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Original Research

Effect of Three Housing Conditions on Osimi Lambs' Behaviour and Performance Under Upper Egypt Climatic Conditions

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Abstract

Improvement of sheep production became a global aim because of the good quality and cheap price of lamb meat. One of the most crucial goals for achieving optimum productivity in Upper Egypt is to protect farm animals from unfavorable climate conditions. Hence, the current study was planned to investigate the influence of three different housing constructions (semi-open, closed and semi-closed plus trees) on feeding behaviour, body weight, serum total protein and glucose levels, as well as faecal coliforms of male lambs under Upper Egypt temperate fall climate. Eighteen lambs were randomly allocated into 3 equal groups (n=6); group I (raised in house 1; semi-shaded (SSB)), group II (raised in house 2; full-shaded (FSB)) and group III (raised in house 3; semi-shaded+ a number of high trees (SSB+T)). The lambs were reared in these housings for 3 months; body weight and feeding behaviour were recorded bi-weekly. In addition, blood total protein and glucose levels, as well as neutrophil\ lymphocyte (N\L) ratio were measured. At the 12th week fecal coliforms count was analyzed, the longest feeding time was associated with highest glucose level in lambs reared in SSB. In addition, body gain was improved significantly in SSB and FSB that accompanied with the high total protein at the 8th week. However, N\L ratio was the lowest in SSB. Fecal coliform count was not affected by housing system. Thus, data suggested that the SSB house had lowest negative impacts on behaviour and performance of lambs followed by FSB and SSB+T housing conditions.

KEYWORDS
Behaviour, Faecal coliforms, Glucose, House, Total protein, Weight

INTRODUCTION

Improvement of sheep production became a global aim because of the good quality and price of lamb meat. One of the most important approaches to enhance lamb growth is the minimizing of environmental stressors. Sheep are traditionally raised using an extensive system that is affected by agroclimatic factors and the rigour of nature (Khant *et al*., 2021). Thus, one of the most crucial goals for achieving optimum productivity in Upper Egypt is to protect farm animals from unfavorable climate conditions. In addition, adjustment of the microenvironment to influence lamb survival by reducing the negative environmental stress and shelter management is the best approach to enhance animal productivity and successful lambs rearing (Nienaber and Hahn, 2007; Bach, 2012).

Scientists have focused on the effects of microclimate within animal housing, management techniques, and the welfare of animals as a result of modern housing systems and the rise of intensive animal husbandry. Housing structures in specialized dairy sheep farms may increase livestock welfare and health by shielding animals from heat or cold stress and providing appropriate nutrition (Berge, 1997; Brosh *et al*., 1998). Sheep are non-aggressive and social livestock distinguished by a condition of panic, stress, and annoyance triggered by even simple management practices, as well as a restricted adjustment to house confinement (Fitzpatrick *et al*., 2006).

The physiological reactions and productive performance of sheep are significantly impacted by housing (Bhatta *et al*., 2005). The roof is crucial in regulating how the animals exchange temperature in the animal housing (Liberati and Zappavigna, 2004). As a result, the animal house's insulated roofing materials lessen the harmful diurnal effects of radioactive heat load on animals (Khant *et al*., 2021). Additionally, group housing may be advantageous when taking the calves welfare and socialization into account (Gulliksen *et al*., 2009).

One of the major challenges for the sheep industry in the future will be to expand production in order to comply with the global demand for the consumption of meat as a further source of protein included in human nutrition (Montossi *et al*., 2013). Early studies focused on the impact of various housing systems on sheep productivity under challenging climatic circumstances, with varying results obtained. Abozed *et al*. (2021) compared sheep kept in closed versus semi-open housing systems during the summer. Moreover, Maurya *et al*. (2013) investigated how the roofed-closed system affected the body weight and daily increase of lambs. Kaya (2011) contrasted feeding Awassi lambs

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indoors versus outdoors. Furthermore, Karabacak *et al.* (2015) investigate the distinctions between closed and open housing systems. Therefore, the current study was planned to investigate the influence of three different housing structures (semi-open, closed and semi-closed plus trees) on feeding behaviour, body weight, some blood parameters and faecal coliforms of male lambs under Upper Egypt temperate fall climate.

MATERIALS AND METHODS

This study was carried out for three months on a total of eighteen lambs of 6 months of age in the Sids Agriculture Research Station sheep experiment unit, Beni-Suef Governorate through a period from September 2021 to December 2021. All lambs were fed ad libitum on total mixed ration (TMR) consists of concentrate and roughages and were randomly allocated into 3 equal groups (n=6); group I (raised in house 1; H1), group II (raised in house 2; H2) and group III (raised in house 3; H3) as in Figure (1).

The experiment was carried out in accordance with the ethical guidelines recommended by Beni-Suef University's Institutional Animal Care and Use Committee (BSU-IACUC). The study was approved by the committee (022-306).

Feed composition

The lambs' fed on a diet that met the requirements of maintenance and production (NRC, 1985). Lambs were fed group feeding on a total mixed ration consisted of 60% concentrate mixture, 20% corn silage and 20% rice straw. Fresh water and minerals were accessible at all times of the experiment.

Behavioural recording and measurement

Feeding behaviour was monitored about 2 meters distance from the stall to avoid the incidence of disturbance to the animals (Martin *et al.*, 1993). Each group was videotaped for thirty minutes during feeding three times daily for two consecutive days at fifteen-day interval (Pereira *et al.*, 2020) and the focal observation of marked animals by painting was used for analysis of feeding behaviour (Pullin *et al.*, 2017). Feeding duration/minute for each lamb was calculated throughout the observation period.

Body weight measurement

Lambs are weighed individually on scale at a constant time of day to minimize variation and obtain accurate weight (Fasted weight) in the morning before feeding or drinking at fifteen days intervals. Then weight gain was calculated by subtracting the current weight from the previous weight biweekly.

Blood sampling and biochemical analysis

A 3 mL of blood were collected from each male every month (for 3 successive months) by simple vein puncture of the jugular vein. The blood was kept into a bottle containing ethylene diamine tetracetic acid (EDTA) as an anticoagulant for haematological assay for counting of total leukocytic count by hemocytometer using Shaw's solution followed by differential leucocytic count of Giemsa stained blood films in accordance with Brooks *et al.* (2022).

A 1 mL of blood samples were taken from each male every month by simple vein puncture of the jugular vein. A 1 ml of the blood sample was put into tubes containing sodium fluoride for glucose assay according to Young (2001). The remaining 2 mL of the blood sample was put into a sterile vacutainer tube without an anticoagulant for centrifugation at 3000 rpm for 15 min. to obtain serum that kept in clean labeled eppendorf tubes at -20 ºC for total protein analysis according to Henry (1964).

Total coliforms count in faeces (cfu/g)

At the end of the experiment; sterile clean tubes were used to obtain faecal samples by rectal stimulation. A Labcon tube with 9 mL peptonized solution (8.5%) was used for dilution of faecal sample (1 gm\each sample) and followed by homogenization in vortex for serial dilutions of 10–1 to 10–12. Each dilution was seeded in triplicate 100 µL by the striate method in Petri dishes containing se¬lective medium for coliforms (Mac Conkey, Sigma-Aldrich, Munich, Germany) and incubated 24-48 hr at 35-37°C. After that, colony-forming units were counted to estimate

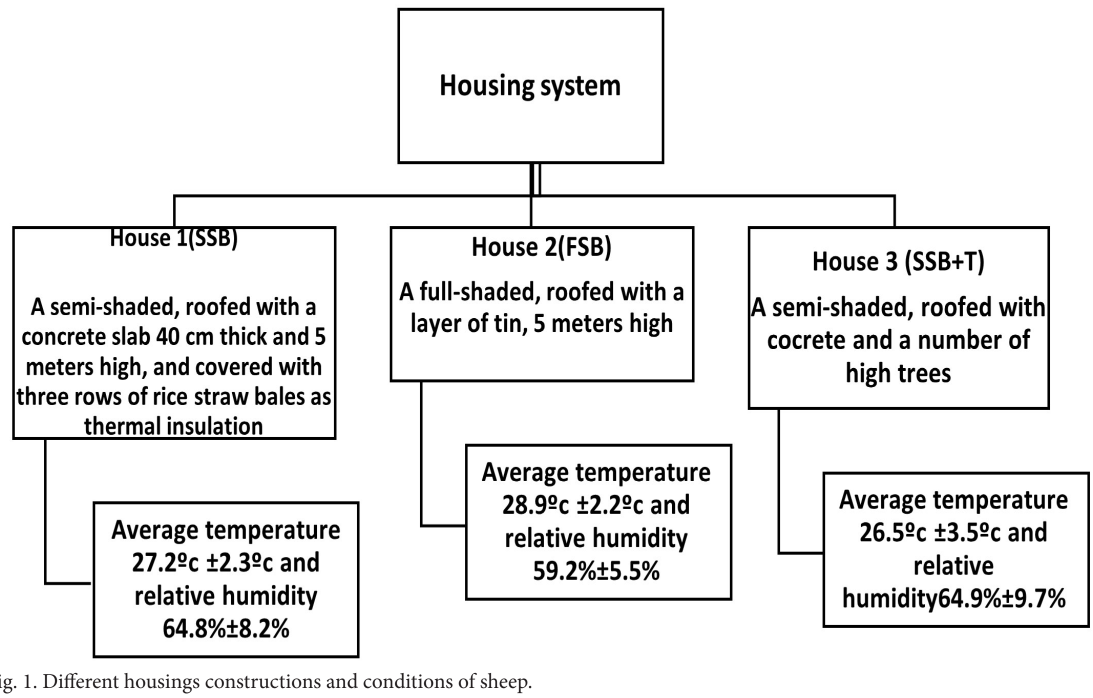

Fig. 1. Different housings constructions and conditions of sheep.

the microbial population, and the data were expressed with the base 10 logarithm function (log_{10}) according to Ayala-Monter *et al.* (2019).

Statistical analysis

Data analysis performed by test of normality followed by one-way ANOVA for normally distributed data and kruskal wallis for data not normally distributed using SPSS version 25. Mean values were considered significantly different at P<0.05 and results were expressed as means ± SE.

RESULTS

Effect of different housing conditions on lambs' feeding behaviour

The feeding behaviour (Table 1) was decreased significantly (P<0.01) in H1 compared to H2 & H3 in the 2nd week, while no significant difference was found among different houses in the 4th week. However, in the 6th week the lambs' feeding behaviour increased significantly (P<0.01) in the H1 compared to H2 & H3 and increased significantly (P<0.01) in the H3 compared to H2. In the 8th week, the lambs' feeding behaviour increased significantly (P<0.05; P<0.01) in H1 compared to H2 & H3 respectively, but increased significantly (P<0.01) in H2 compared to H3. In the 10th week, a significant difference (P<0.01) was observed between H2 and H3 in feeding behaviour. Finally, the feeding behaviour increased significantly (P<0.01) in H1 in comparison with H2 & H3 and increased significantly (P<0.01) in H2 compared to H3 at the 12th week.

Effect of different housing conditions on lambs' body weight and weight gain

The body weight of different lambs increased across the period of study in the same house, but no significant difference was present among different houses. Additionally the weight gain showed a non-significant difference between different houses in the 1st and 3rd months. However, the weight gain decreased significantly (P<0.01) in the H1 compared to H2 &H3 in the 2nd month (Table 2).'

Effect of different housing conditions on lambs' blood haematology

In Table 3, it was obvious that different housing conditions affect N/L ratio in lambs where the total leukocytic count, neutrophils and N/L ratio significantly (P<0.05) increased in H2 compared to H1& H3. As well as, the lymphocyte count reduced in H2 compared to H1 & H3 in 1st month. In the 2nd month the total leukocytic, neutrophil, and lymphocyte counts elevated significantly (P<0.05) in H3 compared to the other houses, but N/L ratio was elevated in H2 than H1 and H3. In the 3rd month no significant difference observed between the different houses, while H3 showed raised neutrophil count and N/L ratio significantly (P<0.05) compared to H1 and H2, moreover no statistical difference (P>0.05) was noticed among different houses in total leukocytic count.

Effect of different housing conditions on lambs serum total protein and glucose level

The obtained data in Table 4 showed that total protein levels in lambs' serum in different houses in the 1st month were non-significantly increased in H1, while it increased in the 2nd month in H2 & H3 with the absence of statistical difference between three houses. In the 3rd month, the total protein levels increased significantly (P<0.01) in H2 compared to H1& increased non-significantly in H3 in relation to H1.

Regarding the glucose levels, it was observed that the glucose levels increased significantly (P<0.05) in H 3 in the 1st & 2nd months in comparison with H1 & H2. However, the glucose level decreased significantly (P<0.05) in the H3 in the 3rd month compared to H1 & H2.

Table 1. Effect of different housing conditions on lambs' feeding behaviour (feeding duration\minute per observation period)

		Different housing conditions		
	House (H) / Weeks	H 1 (SSB)	H 2 (FSB)	H 3 (SSB+T)
Feeding behavior\minute	Two	11.58±0.06^b	19.57±1.05^a	19.90±1.19^a
	Four	24.51±0.07^a	24.66±0.73^a	25.37±0.03^a
	Six	25.95±0.00^a	15.63±0.07^c	22.55±0.46^b
	Eight	29.92± 0.07^a	29.11±0.38^b	15.46±0.11^c
	Ten	20.43±0.76^{ab}	19.23±0.60^b	21.47±0.50^a
	Twelve	29.59±0.11^a	25.04±0.15^b	23.03±0.03^c

Results expressed as mean± SE, n=6

$^{a, b, c}$ different superscript letters indicate significant difference between groups at P<0.01 & a, ab similar superscript letters indicate absence of significance.

SSB: Semi-shaded building; FSB: Full shaded building; SSB+T: Semi-shaded building with trees

Table 2. Effect of different housing conditions on lambs' body weight & weight gain

House (H) / Months	H 1 (SSB)		H 2 (FSB)		H 3 (SSB+T)	
Body weight & weight gain\ kg	WT	WG	WT	WG	WT	WG
First	29.00±1.93^a	2.00±0.52^a	29.50±1.09^a	2.17±0.40^a	26.17±2.36^a	2.67±0.49^a
Second	31.42±1.77^a	0.17±0.17^b	32.25±1.52^a	1.92±0.30^a	29.75±2.64^a	1.42±0.20^a
Third	32.67±1.99^a	1.00±0.39^a	34.83±1.74^a	1.50±0.34^a	32.00±2.52^a	1.75±0.36^a

Results expressed as mean± SE, n=6

$^{a, b}$ different superscript letters indicate significant difference between groups at P<0.01 & a, ab similar superscript letters indicate absence of significance.

SSB: Semi-shaded building; FSB: Full shaded building; SSB+T: Semi-shaded building with trees

Table 3. Effect of different housing conditions on lambs' blood hematology

		Different housing conditions		
House (H)		H 1	H 2	H 3
Parameters (cells count: x10^3 cell /ul)		(SSB)	(FSB)	(SSB+T)
First month	Total leukocytic count	10.82±0.31^c	12.90±0.76^a	11.78±0.91^b
	Neutrophil	5.30±0.12^b	7.58±0.54^a	5.58±0.43^b
	Lymphocyte	5.01±0.17^a	4.86±0.32^a	5.23±0.44^a
	N\L ratio	1.06±0.04^b	1.56±0.05^a	1.07±0.01^b
Second month	Total leukocytic count	8.30±0.23^c	9.93±0.43^b	11.03±0.04^a
	Neutrophil	4.07±0.23^b	5.47±0.34^a	5.33±0.11^a
	Lymphocyte	3.71±0.13^b	4.07±0.16^b	5.00±0.11^a
	N\L ratio	1.10±0.07^b	1.34±0.06^a	1.07±0.03^b
Third month	Total leukocytic count	8.68±0.25^a	9.95±0.48^a	9.98±0.42^a
	Neutrophil	4.02±0.12^b	4.81±0.36^a	5.32±0.18^a
	Lymphocyte	3.91±0.14^a	4.41±0.19^a	4.22±0.19^a
	N\L ratio	1.03±0.02^b	1.09±0.06^b	1.26±0.02^a

Results expressed as mean± SE, n=6

^{a,b} different superscripts indicate presence of significant difference between groups at (P<0.01). a similar superscripts indicate absence of significant difference between groups .

SSB: Semi-shaded building; FSB: Full shaded building;; SSB+T: Semi-shaded building with trees; N\L ratio: Neutrophil\lymphocyte ratio

Table 4. Effect of different housing conditions on lambs' serum total protein and glucose levels

		Different housing conditions		
	House (H)	H 1	H 2	H 3
	Parameters	(SSB)	(FSB)	(SSB+T)
First month	Total protein	10.13±1.51^a	9.60±0.38^a	8.17±0.76^a
	Glucose	74±1.44^b	78.80±3.04^b	86.64±1.86^a
Second month	Total protein	9.36±0.84^a	11.98±1.56^a	10.48±0.72^a
	Glucose	61.92±1.72^b	61.83±1.45^b	68.00±1.93^a
Third month	Total protein	8.15±0.23^b	9.33±0.35^a	8.63±0.15^{ab}
	Glucose	80.42±3.88^a	79.50±3.30^a	68.83±3.03^b

Results expressed as mean± SE, n=6

^{a,b} different superscripts indicate presence of significant difference between groups at (P<0.01). a, ab similar superscripts indicate absence of significant difference between groups .

SSB: Semi-shaded building; FSB: Full shaded building; nSSB+T: Semi-shaded building with trees

Effect of different housing conditions on lambs' faecal coliform count

The obtained data showed that in the 3rd month; the total number of faecal coliforms didn't differ significantly (P>0.05) among all housing conditions (Fig. 2).

DISCUSSION

Generally, the animal shelters lessen peak stress and insulate the animals from adverse weather (De *et al*., 2017). Body weight, nutrient, and water intake under various housing systems can be used as a benchmark for comparing animal health, and general adaptability of animals (Abdel-Rahman, 2008).

Feeding behaviour was increased and decreased in a fluctuated manner in different housing systems and also was independent on house type. This may be explained as when food was provided, eating behaviour increased, and it was claimed that feeding animals in pens allows animals to spend more time eating the allowed diet (Keskin *et al*., 2010). In addition, sheep were fed ad libitum and thus system of feeding may affect the time lambs' spent eating where increasing feeding frequency and providing the daily feed in small amounts at more frequent intervals tend to have a stabilizing effect on ruminal fermentation (Keogh *et al*., 2015; Swelum *et al*., 2017). Also, Casamassima *et al*. (2001) revealed that the Comisana ewes' feeding behaviours were unaffected by housing in the indoor and outdoor groups, respectively, which indicate that the housing system had little to no impact on the ewes' welfare and production.

The current study indicated that housing system didn't alter the body weight and weight gain of lambs. The obtained data run in parallel with De *et al*. (2015) reported that the final body weight and weight gain of lambs were not significantly impacted by housing. However, the lambs maintained in thermocol-insulated sheds were found to gain more body weight. Moreover, Bhatta *et al*. (2004) found that the body weight of sheep was unaffected by the housing system.

It is worth noted that, the best feeding behaviour of lambs was observed in the SSB which is the most common sheep house used. We hypothesized that SSB provide adequate photoperiod (Schanbacher, 1982) and sunlight intensity that may improve the animal temperament and consequently enhance feeding behaviour. The improved feeding behaviour in SSB was associated with the enhanced body gain in the 8th week of the experiment.

Lambs reared in intensive animal production have higher hypothalamic pituitary adrenal (HPA) activity than non-confined conditions (Miranda-de la Lama *et al*., 2012). Regarding the hematological change, the increased N/L ratio and reduced lymphocyte in H2 in all months compared to other houses may be associated with elevated stress which is associated with the introduction of sheep into a new house and these findings run in agreement with previous studies that reported an elevated N/L ratio, and decreased lymphocyte in distressed sheep reared in different houses or exposed to different stress conditions (Moberg and Mench, 2000; Kannan *et al*., 2000; Aguayo-Ulloa *et al*., 2014). Interestingly, it was obvious that animals were able to cope with stress as a result of housing conditions by the alleviated N/L ratio and elevated lymphocyte in the 2nd and 3rd month which run in parallel with Cockram *et al.* (2000) who revealed the ability of animals to recover from transportation stress and introduction into a novel house without affecting blood chemistry. The elevated neutrophil count and N/L ratio in the 3rd month may be attributed to the reduced glucose levels and feeding behaviour in H3 compared to other houses.

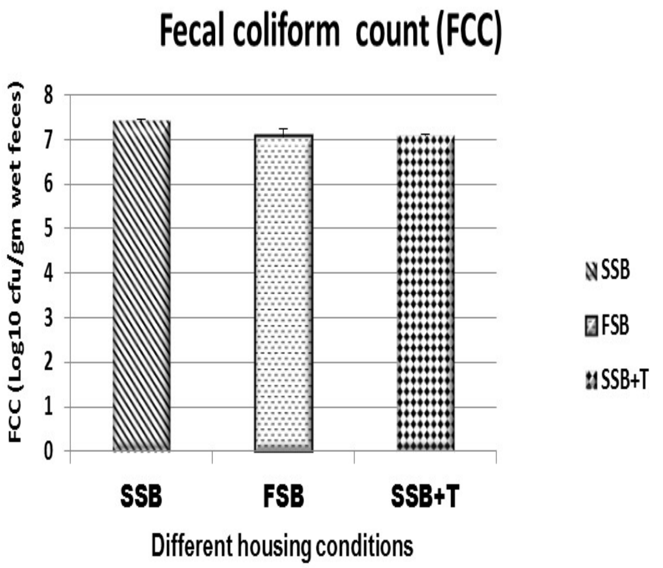

Fig. 2. Effect of different housing conditions on lambs' faecal coliform count.

The findings revealed that, biochemical results, including serum total protein levels was elevated in H2 compared to H1 house system, while the highest blood glucose levels was found in lambs reared in H1, Abozed (2009) reported that ram lambs housed in the close type shaded with double asbestos roofs had higher serum total protein and blood glucose levels than those housed in semi-open houses. Furthermore, Ebahiem *et al.* (2021) found that goats in the shade had blood proteins and glucose levels that were generally higher than goats in the sun. The obtained high glucose level in H1 is correlated to the improved feeding behaviour in H1and H2.

Requirements of ruminants to glucose are met largely through its synthesis that commonly occurs in the liver using glucose precursors that absorbed following fermentation and digestion of the diet (Reynolds, 2005). Hence, high glucose level indicates proper feeding. In addition, ruminal microbial proteolytic activities influence microbial access to the protein, feed intake level, the ingredient composition of the diet, protein solubility, and ruminal pH. The ruminal proteolytic activity is quite variable and influenced to large extent by dietary factors which affect the ruminal microorganisms' number and type (Broderick *et al.*, 1991). Protein is essential for animal growth and performance (Owens *et al.*, 1993).

Faecal (thermo-tolerant) coliforms are coliforms that digest lactose in a medium containing bile salts. The experimental approach detects a significantly narrower spectrum of species than total coliforms (Cabral and Marques, 2006; Cabral, 2010). The majority of research has relied on assessing reductions in common faecal indicator bacteria, which include faecal coliforms, who are prevalent in substantial numbers in the digestive tracts and faeces of animals, even humans (Sobsey *et al.*, 2006). In the present study; the house had no effect on faecal coliform count in lambs' faecal samples which supported with Arzola *et al.* (2014) study that reported a non-significant difference in faecal coliform counts among the treated sheep groups. This indicates that the diet digestibility and consequently conversion rate and performance of lambs may be not markedly affected by housing system.

At the end of the experiment (12th week), the longest feeding time was correlated with highest glucose level in lambs reared in SSB. In addition, body gain was improved in SSB and FSB that accompanied with the high total protein at the 8th week. However, N\L ratio was the lowest in SSB. Faecal coliforms count was not affected by housing system. Thus, data suggested that the SSB housing condition had the lowest negative impacts on behaviour and performance of lambs followed by FSB and SSB+T housing conditions.

FURTHER STUDIES

Further studies is needed to investigate effect of housing system on temperament, immunity and fertility of lambs especially that sheep breeding highly influenced with the photoperiod.

CONCLUSION

Data suggested that the SSB house has the lowest negative impacts on behaviour and performance of lambs followed by FSB and SSB+T housing conditions. In addition, the N/L ratio as an indicator for stress indicated that the closed houses (FSB) at the first period of experiment (uncommon houses) then decreased indicating that lambs' adapted gradually to the novel environments.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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