.19 kg, respectively. Also, *Mohamed (1998)* showed that average age and weight of Ossimi ram lambs at first mounting without erection, at first mounting with erection, and at first ejaculation with spermatozoa were (242 days & 29.5 kg), (289 days & 33.2kg) and (330 days & 38 kg), respectively.

Data in Table (3) show that there was no significant effect of housing system on BW at first mounting without erection, at first mounting with erection and at first ejaculation with spermatozoa (puberty), although values tended to be higher in ram lambs housed in closed houses (DH and DL) than those housed in other housing types.

Among puberty stages, ram lambs in closed houses (DL and DH) had lower (P< 0.01) age at first mounting without erection than those in semi open type, S (192.38 and 194.13 vs. 207.63 days, respectively) while, ram lambs housed in DL type had significantly lower (P< 0.05) age at first mounting without erection than those housed in semi open AS type (Table, 3). However, at the first mounting with erection stage, ram lambs in closed houses (DL, SL, DH and SH) had significantly lower (P< 0.01) age at first mounting with erection than those housed in semi open one. Within closed houses no significant effect of type or height of roofs was detected. Also, at the first ejaculation with spermatozoa (puberty), ram lambs housed in closed houses had significantly lower (P< 0.01) age at puberty than that in semi open one and no significant effect of roof type or height was found.

Ram lambs housed in closed houses had reached puberty stage earlier than those housed in semi open ones (276 vs. 311 days), such result may be due to the higher BW of ram lambs in closed houses than those housed in semi open one (Abozed, 2008).

Testicular measurements

The effects of housing systems on testicular measurements are shown in Tables (4, 5, 6, 7 and 8). The testicular volume means of ram lambs in closed houses (DL, DH, SL and SH) were higher (P< 0.01) than those in semi open one, AS and S (164.38, 162.79, 154.58 and 154.19 vs. 136.25 and 135.92 ml, respectively). Similar results were found by *Gundogan (2007)*, in sheep, who reported a decrease in testes volume in hot months compared with that in moderate and cold months.

With the advance of age, it was observed that the testicular volume of ram lambs kept in closed houses (DL, DH, SL and SH) was higher than those maintained in semi open ones (AS and S), Table (5). This result is agreement with the results of *Hamdon (2005)* who reported that testicular volume of ram lambs increased gradually from 4^{th} to 16^{th} month of age. *Salhab et al. (2001)* found that testicular volume of Awassi ram lambs began to increase at the 7^{th} until 9^{th} month of age.

The effect of housing systems on right and left testis length means of ram lambs are shown in Tables (6 and 7). The results showed that ram lambs housed in closed houses (DH, DL and SL) had significantly (P< 0.01) higher right and left testis length means than those in semi open one.

With the advance of age it was observed that right and left testis length means of ram lambs in closed houses (DL, DH, SL and SH) were higher than those in semi open type (AS and S), Tables (36 and 37). Similar results were obtained by of *Hamdon (2005)* who reported that testis length of ram lambs increased gradually from the 4^{th} to 16^{th} month of age. *Salhab et al. (2001)* found that testis length of Awassi ram lambs began to increase at the 7^{th} month until 9^{th} month of age. The effect of housing systems on scrotal circumference means of ram lambs are shown in Table (8). Data illustrated that ram lambs in closed houses (DL, DH and SL) had significantly higher (P< 0.05) scrotal circumference than that in S and AS housing types. With the advancement of age, it was observed that scrotal circumference of ram lambs in closed houses were higher than those in semi open one (Table, 8). The same trend was found by *Hamdon (2005)* who indicated that scrotal circumference of ram lambs increased gradually from the 4^{th} month of age to puberty. *Salhab et al. (2001)* found that the highest growth in scrotal circumference of Awassi ram lambs began at the 7 months and lasted until 9 months of age.

The increase of testicular measurements of ram lambs in closed houses is associated with the increase of BW of lambs in closed houses compared with lambs in semi open one, which resulted by the decrease in AT in closed houses than those in semi open one. *Hamdon (2005)* showed that the age and the BW of Farafra ram lambs were positively (P< 0.01) correlated with the right testis length, left testis length, scrotal circumference and testicular volume (r = 0.57 - 0.83). *Salhab et al. (2001)* found that the age and the body weight of Awassi ram lambs were positively (P< 0.01) correlated with testicular measurements (r = 0.51 – 0.91). Also, *Abou-Ahmed (1982)* indicated that testes length of rams was longer during spring than during summer (11.48 vs. 9.67

cm). *Yarny et al. (1990)* reported a decrease of testis length and scrotal circumference in ram lambs during hot summer as compared with those lambs under temperate environmental conditions. Also, *Marai et al. (2006)* found that testis length and scrotal circumference values in Suffolk rams were significantly lower ($P < 0.05$) in summer than in winter (11.75 and 23.33 cm vs. 12.25 and 30.33 cm, respectively).

Testosterone hormone level

Least square mean of serum testosterone levels (ng/dl) of ram lambs housed under different housing systems are shown in Tables (9 and 10) and Figures (1&2). Serum testosterone levels of ram lambs increased gradually with advancing of age until attainment of puberty (369.56 ng/dl). Similar results were reported by *Miller et al. (1989)* who showed that serum testosterone levels were increased gradually in Suffolk ram lambs from 24 to 30 week of age. Also, *Salem (1997)* indicated that serum testosterone levels of Saidi ram lambs increased in amplitude and frequency with advancing age until reached 348 ng/dl blood serum at 375 days of age (puberty). *Hamdon (2005)* found that plasma testosterone hormone levels of Farafra ram lambs increased gradually with advancing age until attainment of puberty (583 ng/dl) at age of 329.17 days.

Results showed that ram lambs in closed houses (DH, DL, SL and SH) had higher average serum testosterone levels than that in semi open houses AS and S (242.00, 227.43, 223.20 and 221.73 ng/dl vs. 208.38 and 211.27 ng/dl, respectively, Table, 9 and Figure, 3).

Table (10) illustrates that serum testosterone levels were significantly differed ($P< 0.01$) among puberty stages and each of the first mounting stage and first mounting with erection stage. Similar results were obtained by *Hamdon (2005).* Among puberty stages, housing systems had no significant effect on serum testosterone levels in the first mounting stage. Whereas, in the first mounting with erection stage, serum testosterone levels were significantly ($P< 0.05$) higher in rams housed in closed houses (DH, DL, SH and SL) than those housed in semi open one (AS and S, Table 10). Also, at the first ejaculation (puberty), serum testosterone levels were significantly higher ($P< 0.05$) in ram lambs housed in closed houses (DH, DL, SH and SL) than those housed in semi open one (Table, 10).

The decrease of serum testosterone levels in ram lambs housed in semi open houses than those housed in closed one may be attributed to the elevation of AT in semi open type compared with closed houses (Table 2). *Gomes et al. (1971) and Salem (1997)* indicated that testosterone hormone levels decreased with increasing environmental temperature. Also, ram lambs in semi open type had lower BW than those in closed ones. *Kridli and Al-Yacoub (2006)* found that testosterone concentration was positively correlated with BW ($r = 0.3$). In addition, high scrotal circumference values of ram lambs housed in closed houses (Table 8) may attributed to the increase in testosterone levels (Table 10). *Hamdon (2005) and Kridli and Al-Yacoub (2006)* found significant positive correlation coefficients between testosterone hormone and scrotal circumference.

Table.1 Chemical composition of concentrates and wheat straw

Item	Concentrates	Wheat straw
Dry matter, %	93.70	87.3
Crude Protein, %	13.75	1.51
Crude fiber, %	15.2	42.90
Ether extract, %	3.6	2.47
Ash, %	12	10.04
NFE, %	55.45	43.08
Organic matter, %	88	89.96

Table.2 Average (LSM ±SE) of air temperature (°C), relative humidity (%) and THI index in different housing systems of ram lambs

Parameter	Time	Housing system					
		AS	**S**	**SL**	**SH**	**DL**	**DH**
Air temperature (°C)	**Morning**	24.25 ^{a} ± 0.02	24.17 ^{b} ± 0.02	25.69 ^{c} ± 0.02	25.00 ^{d} ± 0.02	24.83 ^{e} ± 0.02	24.57 ^{f} ± 0.02
	Afternoon	35.00 ^{a} ± 0.02	35.33 ^{b} ± 0.02	32.83 ^{c} ± 0.02	33.08 ^{d} ± 0.02	32.42 ^{e} ± 0.02	32.01 ^{f} ± 0.02
	Average	29.63 ^{a} ± 0.02	29.75 ^{b} ± 0.02	29.27 ^{c} ± 0.02	29.04 ^{d} ± 0.02	28.63 ^{e} ± 0.02	28.29 ^{f} ± 0.02
Relative humidity (%)	**Morning**	71.33 ^{ab} ±0.2	71.67 ^{a} ±0.2	71.24 ^{ab} ±0.2	70.82 ^{b} ±0.2	71.25 ^{a} ±0.2	71.42 ^{a} ±0.2
	Afternoon	37.25 ^{a} ±0.2	37.08 ^{a} ±0.2	39.50 ^{c} ±0.2	38.83 ^{b} ±0.2	38.83 ^{b} ±0.2	38.25 ^{a} ±0.2
	Average	54.29 ^{a} ±0.14	54.38 ^{a} ±0.14	55.37 ^{ci} ±0.14	54.83 ^{b} ±0.14	55.04 ^{bi} ±0.14	54.83 ^{b} ±0.14
THI	**Morning**	68.65 ^{d} ±0.04	68.55 ^{d} ±0.04	70.39 ^{a} ±0.04	71.08 ^{b} ±0.04	69.29 ^{e} ±0.04	70.04 ^{c} ±0.04
	Afternoon	88.03 ^{b} ±0.04	88.90 ^{a} ±0.04	83.75 ^{d} ±0.04	84.30 ^{c} ±0.04	83.60 ^{f} ±0.04	82.71 ^{e} ±0.04
	Average	78.34 ^{a} ±0.03	78.72 ^{b} ±0.03	77.07 ^{d} ±0.03	77.69 ^{c} ±0.03	76.44 ^{e} ±0.03	76.38 ^{e} ±0.03

Values with different letters in the same row are significantly different, (P<0.01); AS (Semi Open house shaded with asbestos sheets). S (Semi open type house shaded with straw earth floors); SL (Single l-ow type). SH (Single high type). DL (Double low roof). DH (Double high roof).).

Table.3 Effect of housing system on pre-pubertal characters of reproductive traits of ram lambs (LSM ±SE)

Housing system*	Pre-pubertal character					
	1th mounting without erection		1th mounting with erection		1th ejaculation (Puberty)	
	Age, days	Weight, kg	Age, days	Weight, kg	Age, days	Weight, kg
AS	203.13 ^{cd} ±3.67	26.13 ±2.32	261.38 ^{a} ±3.67	32.00 ±2.32	310.88 ^{a} ±3.67	36.00 ±2.32
S	207.38 ^{bd} ±3.67	26.88 ±2.32	264.75 ^{ac} ±3.67	32.88 ±2.32	312.00 ^{a} ±3.67	36.75 ±2.32
SL	198.63 ^{bce} ±3.67	25.25 ±2.32	243.50 ^{bd} ±3.67	31.63 ±2.32	278.75 ^{b} ±3.67	37.25 ±2.32
SH	198.88 ^{bce} ±3.67	26.25 ±2.32	250.25 ^{d} ±3.67	32.38 ±2.32	278.50 ^{b} ±3.67	36.50 ±2.32
DL	192.38 ^{ae} ±3.67	26.63 ±2.32	240.88 ^{bd} ±3.67	34.13 ±2.32	274.50 ^{b} ±3.67	39.13 ±2.32
DH	194.13 ^{ac} ±3.67	27.38 ±2.32	244.75 ^{bd} ±3.67	35.00 ±2.32	273.38 ^{b} ±3.67	38.13 ±2.32
Average	199.08 ±1.50	26.42 ±0.95	250.92 ±1.50	33.00 ±0.95	288.00 ±1.50	37.29 ±0.95

Values with different letters in the same column are significantly different, (P<0.05) except a, b (P<0.01). AS (Semi Open house shaded with asbestos sheets). S (Semi open type house shaded with straw earth floor s).SL (Single low type). SH (Single high type).DL (Double low roof). DH (Double high roof).

Table.4 Effect of housing system on testicular measurements of ram lambs (LSM ±SE)

Housing system*	Testicular measurement				
	Testicular volume (ml)	Right testis Length (cm)	Left testis Length (cm)	Scrotal circumference (cm)	Body weight (kg)
AS	136.25 ^{a} ±04.99	7.09 ^{a} ±0.19	7.84 ^{a} ±0.20	23.16 ^{ac} ±0.47	30.98 ^{a} ±0.88
S	135.92 ^{a} ±04.99	7.08 ^{a} ±0.19	7.72 ^{a} ±0.20	23.59 ^{c} ±0.47	30.85 ^{a} ±0.88
SL	154.58 ^{c} ±04.99	8.12 ^{bc} ±0.19	8.71 ^{bc} ±0.20	24.88 ^{b} ±0.47	31.38 ^{a} ±0.88
SH	154.19 ^{c} ±04.99	7.72 ^{c} ±0.19	8.30 ^{ac} ±0.20	24.22 ^{bc} ±0.47	33.10 ^{ab} ±0.88
DL	164.38 ^{bc} ±04.99	8.24 ^{b} ±0.19	8.77 ^{bc} ±0.20	25.23 ^{b} ±0.47	34.46 ^{b} ±0.88
DH	162.79 ^{bc} ±04.99	8.34 ^{b} ±0.19	8.95 ^{b} ±0.20	25.20 ^{b} ±0.47	35.25 ^{b} ±0.88

Values with different letters in the same column are significantly different, (P<0.01) except a, g; b, g (P<0.05) . S (Semi Open house shaded with asbestos sheets). S (Semi open type house shaded with straw earth floors). SL (Single low type). SH (Single high type). DL (Double low roof). DH (Double high roof).

Table.5 Effect of housing system on testicular volume (ml) of ram lambs

Age (Month)	Housing system*					
	AS	S	SL	SH	DL	DH
6	110.00 ±12.21	94.63 ±12.21	114.38 ±12.21	108.13 ±12.21	116.25 ±12.21	114.38 ±12.21
7	113.75 ^{c} ±12.21	102.13 ^{bc} ±12.21	128.75 ^{abc} ±12.21	122.50 ^{abc} ±12.21	149.38 ^{a} ±12.21	131.88 ^{abc} ±12.21
8	137.50 ±12.21	141.25 ±12.21	147.50 ±12.21	145.63 ±12.21	158.13 ±12.21	165.38 ±12.21
9	150.63 ±12.21	146.88 ±12.21	163.13 ±12.21	175.63 ±12.21	177.50 ±12.21	169.13 ±12.21
10	158.13 ^{a} ±12.21	155.00 ^{a} ±12.21	186.25 ^{ab} ±12.21	178.13 ^{ab} ±12.21	183.13 ^{ab} ±12.21	194.38 ^{b} ±12.21
11	147.50 ^{a} ±12.21	175.63 ^{ab} ±12.21	187.5 0 ^{b} ±12.21	195.13 ^{b} ±12.21	201.88 ^{b} ±12.21	201.63 ^{b} ±12.21

* Values are least square means (LSM) ± standard error (SE of LSM). Values with different letters in the same row are significantly different, (P<0.01) except a, g (P<0.05). AS =Semi Open house shaded with asbestos sheets.S =Semi open type house shaded with straw earth floors, SL = Single low type, SH = Single high type, DL =Double low roof and DH =Double high roof.

Table.6 Effect of housing system on right testis length (cm) of ram lambs (LSM ±SE)

Age (Month)	Housing system					
	AS	*S*	*SL*	*SH*	*DL*	*DH*
6	5.05 ^{a} ± 0.47	5.33 ^{ab} ± 0.47	6.51 ^{b} ± 0.47	6.30 ^{ab} ± 0.47	6.50 ^{b} ± 0.47	6.08 ^{ab} ± 0.47
7	6.20 ^{a} ± 0.47	5.79 ^{a} ± 0.47	7.55 ^{b} ± 0.47	6.14 ^{a} ± 0.47	7.53 ^{b} ± 0.47	7.50 ^{b} ± 0.47
8	7.34 ± 0.47	7.48 ± 0.47	7.99 ± 0.47	7.49 ± 0.47	8.16 ± 0.47	8.56 ± 0.47
9	7.95 ± 0.47	7.58 ± 0.47	8.14 ± 0.47	8.56 ± 0.47	8.79 ± 0.47	8.48 ± 0.47
10	7.84 ^{a} ± 0.47	7.76 ^{ad} ± 0.47	9.18 ^{abcd} ± 0.47	8.66 ^{abcd} ± 0.47	8.93 ^{cd} ± 0.47	9.54 ^{bc} ± 0.47
11	8.14 ^{a} ± 0.47	8.55 ^{ab} ± 0.47	9.35 ^{abc} ± 0.47	9.15 ^{ab} ± 0.47	9.51 ^{bc} ± 0.47	9.90 ^{c} ± 0.47

Values with different letters in the same row are significantly different, (P<0.05) except a, b (P<0.01), AS = Semi Open house shaded with asbestos sheets, S = Semi open type house shaded with straw earth floors, SL = Single low type, SH =Single high type, DL =Double low roof and DH = Double high roof.

Table.7 Effect of housing system on left testis length (cm) of ram lambs (LSM ±SE)

Age (Month)	Housing system					
	AS	*S*	*SL*	*SH*	*DL*	*DH*
6	5.80 ±0.49	5.80 ±0.49	6.98 ±0.49	6.75 ±0.49	7.13 ±0.49	6.44 ±0.49
7	6.81 ^{ce} ±0.49	6.45 ^{be} ±0.49	8.05 ^{cd} ±0.49	6.59 ^{be} ±0.49	8.11 ^{dc} ±0.49	8.33 ^{ad} ±0.49
8	8.15 ±0.49	8.16 ±0.49	8.68 ±0.49	8.14 ±0.49	8.80 ±0.49	9.25 ±0.49
9	8.78 ±0.49	8.21 ±0.49	8.88 ±0.49	9.15 ±0.49	9.16 ±0.49	9.18 ±0.49
10	8.74 ^{c} ±0.49	8.46 ^{bc} ±0.49	9.76 ^{abc} ±0.49	9.33 ^{abc} ±0.49	9.6 4 ^{abc} ±0.49	10.38 ^{a} ±0.49
11	8.79 ^{a} ±0.49	9.23 ^{ab} ±0.49	9.93 ^{ab} ±0.49	9.83 ^{ab} ±0.49	9.79 ^{ab} ±0.49	10.14 ^{b} ±0.49

Values with different letters in the same row are significantly different, (P<0.05) except a, b (P<0.01), AS = Semi Open house shaded with asbestos sheets, S = Semi open type house shaded with straw earth floors, SL = Single low type, SH =Single high type, DL =Double low roof and DH = Double high roof.

Table.8 Effect of housing system on scrotal circumference (cm) of ram lambs (LSM ±SE)

	Housing system					
Age (Month)	**AS**	**S**	**SL**	**SH**	**DL**	**DH**
6	19.88 ±1.16	18.50 ±1.16	21.28 ±1.16	20.28 ±1.16	21.44 ±1.16	19.50 ±1.16
7	21.13 ±1.16	20.75 ±1.16	23.80 ±1.16	20.74 ±1.16	23.63 ±1.16	22.81 ±1.16
8	24.00 ±1.16	24.50 ±1.16	24.56 ±1.16	23.54 ±1.16	24.81 ±1.16	26.13 ±1.16
9	24.44 ±1.16	25.31 ±1.16	24.63 ±1.16	26.31 ±1.16	26.06 ±1.16	26.50 ±1.16
10	25.63 ±1.16	25.63 ±1.16	27.13 ±1.16	26.19 ±1.16	26.56 ±1.16	27.75 ±1.16
11	23.88 ^{a} ±1.16	26.88 ^{ab} ±1.16	27.88 ^{b} ±1.16	28.25 ^{b} ±1.16	28.88 ^{b} ±1.16	28.50 ^{b} ±1.16

Values with different letters in the same row are significantly different, (P<0.01). AS = Semi Open house shaded with asbestos sheets, S = Semi open type house shaded with straw earth floors, SL = Single low type, SH =Single high type, DL =Double low roof and DH = Double high roof.

Table.9 Effect of housing system on serum testosterone levels (ng/dl) of growing ram lambs (LSM ±SE)

	Housing system					
Age (Week)	**AS**	**S**	**SL**	**SH**	**DL**	**DH**
24	103.40 ±20.65	102.05 ±20.65	106.17 ±20.65	109.02 ±20.65	94.44 ±20.65	96.80 ±20.65
26	107.69 ±20.65	106.37 ±20.65	108.80 ±20.65	106.85 ±20.65	109.22 ±20.65	101.68 ±20.65
28	116.97 ±20.65	109.62 ±20.65	116.29 ±20.65	142.11 ±20.65	119.97 ±20.65	107.91 ±20.65
30	162.46 ±20.65	152.34 ±20.65	165.39 ±20.65	174.35 ±20.65	187.47 ±20.65	168.76 ±20.65
32	192.82 ^{c} ±20.65	205.53^{abcd} ±20.65	228.40 ^{cd} ±20.65	169.84 ^{bc} ±20.65	252.84 ^{ad} ±20.65	209.96^{abcd} ±20.65
34	272.55 ±20.65	274.54 ±20.65	251.04 ±20.65	277.86 ±20.65	244.24 ±20.65	272.78 ±20.65
36	244.99 ^{ac} ±20.65	262.02 ^{ad} ±20.65	293.05 ^{cd} ±20.65	288.47 ^{cd} ±20.65	301.11 ^{d} ±20.65	355.65 ^{b} ±20.65
38	296.62 ^{ac} ±20.65	335.13 ^{c} ±20.65	333.96 ^{c} ±20.65	334.37 ^{c} ±20.65	307.06 ^{ac} ±20.65	399.08 ^{b} ±20.65
40	391.93 ^{ac} ±20.65	353.83 ^{ad} ±20.65	405.75 ^{cd} ±20.65	392.66 ^{ac} ±20.65	430.54 ^{bc} ±20.65	465.40 ^{b} ±20.65
Average	208.38 ^{bd} ±6.88	211.27 ^{bd} ±6.88	223.20 ^{cd} ±6.88	221.73 ^{cd} ±6.88	227.43 ^{ad} ±6.88	242.00 ^{a} ±6.88

Values with different letters in the same row are significantly different, (P<0.05) except a, b (P<0.01).AS (Semi Open house shaded with asbestos sheets). S (Semi open type house shaded with straw earth floors).SL (Single low type). SH (Single high type). DL (Double low roof). DH (Double high roof).

Table.10 Effect of housing system on serum testosterone levels (ng/dl) during pre-pubertal period of ram lambs (LSM ±SE)

Housing system*	1th mounting	Pre-pubertal period 1th mounting with erection	1th ejaculation (puberty)
AS	118.61 ±17.71	187.69 [a] ±17.71	322.11 [a] ±17.71
S	127.97 ±17.71	185.86 [a] ±17.71	315.74 [a] ±17.71
SL	131.35 ±17.71	243.88 [c] ±17.71	380.49 [c] ±17.71
SH	149.60 ±20.46	264.48 [c] ±20.46	380.83 [bc] ±20.46
DL	152.00 ±17.71	282.17 [bc] ±17.71	388.98 [bc] ±17.71
DH	165.79 ±17.71	285.24 [b] ±17.71	429.25 [b] ±17.71
Average	140.89 [A] ±7.43	241.55 [B] ±7.43	369.56 [C] ±7.43

Values with different letters (capital litter for the same row) are significantly different, (P<0.01) except (small litter for the same column) are significantly different, (P<0.05). AS (Semi Open house shaded with asbestos sheets). S (Semi open type house shaded with straw earth floors). SL (Single low type). SH (Single high type). DL (Double low roof). DH (Double high roof).

Fig.1 Effect of age on testosterone levels ng/dl

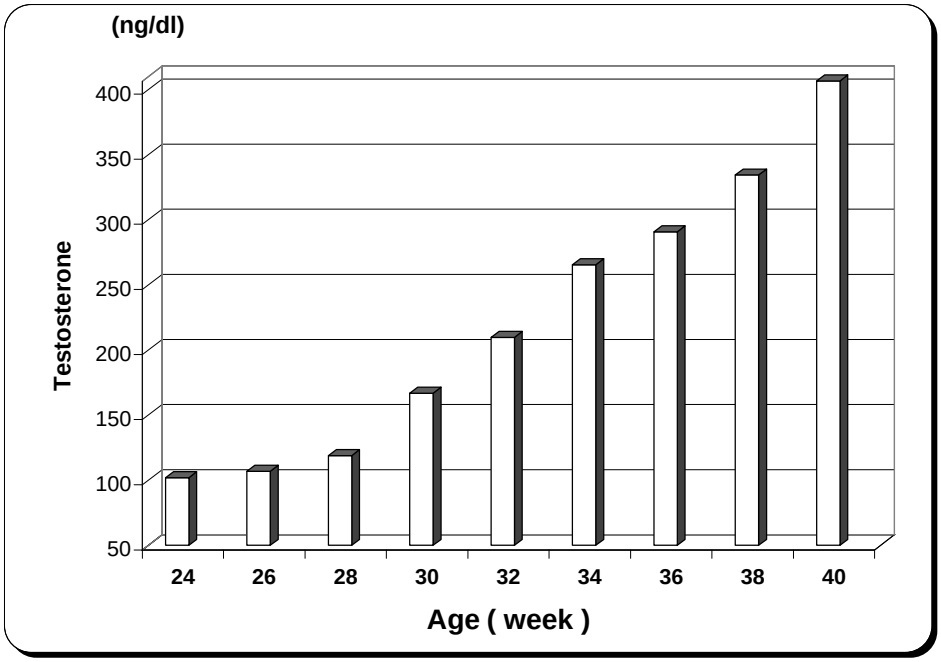
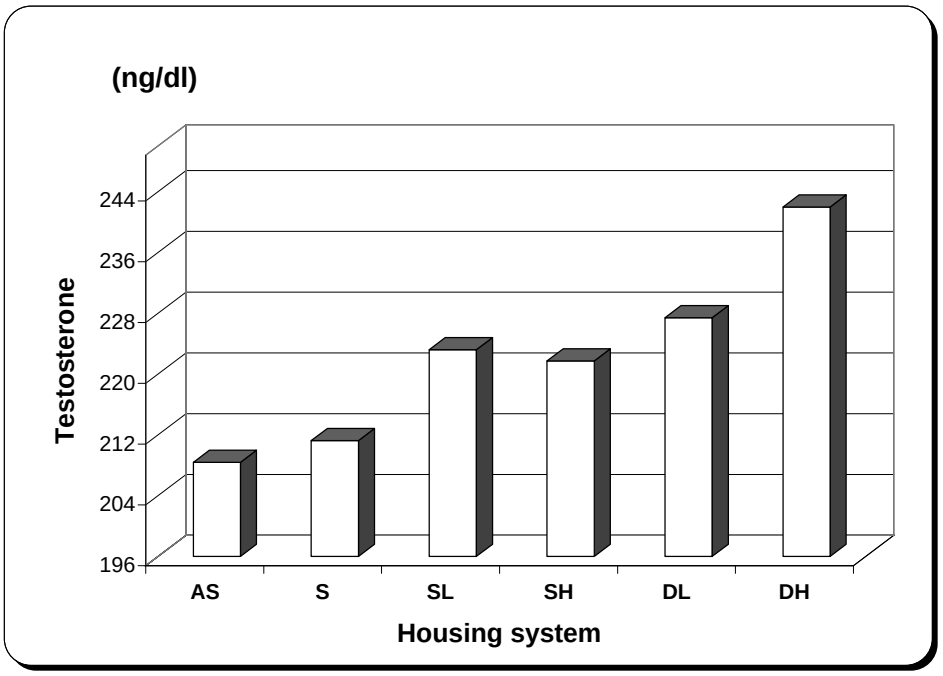


Fig.2 Effect of housing system on testosterone levels ng/dl.



AS (Semi Open house shaded with asbestos sheets). S (Semi open type house shaded with straw earth floors); SL (Single low type). SH (Single high type). DL (Double low roof). DH (Double high roof)

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