Effects of Feeding Systems and Castration on the Growth Performance and some Carcass Traits in Lambs of Dhamari sheep- Yemen

تأثير أنظمة التغذية والإخصاء على كفاءة أداء النمو وبعض صفات الذبيحة في حملان الأغنام الذمارية – اليمن

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ABSTRACT:

A 3×2 experiment was conducted to investigate the effects of different feeding systems (FS) and castration on the growth performance and carcass traits in lambs of Dhamari sheep. 18 lambs were divided into 3 feeding systems with 6 lambs, 3 castrated and 3 uncastrated each. In the first FS, lambs were stall-fed and each lamb received daily 5% dried fodder sorghum, 8% alfalfa (fresh matter) and 1.5% concentrate. In second FS, lambs were grazed and fed 1.5% concentrate. In third FS, lambs were grazed and fed 2.5% dried sorghum fodder and 0.75% concentrate. The feed was offered on the basis of the average live body weight. This experiment was lasted for 120 days. Lambs were weighed fortnightly to measure growth performance. At the end of the experiment, four lambs from each FS (2 castrated and 2 intact) were randomly selected, weighed and slaughtered for carcass evaluation. Results indicated an increase of the total and daily body weight gains by lambs grazed and supplemented with 1.5% concentrate. The lambs grazed showed significantly lower feed intake and better feed conversion ratio (FCR) compared to lambs that did not graze. The grazed Lambs and getting 1.5% concentrate exhibited better weight of carcass and tail fat. The castration had a negative effect ($P<0.05$) on growth body, carcass weight, breast, liver, kidney and tail fat. In conclusion, the grazing lambs with an addition of 1.5% concentrate daily had the best effects on growth and slaughter traits whereas the castration showed negative effects on Dhamari lambs' performance.

***Keywords**:* Dhamari lambs, grazing, concentrate feed, growth rate, slaughter weight.

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المستخلص

أجريت تجربة (٣×٢) لدراسة تأثير أنظمة التغذية والإخصاء على أداء النمو وصفات الذبيحة لحملان الاغنام الذمارية. تم تقسيم ١٨ حملًا إلى ٣ أنظمة تغذية كل منها يتكون من ٦ حملان ، ٣ مخصية و٣ سليمة (غير مخصية). في ألنظام الغذائي ألاول ، تم تغذية الحملان في الحظيرة بدون رعى وحصل كل حمل على ٥٪ من الذرة الرفيعة المجففة و ٨٪ من البرسيم الطازج و١,٥٪ علف مركز. في ألنظام الغذائي الثاني ، تم رعي الحملان وقدم لها علف مركز أضافي بنسبة ١,٥ ٪. في ألنظام الغذائي الثالث تم رعي الحملان وتغذيتها بنسبة ٢,٥٪ من علف الذرة الرفيعة المجففة و ٠,٧٥٪ من العلف المركز. تم تقديم العلف على أساس متوسط وزن الجسم الحي. استمرت هذه التجربة لمدة ١٢٠ يومًا. تم وزن الحملان كل أسبوعين لقياس صفات أداء النمو (الوزن الحي، استهلاك العلف ومعامل تحويل الغذاء). في نهاية التجربة ، تم اختيار أربعة حملان من كل نظام غذايي (٢ مخصية و ٢ سليمة) بشكل عشوائي ووزنها وذبحها لقياس بعض صفات الذبيحة. أشارت النتائج إلى زيادة الوزن الكلي واليومي المكتسب من قبل الحملان المرعية والمكملة بنسبة ١,٥٪ علف مركز. أظهرت الحملان التي تم رعيها انخفاضًا ملحوظًا في تناول العلف مع معدل تحويل غذائي أفضل مقارنة بالحملان التي غذيت في الحظيرة (لم ترعى). اشارت النتايج كذلك ان الحملان التي تم رعيها وحصلت على ١,٥٪ علف مركز قد اضهرت وزنًا أفضل للذبيحة والكتف ودهن الذيل. كان للإخصاء في هذه التجربة تأثير معنوي سلبي على نمو الجسم ووزن الذبيحة والصدر والكبد والكلى ودهن الذيل. في الختام ، كان للرعيّ مع إضافة ١,٥٪ من العلف المركز يومياً تأثير أفضل على النمو وخصائص الذبح ، بينما أظهر الإخصاء تأثيرات سلبية على كفاءة ألاداء عند حملان الاغنام الذمارية

كلمات مفتاحية: الاغنام الذمارية، الرعي ، الأعلاف المركزة ، النمو ، وزن الذبيحة

INTRODUCTION

Animal production is considered as one of the important agricultural activities, which is practiced in almost regions of Yemen. It contributes to achieving an important part of food security and poverty reduction (high nutrients, protein and energy and as a source for raw materials like wool, hair and leather, etc.), and maintains environmental balance. In addition, it is an important source of genetic and biological diversity (Amad and TerMeulen 1997). Animal production contributes

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about 23-24% of the total agricultural production in Yemen (Amad and Zentek 2022). According to the Agricultural Statistics Book (2021), the number of the population reached 10,359,317 sheep, 10,043,023 goats and 1,872,516 cattle. Sheep are the most important type of livestock and can be used for many purposes: as a source of meat and milk and as an additional source of income for farmers. There are several breeds of sheep in Yemen and the Dhamari sheep is considered to be the dominant in the mountainous plains of Dhamar Governorate and the largest species in size compared to the rest of the other local breeds in the country (Al-Azazi 2009).

The Dhamri sheep is a white covered with short, light brown hair along the back and down the legs and fat tail. It is closely related to the agricultural system of the Central Highlands. The sheep feed on pasture and field crop residues after harvesting in dry periods. Under the traditional feeding management, the weight of males at the age of two years ranges between 50-55 kg (Al-Masoudi 2000). It is noteworthy that all sheep breeds in Yemen are characterized by low productivity due to the weakness of their genotype. Other side, there are many factors affecting the sheep development and its production, the most important of which is the high prevalence of animal diseases and pests and the weak nutritional conditions representing in the scarcity of natural pastures and fodder. Kawas et al., (2010) and Ben Salem (2010) stated that in arid and semi-arid regions, the lack of sufficient forage resources over the year is probably the most important factor contributing to the decline in livestock production. Natural pastures are the most important source of feed for sheep in Yemen and its quality and quantity is seasonal, so its availability and nutrients density (energy and protein) is very low and it certainly does not meet the growth requirements of the animals, especially in the dry season, however improved by the rain fall (Amad and

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TerMeulen 1997). These natural pastures are subject to continuous degradation caused by environmental pressures like scarce rainfall, excessive deforestation, irregular grazing and general mismanagement (Shaddad 2006; Al-Azazi 2009). Pastures are intensively overgrazed, resulting in sparse grazing vegetation and a predominance of less productive and less palatable shrubs (El-serafy and El-shobokshy 1990; Ismail 1991). Due to degradation of natural pastures and the non-spreading of forage cultivation, the use of concentrates in the fattening process for sheep is an acceptable alternative, as it efficiently converts into meat while reducing the pressure on natural pastures. Therefore, specialized feeding system and supplement for better performance for lambs are ideal. Studies reported significantly improvement in live weight gain, feed conversion ratio and carcass traits of lambs fed supplement diet or some medicinal plants as compared to sheep with control diet (Nabuurs et al. 1988; Hassan 2009; Hassan et al. 2009; Mousa 2011).

Castration of male sheep and goats is a traditional practice with the purpose to reduce the sexual and aggressive behavior and improve ease of management of these animals (Fahmy et al., 1999; Sales 2014). Reducing aggressive behavior can increase the economic return of the farm by decreasing the incidence of injury of animals and their handlers, reducing damage to pastures, fences, and to feeding and handling equipment, while can lead to reserve energy for growth. On the other hand, castration requires additional labor, painful and increases stress, decreases growth rate and feed efficiency (Seideman et al., 1982; Nazari et al. 2014).

As mentioned above, sheep feeding depends mainly on daily grazing and a bit of food waste which provided to them after grazing. Thus, this study aimed to find a similar alternative feeding system for grazing or a supplement (feed crops and

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concentrates) that can ensure a fast and optimal growth rate and better performance for the lambs of Dhamari sheeps. In addition, the effect of castration on sheep and its performance has not studied in Yemen, so this study could draw general conclusion to its effects by Dhamari sheep.

MATERIALS AND METHODES

Location and experimental animals

The experiment was conducted at the regional research station in the central highlands which located north of the city of Dhamar and at an altitude of 2300 meters above sea level. The station is surrounded by an agricultural area and pastures. The region is semi-arid with an annual rain fall between 350 to 400 mm and temperature varying 29 °C and -4 °C. In this experiment, were used 18 of male Dhamari lambs that obtained from the research station. The lambs were healthy and in good status, with a similar age (3.5 months) and initial live body weight. Nine lambs were castrated with a Burdizzo and nine lambs remained without castration (intact lambs), after 18 days weighed again and distributed to the feeding program (treatments). The lambs received the necessary antibiotics after castration and were also well fed.

All experimental applications in this study following the national and international standard ethics procedures and were approved by the department of animal production in Thamar university and Agricultural Research Authority Dhamar- Yemen.

Experiment design and feed

Male lambs were allocated in a 3 × 2 factorial arrangement and according to this design there were 3 feeding systems with castrated and intact (uncastrated) lambs in this experiment, in total 18 lambs of 6 treatments and 3 lams (replicate) per treatment as shown in Table 1. The lambs were numbered and distributed among the experimental treatments in a homogeneous manner. All lambs were housed in pens of equal

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size with feeders and drinkers and were well-ventilated. Lambs of first feeding system (FS) were stall-fed (not grazed). The lambs of second and third FS were grazed together (grazing time 5 hours, from 8 in the morning to 13 at noon) and then received the appropriate feed (fodder and concentrate) on their return and recalculated each 2 weeks according to live weight. Water was available at all times; all lambs were kept in the same environmental conditions and were vaccinated against infectious diseases and internal parasites according to the program used in the Animal Resources Department of the Agricultural Research Authority. The fodder sorghum and alfalfa were obtained from a local market. The dried sorghum was cut into appropriate sizes of 2.5-3 cm while alfalfa (Berseem) was fed fresh. The proximate nutrients composition of these fodder is presented in table 2. The concentrate feed is bought from local company and its component and nutrients is shown in table 3. This experiment was lasted for 120 days (4 months) from mid of June to mid of October in rainy season and the rangeland (pastures) was relatively in good condition.

Table 1: Experimental design

	Feeding System (FS)	**Castration** (Lambs type)	**Replications** (N)
1-	fodder sorgh. + alfalfa + concentrates (stall feeding)	castrated	3
		uncastrated	3
2-	Grazing + concentrate	castrated	3
		uncastrated	3
3-	Grazing+ fodder sorgh. + concentrate	castrated	3
		uncastrated	3

[1]lambs were not grazed and each one received daily 5% dried sorghum fodder and 8% alfalfa (fresh matter) and 1.5% concentrate on the basis of the average live body weight, sorgh. = sorghum. [2]lambs were grazed and fed 1.5% concentrate on the

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basis of live body weight. [3]lambs were grazed and fed 2.5% dried sorghum fodder and 0.75% concentrate.

Table 2: Nutrients component of sorghum fodder and alfalfa hay (Aksad 2002)

Fodder	Dry matter %	Crud protein %	Digestible protein %	Crud fiber %	Digestible energy (Kcal/kg)
Sorghum	90	6.1	2.5	31	1.3
Alfalfa	90	18.4	12	28	1.9

Table 3: Ingredients of concentrate used in this experiment and its proximate chemical components*

Ingredients	%	Chemical analysis	%
Peas	13	Dry matter	90
Macaroni (scrape)	60	Crude protein	12
Biscuit (scrape)	17	Crude fate	2.5
bran	8	Crude fiber	19
Sea Shells	1.5	Digestible energy	1800 (Kcal/kg)
salt	0.5		

*According to manufacturing company

Studied parameters

Lambs were weighed initially then every 15 days until the end of the experiment to measure the live body weight and the whole and daily body weight gain. The amount of feed intake was calculated each day by weighing the intake of the pasture, fodder and concentrate and by weighing the remainder feed (if any). To calculate the amount of grazing consumed by the lambs of the second and third groups, each lamb was weighed before and after grazing in a five-day cycle, as following:

The amount of grazing consumed = (the weight of the lamb after grazing – the weight of the lamb before grazing) x five days

Feed conversion ratio (FCR) was calculated as total feed intake divided by total weight gain.

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Carcass evaluation

At the end of experimental period, four lambs from each feeding system (2 castrated and 2 intact) were randomly selected, weighed and slaughtered for carcass evaluation and slaughtering following the standard procedures of USDA. The bodies were skinned; the heads, feet and inedible entrails were removed. Also, tail is collected to determine the tail fat by each lamb. Carcass weight and percentage were calculated. Additionally, carcass was dissected and shoulder, leg and breast were removed and weighed. In addition, the liver and kidneys were weighed.

Statistical analyses

The data were analyzed using a completely randomized design (CRD) using the General Linear Model procedures of SAS (2003) to find the main and interaction effects of tested factors (feeding system and castration) and the following mathematical model was used:

$Yijk = \mu + Ai + Bj + (Ai\ Bj) + eijk$

Since:

Yijk = the response variable, μ = overall mean, Ai = effect of feeding, Bj = effect of castration, AiBj = interaction between feeding and castration, Eijk= random error

Duncan's Multiple Range test was used to compare the significant differences between the means by $p \leq 0.05$.

RESULTS

In this study, only the main effects of feeding system and castration are reported due to the important of their effects in Dhamari lambs.

Growth performance

Feeding system and lambs performance

The main effects of tested factors feeding system on growth performance by Dhamari lambs are shown in table 4. The results indicated no effect of feeding system on the live body weight. The live body weight of lambs in the mid and end of the

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experiment period had similar body weight special by the lambs stall-fed and lambs get the third feeding system (lambs were grazed and fed 2.5% dried sorghum fodder and 0.75% concentrate). There is an improvement of live body weight in lambs grazed and additionally fed 1.5% concentrate only but it was not differed significantly with other feeding system. On the other hand, results in this experiment showed that lambs grazed and getting concentrate had significantly ($p < 0.05$) higher total and daily weight gain comparing to the lambs of third group, but there was no significant difference to lambs of first group or between the first and third feeding system (table 4). The mean daily feed intake (g/lamb) and feed conversion ratio (kg/kg) by Dhamari lambs are shown in table 4. There was no difference in total feed intake for the first 2 months of the experimental period among all feeding systems, but it was observed that the lambs grazed and fed dried sorghum fodder and 0.75% concentrate consumed a lower amount of feed, but did not reach the significant difference, however it was significantly ($P<0.05$) lower regarding the total and mean daily feed intake (Table 4). In this experiment, lambs that were only grazed and received concentrate (1.5% of their body basis) showed a significant decrease of total feed intake but no difference regarding daily feed intake compared to lambs of first feeding system. In addition, lambs that grazed 5 hours per day showed significantly better feed conversion ratio compared to lambs that did not graze. However, in terms of this parameter (FCR), there was no difference between lambs' groups which were grazing.

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Table 4: The effects of feeding system on the growth performance in Dhamari lambs (mean, ±standard error)

	Feeding system			
Parameters	**Sorgh. +alfalfa+ Concentrate**	**Grazing+ Concentrate**	**Grazing + Sorgh. + Concentrate**	**Sig.**
Live weight				
ILW (kg/lamb)	13.1 ±0.5	13.3 ±0.2	13.3 ±0.8	n.s
LW (2nd month)	16.3 ±0.9	17.8 ±1.3	16.5 ±1.1	n.s
FLW (kg/lamb)	0.8± 22.6	24.1 ±1.2	22.4 ±1.0	n.s
TWG (kg/lamb)	9.5^{ab} ±0.5	10.8^{a} ±0.5	9.1^{b} ±0.4	*
DWG (g/day)	79^{ab} ±0.04	90^{a} ±0.06	76^{b} ±0.03	*
Feed intake				
FI (for 2 months)	30.6 ±0.0	31.9 ±1.01	27.3 ±2.03	n.s
total FI (kg/lamb)	75.2^{a} ±0.46	73.6^{b} ±0.45	62.1^{c} ±0.57	*
DFI (g/d/lamb)	626.7^{a} ±0.0	612.9^{ab} ±8.9	517.2^{c} ±4.3	*
FCR (kg/kg)	7.9^{a} ±1.3	6.8^{b} ±1.9	6.8^{b} ±1.9	*

IBW = Initial live weight; FLW= Final live weight; TWG= Total weight gain; DWG= Daily weight gain; FI= Feed intake; DFI = Daily feed intake. ^{ab}Mean bearing different superscripts differ significantly *($P<0.05$); n.s = non-significance; n=6

Castration and lamb's performance

In this study the castration had significantly negative effect on the growth of lambs. During all experimental periods (starting, middle and end) showed the castrated lambs a significant decrease of live body weight (kg/lamb). As shown in table 5, the mean live weight of intact (uncastrated) lambs reached 13.3, 17.9 and 23.7 kg/lamb with a calculated percentage change in live weight for these lambs reached 9.0, 20.9 and 9.7 % at the beginning, middle and end of the experiment respectively. The intact lambs achieved the highest live body weight (kg) and percentage body change in the middle of the experiment. On the other hand, the castration did not

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affect the total and daily weight gain of lambs in this study, however, it was observed a tendential improvement of these parameters by the intact lambs. In this study, no significant effect was observed between castrated and intact lambs in relation to feed intake and feed conversion ratio. However, it must be emphasized that intact lambs consumed more feed than castrated lambs and tended to show better feed conversion ratio (FCR), as shown in Table 5.

Table 5: The effects of castration on the growth performance in Dhamari lambs (mean, ±standard error)

Parameters	castration		
	Castrated	Uncastrated	Significance
Live weight			
ILW (kg/lamb)	12.2^{b} ±0.31	13.3^{a} ±0.47	*
LW (2nd month)	14.8^{b} ±0.56	17.9^{a} ±0.62	*
FLW (kg/lamb)	21.6^{b} ±0.56	23.7^{a} ±0.73	*
TWG (kg/lamb)	9.4 ±0.34	10.4 ±0.63	n.s
DWG (g/day)	78 ±0.03	87 ±0.05	n.s
Feed intake			
FI (for 2 months)	29.6 ±1.9	30.5 ±2.1	n.s
total FI (kg/lamb)	70.7 ±2.0	72.0 ±2.2	n.s
DFI (g/d/lamb)	589.2 ±8.5	600.2 ±18.2	n.s
FCR (kg/kg)	7.5 ±0.32	6.9 ±0.43	n.s

IBW = Initial live weight; FLW= Final live weight; TWG= Total weight gain; DWG= Daily weight gain; FI= Feed intake; DFI = Daily feed intake. ^{ab}Mean bearing different superscripts differ significantly *($P<0.05$); n. s = non-significance; n=9

Carcass parameters

Feeding system and carcass parameters

The results of the effect of feeding system on some carcass parameter are showed in table 6. The feeding system grazing with concentrate supplementation achieved significantly

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the best carcass weight (15.5 kg/lamb) compared to other feeding systems. In relation to carcass percentage, there were no significance difference between all groups with tendential improvement by lambs grazed and get concentrate which reached (data not showed). The lambs of feeding system 2 have significantly the highest weight of shoulder (1 kg/lamb) compared to other groups of lamb's shoulders which reached 0.88 and 0.87 kg/lamb. Also, kidney and tail fat (g/lamb) of this group was significance higher than those of feeding system 3. Overall, there were no appreciable differences between groups of feeding system 1 (stall fed) and 3 (grazing and fed sorghum and concentrate) with respect to carcass weight, shoulder and tail fat (table 6). With regard to the weight of leg, breast, and liver no significant differences were present among all feeding systems in this experiment.

Table 6: The effects of feeding system on some carcass parameters in Dhamari lambs (mean, ±standard error)

	Feeding system			
Parameters	**Sorgh. + alfalfa and concentrate**	**Grazing+ concentrate**	**Grazing+ Sorgh. + Concentrate**	**Sig.**
Carcass weight (kg/lamb)	12.3^{b} ±1.25	15.5^{a} ±1.50	12.0^{b} ±1.32	*
Shoulder (kg/lamb)	0.88^{b} ±0.03	1.0^{a} ±0.00	0.87^{b} ±0.03	*
)kg/lamb(Leg	1.1^{a} ±0.06	1.2^{a} ±0.12	1.0^{a} ±0.08	n.s
Breast (kg/lamb)	0.95^{a} ±0.04	0.99^{a} ±0.02	1.0^{a} ±0.1	n.s
Liver (g/lamb)	375^{a} ±32	400^{a} ±56	363^{a} ±55	n.s
)g/lamb(Kidney	111^{a} ±2	108^{a} ±1	^{b} ±4١٠٠	*
)g/lamb(Tail fat	1087^{b} ±59.0	1625^{a} ±375	1175^{ab} ±272	*

^{ab}Mean bearing different superscripts differ significantly *($P<0.05$); n.s = non-significance, n=4

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Castration and Carcass parameters

Table 7 shows the effects of castration on some carcass traits. The intact lambs indicated significantly higher weight of carcass, breast, liver kidney, tail fat weight compared to castrated. On the other hand, dressing percentage, shoulder and leg weight tended to be higher in the intact lambs, but none of the differences were significant. These results indicate that castration has a negative impact on the average carcass weight in lambs and some parts of carcass (breast, liver and kidney).

Table 7: The effects of castration on some carcass parameters in Dhamari lambs (mean, ± standard error)

	castration		
Parameters	**Castrated**	**Uncastrated**	**Sig.**
Carcass weight (kg/lamb)	11.1^{b} ±0.99	15.4^{a} ±1.29	*
Shoulder (kg/lamb)	0.90^{a} ±0.04	0.93^{a} ±0.02	n.s
Leg (kg/lamb)	1.0^{a} ±0.05	1.2^{a} ±0.08	n.s
Breast (kg/lamb)	0.92^{b} ±0.03	1.1^{a} ±0.05	*
Liver (g/lamb)	300^{b} ±13	458^{a} ±20	*
Kidney (g/lamb)	101^{b} ±3	111^{a} ±2	*
Tail fat (g/lamb)	975^{b} ±85.3	1616^{a} ±246	*

^{ab}Mean bearing different superscripts differ significantly *($P<0.05$); n.s=non-significance, n=6

DISCUSSION

Feeding system and growth performance

The improvement of live weight, the total and daily body gains by lambs grazed and supplemented with concentrate could be from one side due to the better growth and fresh mass availability of pasture and the relative high nutrients of pasture, other side it might be attributed to the high content of protein, energy and other nutrients (mineral) in the feed concentrate specially by comparing to lambs in third feeding system. Atti et

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al. (2013) stated that grazing lambs had higher growth rate than feed lot lambs which partially agreed with our findings in this study. Early studies by Guessous and Benslimane (1990) showed similar results and they reported that sheep supplemented with low or high amount of concentrates after grazing had no significant effect on body weight change. These findings of this experiment agree with results reporting that lamb grazing led to enhanced and better nutrition, which ultimately improve the growth performance Abdul-Rahman, et al. 2011; Sultan et al. 2012; Sultan 2016). Also, in a previous study Keady and Hanrahan (2013) mentioned that lambs supplemented with concentrate feed improved the growth performance which agreed with these results regarding the total and daily weight gain, and Gashu et al. (2017) found that sheep supplemented with a high rate of concentrate feed produced the highest net returns which similar to ours results. The significance decrease of total and daily weight gain by lambs of third feeding system is due to the decrease of feed intake ($p \leq 0.05$) in this study, which might be caused by the consumed of fodder sorghum. The high feed intake by stall-fed lambs might be caused by high content of indigestible crude fiber in sorghum fodder and alfalfa, since it is known that fodder sorghum is poor in nutrient especially digestible energy and protein. Therefore, the lambs in this group ate more feed to compensate for the nutrient deficiency. On the other hand, the decreasing of feed intake in lambs of group 2 and 3 may be a consequence of the good quality of pasture (rainy season) and higher nutrients in the concentrate supplementation leading to better feed conversion ratio and weight gain. This is consistent with previous studies that mentioned that dietary supplements result in improved animal growth and FCR (Almahdawi 2011; Mousa, 2011; Hassan et al. 2012). Also, many shrubs and fodder trees have high protein content and are potentially promising supplement (Mousa, 2011). The

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supplement contents essential nutrients for rumen microorganisms, improving rumen microbial activities, and providing more nutrients to the animal (Van Soest, 1994). Moreover, Keady and Hanrahan (2013) showed that the response to concentrate supplementation depended on forage feed value which insured that the concentrate supplement in this experiment reacted better with pasture feed and improved the performance comparing to lambs fed in stall.

Castration and lamb's performance

The loss of live weight and the slow growth of castrated lambs in this study agreed with earlier studies which reported that a greater growth response and final body weight for intact lambs than castrates and especially when castration is performed late (Ford and Gregory 1983; Worrell et al. 1987; Demissie et al., 1989). Mahgoub et al. (1998) found that intact males of Omani sheep grew faster and were significantly heavier than castrates agreeing with these results. A comparative study on lambs confirmed that intact males achieved higher carcass weights than castrates (Cloete et al., 2012). On the other hand, the disappearance of the significant differences between intact and castrated lambs regarding the total and daily weight gain in this study it might be due to that the castrated lambs in the last stages of the experiment grew rapidly, but they could not reach the same growth rate of intact lambs which in accordance with the findings of Melches et al., (2006) who mentioned that lambs are also able to compensate for weight loss post-castration. These results are in consistence with earlier studies who confirmed that intact lambs were significantly superior in average total and daily weight gain comparing to castrated ones, the predominance of intact lambs is caused by the stimulation of sex hormones testosterone (Seideman et al. 1982; Hanrahan 1999; Liu et al. 2022). Moreover, Kiyma et al., 2000 reported that an improved growth rate in intact lambs could be associated

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with male sex hormones (testosterone) which increasingly stimulates dietary nitrogen utilization efficiency. The results of live weight by castrated and intact lambs in this study is disagreed with O'Riordan and Hanrahan (1992) who found no significant difference between intact and castrates in 14, 20 and 25 weeks of age. In addition, this result disagrees with Schreurs (2013) and Gashu et al. (2017) who found that intact sheep had higher average daily gain (g/d) compering to castrated lambs. Also, studies have mentioned comparing with castrates that rams grow faster, have higher feed utilization rates and higher final life body weight (Nazari et al. 2014; Claffey et al. 2018; Liu et al. 2022). In relation to feed intake and FCR, there were no significant differences between among both groups. However, there was a tendential higher feed intake and better FCR by intact lambs, which may be attributed to the fact that the castrated lambs had the lowest consumption of feed at the beginning of the experiment due to the stress they were exposed to after castration, while the intact lambs consumed more feed, but they exhibited a better nutrients utilization. The results in this study disagreed with Gashu et al. (2017) and Claffey et al. (2018) who reported that intact lambs indicate significantly better feed conversion ratio than castrated lambs that caused by sex hormone which lead to increase the efficiency of dietary nutrient utilization, through enhancing feed efficiency (Ismail 2006). Liu et al. (2022) showed that the FCR of rams was 12-15% higher than that of castrates, which tends to be similar to our results which showed an improvement of the FCR by 8%.

Feeding system and carcass parameters

Previous reports mentioned that feeding system can affect the carcass and the degree of fattening (Lewis et al., 2002; Ramírez-Retamal and Morales 2014). Priolo et al. (2002) reported that lambs raised at pasture had lighter carcasses and lower caudal fat. These finding are similar to our results

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regarding the carcass weight by lambs grazed and supplemented with 1.5% concentrate, but in contradiction to Atti et al. (2013) who indicated no difference between lambs of pasture and stall-fed lambs. Moreover, previous studies reporting that lambs fed concentrate had higher final live weights and carcass weights and dressing (%) than lambs fed forage (McClure et al. 1985; Field et al. 1990; Mazumder et al. 1998, Mustafa et al. 2008). The result of tail fat is in contradiction with previous studies showing that lambs fed by grazing had low levels of fat than stall fed lambs (Sañudo et al., 2000; Priolo et al. 2002; Nuernberg et al. 2005) but in agreement with finding from Atti et al. (2013) who found similar carcass (%) and fat proportion by lambs of pasture and feed lot. On the other side, Stenberg et al. (2020) found that lambs reared on semi-natural pasture had a lower carcass weight and dressing (%), which is inconsistent with the result of this experiment. Additionally, it was reported that dressing percentage increases with increasing proportions of concentrates in the ration, but on the contrary the high percentages of roughage with crude fiber and low digestibility contributing to low dressing percentages (Payne and Wilson 1999; Rahmann and Aksoy, 2014; Assan 2015).

Castration and carcass parameters

In our experiment there were obviously a negative effect of castration on body live weight and carcass parameters. The reason is attributed to the fact that the castrated lambs underwent a relapse phase after the castration process, which negatively affected their growth rate in the first experimental periods and resulted in decreases final live weight which leading to low carcass weight and fat deposition. Studies reported that castration of male animals reduces the animal's anabolic potential and increases fat deposition (Needham et al.2017) and did not affect the carcass weight (Haddad et al. 2006), contradicting our findings. The results in this experiment agreed

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with the results of Haddad et al. (2006) and Torres-Geraldo et al., (2020) who indicated that the dressing percentages of lambs were not affected by castration and inconsistent to results of Mahgoub et al (1998), Sales (2014) and Claffey et al. (2018) who found lower dressing percentages ($P < 0.5$) and carcass fat (Sales 2014;) compared to castrates. A previous study by Mahgoub et al. (1998) showed that castrated lambs had deposited more fat in the tail and Omentum than intact lambs, similar to the results of Torres-Geraldo et al., (2020) indicating that intact lambs grow faster and exhibit greater muscle mass and less fat deposition than castrated lambs. The significant effect on the average weight of the kidneys and liver by intact lambs is due to the fact that castration had a negative effect on the average weights of this organs (liver and kidney) in castrated lambs.

CONCLUSION

From this study, it can be concluded that the natural pasture feeding system with concentrate supplementation gave the best results in terms of total and daily gain weight, feed conversion ratio and better carcass weight and fat deposition (tail fat). Lambs that were grazed and supplemented with forage sorghum and concentrate showed a decreased growth rate due to low feed intake possibly caused by fodder sorghum. These two systems are very similar to the feeding system used by local sheep farmers and are recommended for use. Dhamari sheep responded negatively to the castration process and showed lower growth and carcass performance.

ETHICAL CONSIDERATION

This study was carried out in accordance to the ethical rules for handling the experimental animals, Yemen.

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CONFLICT OF INTEREST

Authors have no conflicts of interest to disclose

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