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Original Article

Effect of Melatonin Implants and Nutritional Restriction on Growth Performance of Local Male Lambs

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Abstract

This experiment was conducted from 17 October 2021 to 9 January 2022 on the Department of Animal Production sheep field at the College of Agriculture, University of Anbar. The study aimed to determine the impact of melatonin implants and dietary restrictions on local male lambs' nutritional and growth performance. It included 16 local male lambs ranging in age from 5 to 6 months and weighing an average of 35.31 3.71 kg. The lambs were separated into four equal groups (n=4) and placed in separate pens. The actual duration of the experiment was 69 days, divided into two phases: the first phase consisted of 42 days of nutritional restriction, and the second phase consisted of 27 days of re-nutrition. As a control treatment during the stage of nutritional restriction, the first group (T_1) was fed ad libitum. In contrast, the second group (T_2) was fed Ad libitum with 36 mg subcutaneous-ear implanted melatonin implants, and the third group (T_3) was fed a restricted diet (R) of 75% of the Ad libitum. Comparatively, the fourth group (T_4) was fed a restricted diet of 75% of the Ad libitum with 36 mg of subcutaneous-ear implanted Melatonin. Until the end of the re-feeding phase, all experimental treatments were provided with unrestricted access to food. The nutritional and growth performance parameters were measured during the nutritional restriction and re-feeding stage and the entire experiment duration. During the nutritional restriction stage (42 days), there was no significant difference between the experimental treatments in terms of total weight gain, daily weight gain, feed conversion efficiency, and feeding efficiency. However, the experimental groups exhibited statistically significant differences in daily feed intake, daily dry matter intake, and dry matter intake as a percentage of body weight. In the re-feeding stage, there were no significant differences in the above nutritional and growth parameters among the experimental groups (27 days). This experiment concluded that feeding local male lambs 75% of Ad libitum with or without melatonin implants for 42 days, followed by re-feeding for 27 days, maintained the growth performance of the lambs with minimal feed intake and reduced lamb production costs.

Keywords: Melatonin, Nutritional restriction, Growth performance, Male lambs

1. Introduction

Nutrition is the main factor affecting the productivity of animal production projects, especially ruminants, because they consume large quantities of feed compared to poultry. Thus, breeders seek to find strategies and feeding systems that reduce the cost of feeding and improve the productive performance of animals (1). Numerous possible strategies have been investigated for production cost reduction to reduce feed costs and make lamb production projects more profitable, including using nutritional restriction - compensatory growth (2). Nutritional Restriction - Compensatory Growth is one of the strategies used in some countries to reduce the cost of lamb production, especially when the number of cultivated feed decreases or its prices rises, or the addition of feed supplements is not economically feasible. It was also suggested to improve feeding efficiency (3). Nutritional

Restriction is feeding the animal at a level lower than Ad Libitum. Compensatory Growth is the animal's ability to compensate for what it missed in growth in earlier periods as a result of nutritional restriction when free access to good quality feed is available (2). Several studies indicated that using the nutritional restriction program at the level of 10, 20, 25, 30, and 40% with re-alimentation improved growth performance, feeding efficiency, and the ability to digest nutrients in male lambs (2, 4-6). Melatonin is the main secretion of the pineal gland (7), and it performs many vital functions in the body. It works to regulate the daily and seasonal harmony of biological activities in the body of the organism, such as sleep and wakefulness, body temperature, and hormone levels (8). Besides, regulating the seasonal reproduction in animals whose reproduction depends on the photoperiod (9).

Moreover, Melatonin acts as an antioxidant (10) and an immune stimulator (11). Previous studies indicated a possible role of Melatonin in reducing the harmful effects of low nutrition levels (12). As well as that, Melatonin improved reproductive performance in flocks of low-nutrition sheep (13). Considering the significance of the topic and the paucity of information sources on the effect of Melatonin on the growth performance of lambs under nutritional restriction, it was determined that further research was necessary. The research hypothesis in the current study stated that melatonin implants with nutritional restriction improve growth and nutritional performance in local male lambs. Therefore, the current study aimed to identify the effect of melatonin implants and nutritional restrictions on the growth performance of local male lambs.

2. Materials and Methods

2.1. Experiment Design

This experiment was conducted in the sheep field of the Department of Animal Production at the College of Agriculture, University of Anbar, for the period from Oct. 2021 to 9 January 2022. The experiment included 16 local male lambs; their ages ranged from 5-6 months, with an average weight of 35.31±3.72 kg. The lambs were placed in a fenced enclosure barn consisting of an exposed part and a shaded part and provided with 16 individual pens made of iron with dimensions (150 × 100 × 110 cm), while a plastic bucket for fodder and another for water. All lambs were identified with ear tags and treated with internal and external anti-parasites. The lambs were injected with the vaccine against diseases caused by Clostridium bacteria, and mineral salts were provided. The lambs were reared before the start of the experiment in a preliminary phase for a week to adapt the lambs to the individual pens and the new ration. Gradually converting the lamb feed to the Pelleted Total Mixed Ration (TMR) locally manufactured according to the feed materials and proportions tabulated in table 1. The chemical analysis of the ration is shown in table 2, where 500 g of high-quality alfalfa hay and 100 g of TMR ration were provided to each lamb, after which the alfalfa hay was gradually reduced, and the TMR ration was gradually increased until the lambs were completely dependent on the new ration.

Table 1. Ingredients and proportions of the experiment diet

Ingredient	(%)
Barley	25
Wheat flour	20
Wheat bran	22
Soybean meal	9
Soybean oil	1
Salt	1
Lime	1
Alfalfa hay	20
Antitoxin	0.2
Premix	0.8
Total	100

Table 2. Chemical analysis of the experiment diet

Chemical composition	%
Dry matter (DM)	90.31
Crude protein (CP)	16.49
Crude fat (ether extract) (EE)	2.43
Crude fiber (CF)	9.41
Ash	7.16
Nitrogen Free Extract (NFE)	54.82
Metabolizable energy ME (MJ/kg dry matter)*	13.55
Metabolizable energy ME (kcal/kg dry matter)	3212

The Metabolizable energy was estimated according to the following equation (Ellis, 1980):
ME(MJ/kg DM)= 0.31CP+0.21EE+0.4NFE

The diet was provided once a day at nine o'clock in the morning at the rate of 1.75 kg, and on the next day, at the same time, the remaining feed was weighed. Thus, the feed intake per day is calculated to estimate the quantity of rationed feed provided for the nutritional restriction treatment by subtracting the quantity of the remaining feed from the quantity of the provided feed. The duration of the actual experiment was 69 days, divided into two stages, the first stage of nutritional restriction (42 days) and the second stage of re-alimentation (27 days). In the stage of nutritional restriction, the first group (T_1) was fed on Ad libitum as a control treatment. Then, the second group (T_2) was fed on Ad libitum with melatonin implants at a dose of 36 mg (2 implants) subcutaneous-ear implanted. Besides, the third group (T_3) was fed on a restricted diet of 75% of Ad libitum, while the fourth group (T_4) was fed on a restricted diet of 75% of Ad libitum with melatonin implants at a dose of 36 mg (2 implants) subcutaneous-ear implanted. The amount of local feed provided to the third and fourth group of lambs was estimated by determining the average amount of dry matter consumed per day by the Ad libitum group (the first group) multiplied by 0.75. The restricted feed quantity is adjusted weekly until the end of the nutritional restriction stage. As for the re-alimentation stage, the feed is provided freely and for all trial treatments until the end of the re-alimentation stage.

The lambs were weighed weekly on days 0, 7, 14, 21, 28, 35, 42, 49, 56, 63, and 69 of the experiment and weighed in the morning by an electronic field scale. Total weight gain, daily weight gain, feed intake, dry matter intake, feed conversion efficiency, Feeding efficiency, and the percentage of dry matter intake by body weight were estimated during the period of nutritional restriction and re-alimentation, and the total period of the experiment.

2.2. Statistical Analysis

Statistical analysis was conducted in (One Way Analysis), which included the effect of experimental treatments and periods on the studied traits, using the General Linear Model and the SAS statistical program version 9 (SAS, 2003). The significant differences between the means were tested using the Duncan multiple ranges test (14) at the level of significance ($P<0.05$) according to the following mathematical model:

$Y_{ij}=\mu + T_i + E_{ij}$

Where:

Y_{ij}: the observation value j of the studied characteristic of treatment i.

μ: the general average.

T_i: the effect of treatment i.

E_{ij}: the random error assumed to be normally distributed with a mean of zero and a variance of $\sum 2$.

3. Results and Discussion

The current experiment showed the effect of melatonin implantation and nutritional restriction on the growth performance of local male lambs. This experiment is the first of its kind, according to the information available. The results (Table 3) concerning the growth and nutritional performance during the nutritional restriction (42 days) showed no significant differences in the final weight of lambs between the experimental treatments. It amounted in treatments 43.3±2.84, 45.6±1.58, 41.3±2.34, and 42.5±0.86 kg for the treatments T_1, T_2, T_3, and T_4, respectively. Likewise, there were no significant differences in the total weight gain rate among the experimental treatments, which amounted to 8.0±1.60, 10.2±0.940, 6.3±0.519, and 7.1±1.06 kg for the treatments (T_1, T_2, T_3, and T_4), respectively. It was similarly noted that there were no significant differences in the rate of daily weight gain between the experimental treatments, as it amounted to (190±38.3, 243±22.3, 150±12.3, and 169±25.3g) for the treatments (T_1, T_2, T_3, and T_4), respectively. This result agreed with what was found by Abouheif, Al-Sornokh (2), as there were no significant differences in the final weight rate of Najdi lambs fed on a restricted diet by 10 and 20% during the period of nutritional restriction (6 weeks).

Table 3. Growth and nutritional performance during the nutritional restriction stage (42 days) in local male lambs

Parameters	Treatments				Significant level
	T_1 Ad. Lib.	T_2 Ad. Lib.+Mel.	T_3 Rest.	T_4 Rest.+Mel.	
Initial weight (kg)	35.3±2.14*	35.4±2.01	35.0±2.73	35.4±1.08	NS**
Final weight (kg)	43.3±2.84	45.6±1.58	41.3±2.34	42.5±0.86	NS
Total weight gain (kg)	8.0±1.60	10.2±0.940	6.3±0.519	7.1±1.06	NS
Daily weight gain (g/day)	190±38.3	243±22.3	150±12.3	169±25.3	NS
Daily feed intake (g/day)	1614±141[a]	1500±77.9[a]	1067±44.7[b]	1068±26.7[b]	0.0008
Daily dry matter intake (g/day)	1458±127[a]	1355±70.2[a]	963±40.3[b]	965±24.1[b]	0.0008
Dry matter intake (%) of body weight	3.35±0.119[a]	2.97±0.188[a]	2.35±0.104[b]	2.27±0.047[b]	0.0001
Feed conversion efficiency (g dry matter intake/g weight gain)	7.70±1.73	5.57±0.517	6.42±0.721	5.71±0.601	NS
Feed efficiency (g weight gain/kg dry matter intake)	130±25.9	179±18.0	156±20.8	175±21.6	NS

* (Mean ± Stander Error)
** NS: means non-significant
a,b Means in the same row with different letters differ (P<0.01)

These results did not agree with what was found by Abouheif, Al-Owaimer (6) noticed a significant decrease in the daily weight gain of male Najdi lambs during the nutritional restriction in the two treatments, 25% and 40%, compared to the Ad libitum treatment. de Araújo, Pereira (15) found significant differences in Morada Nova lambs' average final weight and daily weight gain during the nutritional restriction, as the Ad libitum treatment in the final weight and daily weight gain exceeded both the nutritional restriction treatment by 30% and 60%. This difference may be attributed to the different breeds of lambs, the diet's composition, the lambs' age and weight when starting nutritional restriction, and the level and duration of nutritional restriction and re-alimentation. The results showed that there were significant differences in the daily feed intake during the nutritional restriction stage, as it amounted to 1614±141, 1500±77.9, 1067±44.7, and 1068±26.7 g for the treatments T_1, T_2, T_3, and T_4 respectively. In addition to the presence of significant differences in the average daily dry matter intake was (1458±127, 1355±70.2, 963±40.3, and 965±24.1 g) for the experimental treatments T_1, T_2, T_3, and T_4, respectively. Moreover, significant differences also showed in the percentage of dry matter intake from body weight, as it reached (3.35±0.119, 2.97±0.188, 2.35±0.104, and 2.27±0.047%) in the treatment (T_1, T_2, T_3, and T_4) respectively. This finding agreed with what was found by Abouheif, Al-Owaimer (6), Abouheif, Al-Sornokh (2), and Abouheif, Al-Sornokh (4). As for nutritional performance during the restriction stage, there were no significant differences in the feed conversion efficiency (g dry matter consumed /g of weight gain) between the experimental treatments. The above efficiency has amounted to 7.70±1.73, 5.57±0.517, 6.42±0.721, and 5.71±0.601 for treatments (T_1, T_2, T_3, and T_4), respectively. Also, there were no significant differences in feeding efficiency (g weight gain /kg dry matter consumed) between the experimental treatments, as it reached (130±25.9, 179±18.0, 156±20.8, and 175±21.6) treatments (T_1, T_2, T_3, and T_4) respectively. This result agreed with what was found by Abouheif, Al-Sornokh (2). However, no significant differences were observed in the feed conversion efficiency between the Ad libitum treatment and the nutritional restriction treatment (10%). Though, the results did not show consistent with Abouheif, Al-Owaimer (6) findings, as they noticed a significant decrease in the feeding efficiency for the two nutritional restriction treatments, 25%, and 40%, compared to the Ad libitum treatment. It was observed from the above results that the nutritional restriction at a level of 25% for 42 days did not have a negative impact on the growth and nutritional

performance of the local male lambs. As for the effect of melatonin implants with the nutritional restriction, it seems that there are indications of a possible effect of Melatonin in improving the efficiency of feed utilization.

The results of growth and nutritional performance during the re-alimentation stage (27 days) listed in table 4 showed that there were no significant differences between the experimental treatments in the final weight of lambs and total weight gain, daily weight gain, daily feed intake, daily dry matter intake, percentage of dry matter intake by body weight, feed conversion efficiency, and feeding efficiency. The results agreed with Abouheif, Al-Owaimer (6) that in the re-alimentation stage (49 days) for Najdi male lambs whose average weight at the start of the nutritional restriction was 30 kg, they did not show a significant difference in the rate of daily weight gain. As well as the daily dry matter intake and feeding efficiency between the treatments of Ad libitum, nutritional restriction (75% of Ad libitum), and nutritional restriction (60% of Ad libitum). In contrast, these results did not agree with Abouheif, Al-Owaimer (6), as significant differences were observed in the rate of daily weight gain and feeding efficiency in lambs whose average weight at the start of the nutritional restriction was 36 kg. The two treatments of nutritional restriction (60% of Ad libitum) and nutritional restriction (75% of Ad libitum) were superior to the treatment of Ad libitum, while no significant differences appeared in the daily dry matter intake among the above treatments. Furthermore, Abouheif, Al-Sornokh (4) also noted that in the re-alimentation stage, the two treatments of nutritional restriction (90% and 80% of Ad libitum) significantly exceeded the daily weight gain over the Ad libitum group, while there were no significant differences in dry matter intake among the three treatments.

Table 4. Growth and nutritional performance during the re-alimentation stage (27 days) in local male lambs

Parameters	Treatments				Significant level
	T_1 Ad. Lib.	T_2 Ad. Lib.+Mel.	T_3 Rest.	T_4 Rest.+Mel.	
Initial weight (kg)	43.3±2.84*	45.6±1.58	41.3±2.34	42.5±0.86	NS**
Final weight (kg)	47.5±2.56	49.4±2.29	47.2±2.04	47.8±1.66	NS
Total weight gain (kg)	4.2±0.588	3.8±0.627	5.9±0.555	5.3±0.733	NS
Daily weight gain (g/day)	156±21.7	141±23.2	218±20.5	196±27.1	NS
Daily feed intake (g/day)	1875±118	1833±186	1803±141	1564±125	NS
Daily dry matter intake (g/day)	1693±106	1655±168	1628±127	1412±113	NS
Dry matter intake (%) of body weight	3.57±0.413	3.36±0.366	3.42±0.125	2.96±0.260	NS
Feed conversion efficiency (g dry matter consumed/g weight gain)	10.8±2.16	11.7±3.46	7.5±1.00	7.2±0.712	NS
Feed efficiency (g weight gain/kg dry matter consumed)	92.1±14.2	85.2±22.3	133±19.3	139±14.9	NS

* (Mean±Stander Error)
** NS: means non-significant

The results of growth and nutritional performance are shown in table 5; during the stages of nutritional restriction and re-alimentation (69 days) indicated that there were no significant differences in the average final weight of lambs among the experimental treatments, as it reached 47.5 2.56 kg in treatment (T1), 49.4 2.29 kg in treatment (T2), 47.2 2.04 kg in treatment (T3), and 47.8 1.68 kg in treatment (T4). However, there were no significant differences in the total weight gain between treatments, as it amounted to in treatment (T_1) 12.2±1.39 kg, treatment (T_2) 14.0±0.557 kg, treatment (T_3) 12.2±1.02 kg, and treatment (T_4) 12.4±2.10 kg. Moreover, no significant differences were recorded in the daily weight gain,

which amounted to (176±16.2, 202±5.15, 177±15.7, and 179±29.8 g) for treatments T_1, T_2, T_3, and T_4, respectively. As for the daily feed intake, the results showed significant differences between the treatments, as the T_4 treatment recorded the lowest feed intake (1315±70.0 g), followed by the T_3 treatment, which amounted to 1435±83.4 g, compared to the treatments T_1, and T_2 with 1745±78.8, 1689±137 g, respectively. Significant differences were observed in the daily dry matter intake among the treatments, which amounted to (1576±71.2, 1525±124, 1296±75.3, and 1188±63.2 g) for treatments T_1, T_2, T_3, and T_4, respectively, and the treatment T_4 recorded the lowest daily dry matter intake.

It was noted that there were significant differences in the percentage of dry matter intake of body weight, which amounted to 3.48±0.212, 3.22±0.296, 2.88±0.033, 2.62±0.139%) in the treatments T_1, T_2, T_3, and T_4 respectively, where T_4 recorded less dry matter intake. However, no significant differences were recorded in the feed conversion efficiency (g of dry matter consumed/g of weight gain) between the experimental treatments, as it reached in treatment (T_1) 8.9±1.20, treatment (T_2) 7.5±1.61, treatment (T_3) 7.3±0.813, and treatment (T_4) 6.6±0.651. Also, no significant differences were recorded in feeding efficiency (g weight gain /kg dry matter consumed) between the experimental treatments, which amounted to 111±15.0, 132±9.67, 137±19.1, 151±19.6 g for treatments T_1, T_2, T_3, and T_4 respectively. Nutritional Restriction - Compensatory Growth is one of the strategies used in some countries to reduce the cost of lamb production, especially when the number of cultivated feed decreases or its prices rises, or the addition of feed supplements is not economically feasible (3, 16). It was also suggested to improve feeding efficiency (17). Abouheif, Al-Owaimer (6) found that the nutritional restriction program at a level of 40% for 5 weeks, followed by re-alimentation for 4 weeks, was used to bring about compensatory growth and to improve the growth rate in developing lambs. The improvement in growth performance is not due to an increase in dry matter consumption but is likely to be due to an improvement in feeding efficiency in the re-alimentation stage and/or a decrease in heat production during the nutritional restriction continues during the re-alimentation stage. Abouheif, Al-Sornokh (2) noted that a nutritional restriction program at a level of 10% for 6 weeks, followed by re-alimentation for 2 weeks, can be used as a nutritional practice in fattening lambs. Abouheif, Al-Sornokh (4) concluded the possibility of using a nutritional restriction program at a rate of 10-20% as an alternative to Ad libitum in improving the growth performance of Najdi lambs. The current results showed that feeding local male lambs at 75% of Ad libitum (25% nutritional restriction) with or without melatonin implants for 42 days followed by re-alimentation for 27 days had no negative impact on the growth performance of local male lambs. In addition, the two nutritional restriction treatments with or without melatonin implants recorded the lowest consumption of feed and dry matter compared to the Ad libitum treatments with or without melatonin implants. This may be due to the decrease in feed consumption as a result of nutritional restriction may lead to an increase in digestibility due to an increase in the duration of food stay in the digestive tract, especially in the rumen, which prolongs the exposure of rumen microbes to feed particles. Digestibility improvement is more evident in the rations rich in concentrates than the rations of rough feeds (18), as the ration used in the current experiment contains 80% concentrates and 20% alfalfa hay. As for the effect of melatonin implants, there is no information available, but there are previous studies indicating a possible role of Melatonin in reducing the harmful effects of a low level of nutrition. In a study conducted by Fang, Zhang (12) on the effect of melatonin implants on the viability of embryos in ewes raised under a low level of nutrition, they found that treatment with Melatonin significantly improved the viability of the embryos obtained from ewes placed under a low feeding level. It was concluded that using melatonin implants is a useful

method, significantly when fetal development is affected by the adverse effects of low nutrition. Mansoor, Saleh (13) observed that melatonin implants improved reproductive performance in local ewes under a low level of nutrition. On the other hand, Tordjman, Chokron (19) verified that the gut has the ability to synthesize circulating Melatonin in the blood, as well as being able to synthesis melatonin in Enterochromaffin cells that are located in the epithelial layer of the digestive tract. It was noted that the melatonin implants in mice led to an increase in the concentration of Melatonin in the different parts of the digestive tract, and it was assumed that an increase in the level of Melatonin in the digestive tract leads to a decrease in the speed of food passage as a result of the effect of Melatonin in the relaxation of the digestive tract, and thus gives sufficient time for absorption and utilization of digested nutrients.

The results of the weekly body weight in figure 1 during the periods of nutritional restriction and re-alimentation showed no significant differences in the average weekly body weight between treatments and for all periods. It is noted in the two treatments of nutritional restriction (T_3 and T_4) that the body weight gradually increases with the progression of weeks, although feeding it during the stage of nutritional restriction constitutes 75% of the Ad libitum (25% of nutritional restriction). This indicates that the level of nutritional restriction of 25% did not have a negative impact on the growth performance of local lambs. It was also noted that the trajectory of the bodyweight curve in treating Ad libitum + Melatonin (T_2) is higher than in treating Ad libitum (T_1). Besides, the curve trajectory of the treatment of nutritional restriction + Melatonin (T_4) is higher than that of the treatment of nutritional restriction (T_3), which may indicate the existence of a possible role for Melatonin in improving the growth performance of local lambs.

The cost of producing 1 kg of weight gain for the experimental treatments showed in figure 2; it included the cost of the consumed feed only. It was noted that the cost of producing 1 kg of weight gain in T_1 (7671 Iraqi dinars), T_2 (6297 Iraqi dinars), T_3 (6183 Iraqi dinars), and T_4 (5222 Iraqi dinars). The results agreed with Cui, Wang (3) that nutritional restriction is a strategy to reduce the cost of lamb production.

Table 5. Growth and nutritional performance during the stages of nutritional restriction and re-alimentation (69 days) in local male lambs

Parameters	Treatments				Significant level
	T_1 Ad. Lib.	T_2 Ad. Lib.+Mel.	T_3 Rest.	T_4 Rest.+Mel.	
Initial weight (kg)	35.3±2.14*	35.4±2.01	35.0±2.73	35.4±1.08	NS**
Final weight (kg)	47.5±2.56	49.4±2.29	47.2±2.04	47.8±1.66	NS
Total weight gain (kg)	12.2±1.39	14.0±0.557	12.2±1.02	12.4±2.10	NS
Daily weight gain (g/day)	176±16.2	202±5.15	177±15.7	179±29.8	NS
Daily feed intake (g/day)	1745±78.8^{a}	1689±137^{ab}	1435±83.4^{bc}	1315±70.0^{c}	0.0264
Daily dry matter intake (g/day)	1576±71.2^{a}	1525±124^{ab}	1296±75.3^{bc}	1188±63.2^{c}	0.0264
Dry matter intake (%) of body weight	3.48±0.212^{a}	3.22±0.296^{ab}	2.88±0.033^{ab}	2.62±0.139^{b}	0.0365
Feed conversion efficiency (g dry matter consumed /g weight gain)	8.9±1.20	7.5±1.61	7.3±0.813	6.6±0.651	NS
Feed efficiency (g weight gain/kg dry matter consumed)	111±15.0	132±9.67	137±19.1	151 ± 19.6	NS

* (Mean±Stander Error)

** NS: means non-significant

a,b Means in the same row with different letters differ (P<0.01)

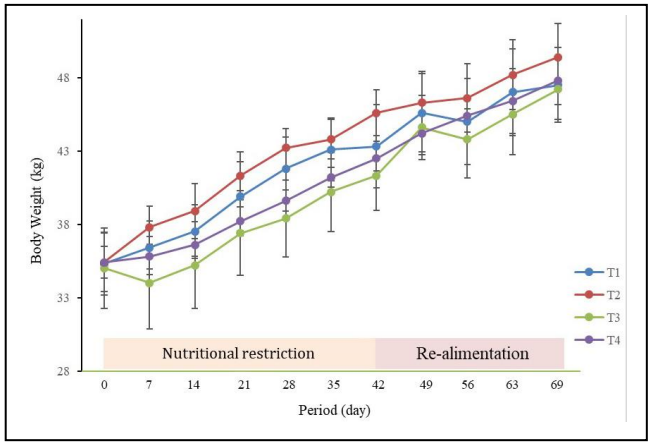

Figure 1. Weakly body weight during the period of nutritiona restriction and re-alimentation in local male lambs

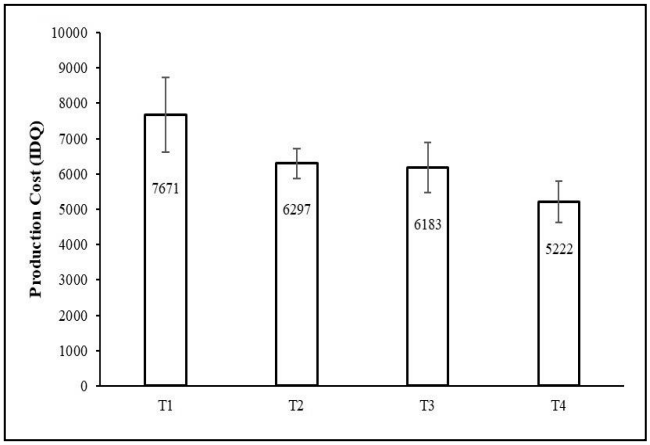

Figure 2. The cost of producing 1kg weight gain for experimental treatments

The current study concludes that feeding local male lambs at a level of 75% Ad libitum (25% Nutritional restriction) with or without melatonin implants for 42 days followed by re-alimentation for 27 days maintained growth performance with less dry matter consumption. Moreover, melatonin implants with Nutritional restriction (75% of Ad libitum) reduced the production cost of 1 kg of weight gain.

Authors' Contribution

Study concept and design: B. N. R. A. and A. R. M.
Acquisition of data: B. N. R. A. and A. R. M.
Analysis and interpretation of data: B. N. R. A. and A. R. M.
Drafting of the manuscript: B. N. R. A. and A. R. M.
Critical revision of the manuscript for important intellectual content: B. N. R. A. and A. R. M.
Statistical analysis: B. N. R. A. and A. R. M.
Administrative, technical, and material support: B. N. R. A. and A. R. M.

Ethics

All the procedures were approved by the ethics committee of the University of Anbar, Ramadi, Iraq.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Al-Jassim AF, Al Hashimi HH, Al-Bidhani MK. Effect of feed restriction with or without addition saccharomyces cerevisiae on blood and serum biochemical parameters of Arabian lambs. Int J Pure App Biosci. 2018;6(1):1315-21.
2. Abouheif M, Al-Sornokh H, Swelum A, Yaqoob H, Al-Owaimer A. Effect of different feed restriction regimens on lamb performance and carcass traits. Rev Bras Zootecn. 2015;44:76-82.
3. Cui K, Wang B, Ma T, Si B, Zhang N, Tu Y, et al. Effects of dietary protein restriction followed by realimentation on growth performance and liver transcriptome alterations of lamb. Sci Rep. 2018;8(1):1-10.
4. Abouheif M, Al-Sornokh H, Swelum A, Ahmed TS, Mahmoud FA, Haroon R. Effects of intake restriction and realimentation on diet digestion and ruminal fermentation by growing lambs. Global Adv Res J Agric Sci. 2016;5:126-31.
5. Babu B, Suryanarayana M, Rao E, Latha P. Effect of feed restriction on performance and nutrient digestibility in ram lambs. Int J Curr Microbiol Appl Sci. 2017;6:566-72.
6. Abouheif M, Al-Owaimer A, Kraidees M, Metwally H, Shafey T. Effect of restricted feeding and realimentation on feed performance and carcass characteristics of growing lambs. Rev Bras Zootecn. 2013;42:95-101.
7. Abecia JA, Luis S, Canto F. Implanting melatonin at lambing enhances lamb growth and maintains high fat content in milk. Vet Res Commun. 2021;45(4):181-8.

8. Irianti L. Pengaruh shift kerja terhadap kelelahan dan performansi pengendali kereta api indonesia. Jurnal Rekayasa Sistem Industri. 2017;6(2):79-91.
9. Malpaux B, Chemineau P, Pelletier J. Melatonin and reproduction in sheep and goats. Melatonin: CRC Press; 2020. p. 253-87.
10. Reiter RJ, Mayo JC, Tan DX, Sainz RM, Alatorre-Jimenez M, Qin L. Melatonin as an antioxidant: under promises but over delivers. J Pineal Res. 2016;61(3):253-78.
11. Habibu B, Dzenda T, Ayo J, Yaqub L, Kawu M. Haematological changes and plasma fluid dynamics in livestock during thermal stress, and response to mitigative measures. Livestock Sci. 2018;214:189-201.
12. Fang Y, Zhang J, Li Y, Guo X, Li J, Zhong R, et al. Melatonin-induced demethylation of antioxidant genes increases antioxidant capacity through RORα in cumulus cells of prepubertal lambs. Free Radic Biol Med. 2019;131:173-83.
13. Mansoor AR, Saleh ID, Dakheel HA. Effect of addition of melatonin to the intravaginal sponges on oxidative status and reproductive performance in Iraqi awassi ewes. Ann Trop Med Public Health. 2020;23:120-7.
14. Duncan DB. Multiple range and multiple F tests. biometrics. 1955;11(1):1-42.
15. de Araújo TL, Pereira ES, Mizubuti IY, Campos AC, Pereira MW, Heinzen EL, et al. Effects of quantitative feed restriction and sex on carcass traits, meat quality and meat lipid profile of Morada Nova lambs. J Anim Sci Biotechnol. 2017;8(1):1-12.
16. Ahmad AS, Al-Rawi FT, Abdul-Rahaman YT, Mohammed TT, Mahmud KI. Effect of Tryptophan injection on the semen quality in Iraqi Shami buck. IOP Conf Ser: Earth Environ Sci. 2021;761(1):012093.
17. Fischer A, Edouard N, Faverdin P. Precision feed restriction improves feed and milk efficiencies and reduces methane emissions of less efficient lactating Holstein cows without impairing their performance. J Dairy Sci. 2020;103(5):4408-22.
18. Ginane C, Bonnet M, Baumont R, Revell DK. Feeding behaviour in ruminants: a consequence of interactions between a reward system and the regulation of metabolic homeostasis. Anim Prod Sci. 2015;55(3):247-60.
19. Tordjman S, Chokron S, Delorme R, Charrier A, Bellissant E, Jaafari N, et al. Melatonin: pharmacology, functions and therapeutic benefits. Curr Neuropharmacol. 2017;15(3):434-43.