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Effect of Compensatory Growth on Carcass Characteristics of Sudanese Desert Lambs

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Abstract

This study was conducted to detect the effect of compensatory growth on carcass characteristics of the Sudanese desert lambs. Twelve lambs (Hamri ecotype) of the same initial weight (23±16 Kg) were used in this experiment. The animals were randomly divided into two groups. The first group (A) was adlibitum offered a high energy diet (10. 50 MJ/Kg DM) for 60 days. While the second group (B) was given a low energy diet (8.03 MJ/Kg DM) throughout the same period (60 days).Lambs of the second group were found just to maintain their weight. After that period the lambs from the second group were offered the high energy diet (10. 50 MJ/Kg DM) until they reached the final weight obtained by the first group. It spent 45 days to reach that weight. At the end of the experiment four animals from each group were chosen randomly for slaughter to obtain carcass data and physical and chemical meat analysis. The results showed that hot and cold carcass weights, dressing percentage were not significantly different between treatments. Similarly dressing percentage was not significantly different between treatments. Body components were not significantly different between treatments except mesenteric fat which was significantly ($p<0.05$) higher in rehabilitated lamb group. The proportion of muscle and fat were significantly greater in the rehabilitated lambs than in free fed lambs. Meat chemical analysis were not significantly different between the two groups, however the fat was significantly ($p<0.05$) greater in rehabilitated lamb group. Meat quality attributes showed significantly higher colour co-ordinates (L) and (a) and superior water holding capacity in rehabilitated lambs group than in free fed lamb group.

Keywords

Sudanese Desert Lambs, Compensatory Growth, Carcass Characteristics

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1. Introduction

Various studies deal with the effect of compensatory growth on carcass characteristics as Wilson and Osbourn 1960 and others reported increases in protein and water of refed animals. In other reports body composition was not affected by a period of feed restriction followed by realimenation. Thornton et al., 1979 and Drouillard et al., 1991). Kabbali et al. (1992) studied the effect of Compensatory Growth on body composition and found that in refed lambs the Weight of the liver was greater ($p< 0.05$) than in continuously fed lambs. However, weights of mesenrtic and kidney fat were reduced ($p< 0.05$) in refed lambs. They also found that water content of the carcass and non carcass tissues was higher ($p< 0.05$) and fat content was lower ($p< 0.05$) in refed lambs.

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Other studies reported similar results as Turgeon et al (1986) and Castren et al (1991) who observed increase in water content and decrease of fat in refed compared with normal Lambs. However other studies reported results which were at variance with the previous studies and these apparent contradictions arise from the diversity of factors involved in compensatory growth.

The objectives of this study are to investigate the effect of compensatory growth on carcass characteristics of Sudanese desert lambs.

2. Materials and Methods

Experimental animals: Twelve ram lambs of the desert sheep (Hamari ecotype) were used. They were rested, ear tagged and kept for a pre-experimental period of three weeks. During this period animals were fed on groundnut hulls 34.6%, Sorghum grains 22%, Wheat bran10%, Groundnut Cake 8%, urea 1.31 %, common salt1%, and Limestone1%. The animals were treated with antibiotic and Albendazole. At the end of the adaptation period animals were weighed following an overnight fast except for water and divided into two groups of equal average live weight of (23±16Kg).Each group was further divided into three groups of two lambs each.

Experimental procedure: Immediately after adaptation period, the two animal groups (group A and B), were randomly assigned to the feed management. Group (A) was ad libitum fed on a high energy diet containing 10.50 MJ/Kg ME and 14.67% cp (table 1). The feeding continued for 8 weeks and the lambs attained a final weight of 36.6kg. Feeding in group (B) was offered into two interchangeable periods. In the first period low energy diet containing 8.03 MJ/Kg ME and 14.70% C was offered ad libitum for a period of 8weeks. In the second period the lambs were also ad libitum offered the high energy diet until they attained the final weight of group (A).They took 6 weeks to reach that weight.

Table (1). Ingredient proportions of experimental diet.

INGREDIENT proportion (%)	HIGH energy diet	LOW energy diet
Sorghum grain	40	4
Wheat bran	15	5
Groundnut cake	11	6
Molasses	14	30
Groundnut hull	17.8	51.4
Urea	0.2	2.4
Limestone	1	1
Common salt	1	1
total		
ME(MJ/Kg)	10.50	8.03
Cp%	14.67	14.70

Data collection: Slaughter and carcass data include slaughter weight, hot and cold carcass weight and wholesale cuts weights. Proximate analysis and quality attributes for meat was done.

Statistical procedure: The data was analyzed by student t-test according to (Snedecor and Cochran, 1980).

3. Results

Carcass yield and characteristics: Table (2) displays carcass yield and characteristics of adlibitum fed and rehabilitated lambs. The empty body weight, slaughter weight, hot and cold carcass weights were not significantly different between the two groups, but were slightly heavier in rehabilitated lambs than in adlibitum fed lamb groups. Hot and cold dressing percentages whether calculated on live or empty body weight basis were not significantly different between the two groups, however in the rehabilitated fed group it was slightly heavier than in the ad libitum fed one. Chiller shrinkage was not significantly different between the two lamb groups.

Table (2). Carcass yield and characteristics of adlibitum fed and rehabilitated Sudan desert lamb.

Item	Adlibitum fed group (A)	Rehabilitated group (B)	Level of Significance
Slaughter weight (kg)	36.75±44.75	37.13±2.19	NS
Hot carcass weight(kg)	18.38±2.57	18.57±3.87	NS
Cold carcass weight(kg)	17.89 ±12.58	18.03±68.75	NS
Cold carcass side weight (Kg)	8. 95±3.14	9. 01±7.19	NS
Empty body Weight (kg)	30.43±7.37	31.08±3.47	NS
Chiller shrinkage (%)	0.49±0.18	0.56±0.05	NS
Hot dressing % (live weight base)	44.90±1.14	45.00±5.03	NS
cold dressing% (live body weight base)	44.10±4.89	44.78±1.26	NS
Hot dressing% (empty weight base)	49.13±6.32	49.93±5.26	NS
Cold dressing%(empty body weight base)	48.17±6.70	49.07±4.92	NS

Body components: The proportions of the non-carcass components calculated on empty body weight base are shown in table (3). Head, skin, four feet, rumen full, rumen empty, intestines full, intestine empty, gut fill, reproduction organs, liver, kidney, heart, lung and trachea, and spleen were not significantly different between the two lamb groups. However there was a slight increase in the proportion of liver and kidneys. The proportion of the omentum and kidney fat depots were heavier and that of the mesenteric fat was significantly ($P<0.05$) heavier in rehabilitated than in ad libitum fed lambs. The proportions of the non-carcass

components calculated on empty body weight base are shown in table (2). Head, skin, four feet, rumen full, rumen empty, intestines full, intestine empty, gut fill, reproductive organs, liver, kidney, heart, lung and trachea, and spleen were not significantly different between the two lamb groups. However there was a slight increase in the proportion of liver and kidneys. The proportion of the omentum and kidney fat depots were heavier and that of the mesenteric fat was significantly (P<0.05) heavier in rehabilitated than in adlibitum fed lambs.

Table (3). Body components of ad libitum fed and rehabilitated Sudan desert lambs (%of EBW).

Item	Ad libitum fed Group (A)	Rehabilitate d group (B)	Level of Significance
No. Animals	4	4	
Head	7.57±0.96	7.28±0.18.	NS
Skin	3.22 ±0.08	3.44 ±0.04	NS
Four feet	1.80 ±0. 57	1.68 ±0.22	NS
Rumen full	3.79± 0.46	3.59 ±0.19	NS
Rumen empty	2.0± 0.06	1.87 ±0.17	NS
Intestines full	2.93 ±0.03	2.96±0.07	NS
Intestines empty	2.08±0.02	1.85±0.60	NS
gut fill	3.89± 0.21	3.87±0.42	Ns
R. organs	1.37±0.03	1.33±0.07	NS
Liver	1.63±0.01	1.66±0.03	NS
Kidney	0.33± 1.88	0.37±0.01	NS
Heart	0.45±0.01	0.43±0.01	NS
Lungs &trachea	1.66±0.01	1.66±0.02	NS
Spleen	0. 39± 0.02	0.39 ±0.09	NS
Mesenrtic fat	0.86±.0.86	1.99±0.83	*
Omentum fat	1.49±0.02	1.51 ±0.02	NS
Kidney fat	1.47±0.05	1.52 ±0.06	NS

Wholesale cuts yield: Table (4) presents the yield of wholesale cuts from carcasses of adlibitum and feed rehabilitated lambs. There were no significant differences in the percentages of neck, leg and chump, single short forequarter loin and best end of neck. The tail was significantly (P<0.05) heavier in rehabilitated than in adlibitum lamb group.

Table (4). Yield of wholesale cuts from adlibitum fed and rehabilitated Sudan desert lambs (% of side weight).

Item	Ad libitum group (A)	Rehabilitate d group (B)	Level of Significance
Neck	8.87±0.27	8.36 ±1.27	NS
Single short forequarter	27.59±11.658	27.71± 8.22	NS
Best end of neck	5.64± 2.01	5.62 ± 0.34	NS
Breast	5.46± 0.56	5.80 ± 3.50	NS
Loin	10.75 ±0.40	10.76 ± 3.33	NS
Leg and chump	31.97 ± 9.31	31.74± 6.76	NS
Tail	2.64 ± 0.27	3.36 ± 0.18	*

Joint composition: Table (5) shows joint composition as percentage of the loin Joint weight. Muscle and fat percentages were significant (P<0.05) heavier in rehabilitated group than in the adlibitum fed lambs. Bone and trimmings were not significantly different between the two groups, but bone was slightly heavier in the adlibitum fed lambs.

Meat chemical composition: Meat chemical composition data of the experimental lambs are shown in table (6) fat was significantly (P<0.05) greater in restricted than in adlibitum fed groups. Moisture, protein and ash were not significantly different between the two experimental groups. The protein content increased slightly in rehabilitated fed group, while moisture and ash were higher in adlibitum fed lambs.

Table (5). Joint Composition of ad libitum fed & rehabilitated Sudan desert lambs (% of loin cut weight).

Item	ad libitum fed group (A)	Rehabilitated group (B)	Level of Significance
Muscle	43.0±9.08	45.88±8.88	*
Fat	4.37±0.64	4.96±0.20	*
Bone	3.89±0.33	3.66±0.21	NS
Trimmings	2.07±0.03	2.01±0.13	NS

Table (6). Chemical composition of meat from adlibitum fed and rehabilitated Sudan desert lambs.

Item	Adlibitum fed group (A)	Rehabilitated group (B)	Level of Significance
No of animals	4	4	
Moisture %	71.89± 6.69	70.27±8.73	NS
Protein %	21.5± 2.74	21.67±1.90	NS
Fat %	2.71±1.58	3.68±.0.35	*
Ash %	1.06±2.1	1.02±3.28	NS

Meat quality attributes: Data of meat quality attributes of experimental lambs are given in Table (7). Meat colour co-ordinates (L) was significantly (P<0.05) higher and redness (a) was highly significantly (P<0.01) higher in rehabilitated than in adlibitum fed lambs. Yellowness (b) co-ordinate was not significantly different between the two treatments. Water holding capacity was significantly (P<0.001) superior and cooking loss was low in the meat from rehabilitated lambs than that form adlibitum fed lambs.

Table (7). Quality attributes of meat from adlibitum fed and rehabilitated Sudan desert lambs.

Item	Adlibitum fed group (A)	Rehabilitated group (B)	Level of Significance
No of animals	4	4	
Color: L	31.2±1.63	32.40±0.64	*
A	15.15±0.21	20.35±1.57	***
B	7.8± 1.05	7.6 5±0.68	NS
Water holding capacity	2.37 ±0.63	1.92±0. 2	**
Cooking loss	34.28±4.19	33.15 ±1.81	NS

4. Discussion

Non-carcass components: Non-carcass components were not significantly different in rehabilitated and normally growing lamb groups. These results were similar to those obtained by Shadnoush et al., (2011) who measured the effect of restricted feeding and re-feeding on intake, body weight and development of body organs, and found no significant differences between groups in weight of stomach complex, intestines, lung, kidneys, head, feet, and pelt as proportion of

live weight. Rayan et al., (1993) studied compensatory growth of cattle and sheep that were restricted for 80 to 90 days. They found that during a period of three months of restriction these animals loss weight in their livers, digestive tracts, meat, and hides. While weights of lung, feet, head and bones remained unchanged during feed restriction as these are early maturing organs. These findings were in agreement with the results of other authors Dashtizadeh et al., 2008; Kamalzadeh et al., 1998 and Mahouachi and Atti 2005. The slight increase in the liver weight of rehabilitated group in this study coincided with report by of Sami et al., (2013) that the liver weight was significantly higher in rehabilitated lambs. In reports by Turgeon et al. (1986) and Mora et al. (1996) during the first phase of the realimenation period, energy was diverted mainly to replenish protein and glycogen reserves in gut and liver tissues. However, in other reports the liver was not affected by a period of feed restriction followed by realimenation (Kabbali et al., 1992ab and Murphy et al., 1994).

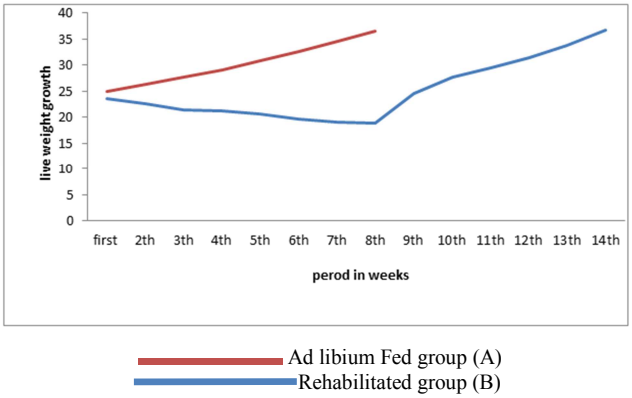

Fig. (1). Effect of compensatory growth on body weight change.

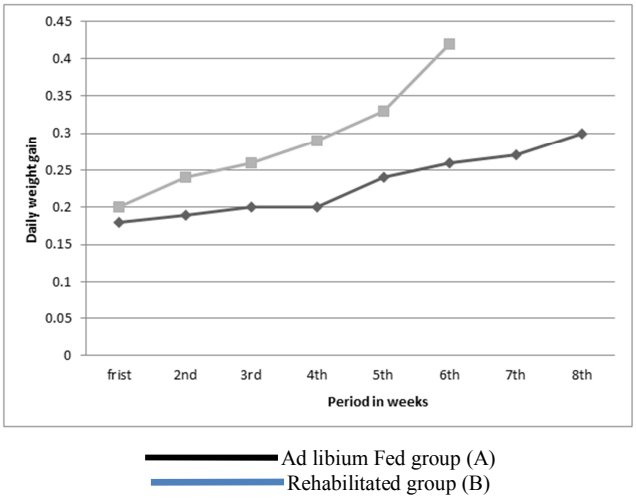

Fig. (2). Effect of compensatory growth on daily weight gain.

Fat depots (mesenteric, omentum and kidney) fat increased in rehabilitated lamb group compared with free fed lambs. This agreed with earlier report of (Wilson and Osbourn, 1960) and also with other authors as Sami et al., (2013) who found that the accretion of fat was higher ($p<0.05$) during rehabilitation of lambs following feed restriction.

Dressing percentage: Dressing percentage of this study shown in table (4) revealed that there was no significance different between ad libitum fed and rehabilitated lambs. The fact that these animal were slaughtered at equal body weights and that they had similar hot and cold carcass weights explain this finding. This agreed with Abouheif et al., (2013) who studied the effects of feed restriction followed by realimenation on performance and carcass characteristics and dressing percentages of lambs in various feeding restrictions and weight groups and found no significant ($P>0.01$) difference in dressing percentage between rehabilitated and free fed lambs. This result also agreed with previous reports that dressing percentages were not significantly affected by feed restriction and realimenation (Murphy et al., 1994; Dashtizadeh et al., 2008 and Al-Selbood, 2009).

Carcass characteristics: Lack of difference in hot and cold carcass weights in rehabilitated and free lamb groups could be explained by the findings that the slaughter weight of the two groups was not significantly different and that their non-carcass components were not significantly different in weight. These were in agreement with Soheir and Babiker, (2005) who reported no significant difference among restricted cattle group and control in empty body weight during full feeding period. Hot and cold carcass weights were also similar between the rehabilitated and normally growing lamb groups.

Wholesale cuts yield: As seen in table (6) wholesale cuts yield Neck, Leg and chump, Single short forequarter, Breast, Loin and Best end of neck as percent of cold carcass weight of adlibitum fed and rehabilitated lambs were not significantly different. This could be due to the same slaughter weight and carcass weight of the two groups. Yáñez et al., (2007) investigated the effect of feed restriction on yield of retail cuts and tissue composition of carcass of Saanen kids which had adlibitum access to feed or 30 or 60% of adlibitum and found greater proportion of chump and lower proportion of neck of animals fed adlibitum. The leg, chump and $6^{th}$to 13^{th} rib, 1^{th} to 5^{th} rib, shoulder, brisket, (leg+ shoulder+ chump) and loin were not affected by feed restriction than free feeding. Tail was significantly higher in rehabilitated lamb cuts. The finding that rehabilitated lambs deposited more fat than free fed lambs were similar to those obtained by ledin, (1983) and Notter et al., (1983) who indicated higher fat content in rehabilitated animals.

Meat quality attributes: Meat quality attributes of adlibitum fed and restricted lambs shown in table (7) indicated significance increase ($p<0.01$) in color co-ordinates lightness

(L) and redness (a) values in meat from rehabilitated group than control group. Increased muscle fatness might have increased lightness values. Redness values normally increase with the increase in muscle proteins due mainly to their myoglobin component. Myoglobin is the major fraction that affects muscle redness (lawrie, 1991). Likewise. Daniel et al., (2007) found that feed restriction decreased fiber diameter and the amount of fast twitch fibers in both the Longissimus dorsi and the vastus lateralis. The reasonably high L* values could imply that muscle differentiation was shifted more towards making white muscle fibers rather than red in restricted muscle thus increasing colour co –ordinates Lightness (L).In this study the water holding capacity was superior in the meat from rehabilitation than from control groups because of the increase in fat in the muscle of this group which tended to improve their water holding capacity (lawrie 1991) and decrease cooking loss. The effect of re-feeding on meat quality is controversial and this discrepancy is related mainly to the length and energy level of the recovery period. These findings agreed with Yagoub and Babiker (2009) who studied the effect of compensatory growth on growth and carcass characteristic of Sudanese female goats. The meat from compensating goats had superior water holding capacity and less cooking loss than that from control goats.

Joint composition: Joint composition as percentage of joint weight indicated that muscle and fat tissues were almost significance ($p<0.05$) higher in the rehabilitated lambs. Increase of muscle size and age of the animals might be the reason. These results were in line with some reports that indicated an increase in body fat content (Ledin, 1983and Notter et al., 1983) and lean tissue of realimenated animals (Dashtizadeh et al., 2008 and Al-Selbood, 2009). Sami et al., (2013) indicated an increase in the accretion rate of fat in restricted and then rehabilitated lambs.

Meat chemical composition: Meat chemical composition shown in table (6) indicated significantly ($p<0.05$) greater fat in rehabilitated than in adlibitum fed lambs. This result was in line with what was stated that during realimenation, more protein is deposited initially but further gain in bodyweight was due to increased fat (Rompala et al., 1985 and Wright and Russel, 1991). Droulliard et al., (1991) indicated that, lambs that were protein restricted lost protein, fat, and water at a high rate for each day that they were restricted. Once returned to a complete diet, lambs gained protein and fat at a much faster rate than control lambs. Sami et al., (2013) studied the effect of feed restriction and re-feeding on the growth rate, carcass tissues and non-carcass components and composition in Najdi male lambs. Chemical fat was higher ($P<0.05$) in the lambs that had been feed restriction than the control lambs. Greeff et al.,(1986) and Marais et al., (1991) stated that the relationship of lean composition was upset by feed restriction followed byre-feeding, and that re-fed lambs had more protein than controls. In this study the decreased proportion of muscle moisture with increased proportion of fat was expected as these two parameters are inversely related. Fleming (1969) and Hoke et al., (1999) also found this inverse relationship between fat and moisture.

5. Conclusion

It could be concluded that rehabilitation of Sudanese desert lambs after a period of feed restriction significantly ($p<0.05$) increase mesenteric fat and fat content of the meat. Also rehabilitation induced superior water holding capacity.

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