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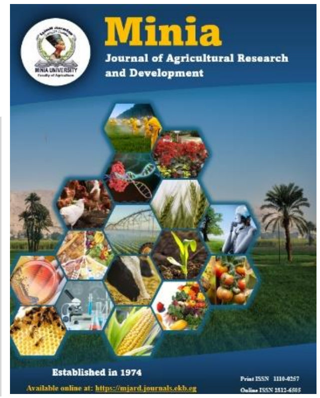

Productive and economical performance evaluation of V-line male growing rabbits as affcted by feed restriction

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ABSTRACT

This study was done to determine the effect of feeding system for growing rabbits to improve the productive and physiological response.. Fourty-five V-line male growing rabbits, average age 5 weeks and weighing average of 742.4±5.4 were used in this study. The experiment was lasted for 6 consecutive weeks. The first group was received free feeding of recommended diet daily and served as a control (**C**), the 2nd group (**G1**), was received 75% of recommended diet daily; the 3rd group (G2), was received free feeding of recommended diet daily for 2 days and fasting for 1 day (skip-a-day system) (G2). Results showed that live body weight and body weight gain of G1 (75%) was significantly ($P \leq 0.05$) higher than Cgroup free feeding while, G2 (skip-a-day system) showing the lowest weight. Body weight gain was higher in G1 in compared with C group and G1 but differences were not significant. Feed conversion ratio (FCR) for all restricted groups G1 and G2 were significantly improved ($P \leq 0.05$) compared with control group (C). The data revealed that G2 (skip-a-aday system) had the lower feed cost, highest net revenue, highest economic efficiency (EE%) and relative economic efficiency (REE%), however, G1 had the highest net profit. Feed restriction in Growing male rabbits showed the most beneficial effects on live body weight, body weight gain, economic evaluation and carcass traits.

Keywords: Productive, economic performance, feed restriction, rabbits.

INTRODUCTION

Rabbit industry can play an essential role in solving a part of the meat shortage and overcoming the gab between demand and supply of animal protein. Rabbits are more suitable than many other types of livestock for producing animal protein for human consumption **(Restogi, 2001).** They are non ruminant's herbivorous animals having small body size, short reproductive cycles and high meat quality **(Maertens, 1992).**

The advantages of rabbits are largely due to their rapid growth rate, high genetic selection potential, efficient feed and land utilization, low rivalry on human meals, and high quality nutritional meat (**Badawi *et al.*, 2016**). Rabbit nutritionists are looking for developing estrategies capable of reducing

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digestive disorders and increasing feed efficiency, so lowering feeding and total production costs (**Maertens 2009**).

In practical condition, a moderate feed restriction in growing rabbits could be used with some advantages in comparison with ad libitum feeding where it increase digestive efficiency. Two primary approaches to feed restriction are commonly employed. The first is qualitative restriction, which involves modifying the composition of the diet such as reducing energy intake by incorporating high-fiber ingredients, particularly for young reproductive females. The second approach is quantitative restriction, which can be implemented by either limiting the duration of access to feed or by reducing the amount of feed offered. Among these methods, the most precise way to control post-weaning feed intake is to provide a fixed daily amount of pelleted feed.; however, this quantity could be given all at once (**Gidenne *et al.,* 2009 b and c**) where the favorable effect of an intake limitation originates from the feed quantity itself or not from the feed distribution technique. Also a quantity restriction can be classified into two classes; a moderate restriction during growth by feeding plans (80% of *ad libitum* from 35 to 77 day; restriction at 70% from 35 to 56 day followed by restriction at 90% from 56 days; and restriction at 90% from 35 to 56 day followed by restriction at 70%).

In fattening rabbits, restricted feed intake has been shown to stimulate compensatory growth and enhance feed efficiency **(Gidenne *et al.,* 2009)**, reduce carcass fat content **(Tůmová *et al.,* 2007)**, and in some cases, lower the incidence of post-weaning digestive disorders, including epizootic rabbit enteropathy **(Di Meo *et al.,* 2007)**.
The objective of this study was to determine the effect of feeding systm for growing rabbits to improve the productive and physiological response of growing rabbits.

MATERIALS AND METHODS

This study was carried out at a private commercial rabbitary farm located in Minia government, Upper Egypt, during the period from December 2020 to March 2021. The aim of experiment was to study the effect of feed restriction (quantity or periodically) on some productive and physiological responses of growing rabbits.

This experiment was designed to investigate the effect of feeding V-line growing rabbits on three systems of feed restrictionas follows in Table 1.

Table 1. The design of the dietary treatments

Groups	Treatments
C	Rabbits fed 100% of recommended daily
G1	Rabbits fed 75% of recommended daily
G2	Rabbits fed 100% of recommended for 2 days followed by fasting for 1 day (Skip-a-day system)

C: Control group, G1: Group 1, G2: Group 2

Experimental animals:

A total number of 45 V-line growing male rabbit aged 5 weeks, were randomly distributed into (3 treatments × 5 replicates × 3 rabbits = 45) rabbits. All rabbits were allocated in cages with slatted floor of iron (made of electrostatic sheets). Each 3 rabbits were housed in one cage. The dimensions of the cage were (45× 45×38 cm) for length, width and hight, respectively. All cages were setup in open house. All rabbits were housed indor 14 hours' light/day during the experimental period (5-11weeks of age). Free drinking water was avaliable throughout nipples (automatic drinkers) during the experimental period. The air temperature, relative humidity and temperature-humidity index (THI) inside the building during the time of the experiment were measured daily at 6 am and 6 pm. The air temperature was ranged between 15 and 34°C, relative humidity was ranged between 19 and 35 and temperature humidity index (THI) was ranged between 18 and 33, which was calculated by using the following equation:

THI = db°C – [(0.31 - 0.31× RH %)×(db°C - 14.4)],

Where: db°C is dry bulb temperature in Celsius and RH is the relative humidity as a percentage. The values obtained are then classified as absence of heat stress (<27.8), moderate heat stress (27.8-28.8), severe heat stress (28.9-29.9) and very severe heat stress (≥30.0) according to **Marai *et al.*, (2001**).

Experimental diets: -

All experimental diets were formulated to contain adequate levels of nutrients for V-line rabbits as recommended by the National Research Council, (**NRC, 2004)**. The chemical analysis of ingredients and diets were determined according to **AOAC (2006)**. The composition and chemical analysis of ingredients and diets were shown in Table 2.

Table 2. Composition and calculated analysis of the experimental diets for growing rabbits

Ingredients%	Experimental diet
Ground yellow corn	38.85
Soya bean meal (44%)	15.60
Alfalfa hay	25.00
Wheat bran	18.75
Lime stone	1.00
Salt	0.50
Premix*	0.30
Total	100
Calculated analysis%	
Digestible energy. (kcal / kg feed)	2542.66
Crude protein %	17.6
Crude fiber %	12.146
Ether extract %	2.67
Calcium %	0.87
Available phosphorus %	0.47
Methionine %	0.79
Lysine %	0.37

*Each 2.5 kg of vitamins and minerals mixture contains:12000.000 IU vitamin A acetate; 2000.000 IU vitamin D3; 10.000 mg vitamin E acetate; 2000 mg vitamin K3; 100 mg vitamin B1; 4000 mg vitamin B2; 1500 mg vitamin B6; 10 mg vitamin B12; 10.000 mg pantothenic acid; 20.000 mg Nicotinic acid; 1000 mg Folic acid; 50 mg Biotin; 500.000 mg chorine; 10.000 mg Copper; 1000 mg Iodine; 300.00 mg Iron; 55.000 mg Manganese; 55.000 mg Zinc, and 100 mg Selenium.

Growth performance parameters:

Live body weight of each replicate group (three rabbits per replicate) was recorded with gram-level precision at biweekly intervals throughout the experimental period, from 5 to 11 weeks of age. Body weight gain per rabbit during each interval was calculated by subtracting the mean initial weight from the mean final weight of that period. A predetermined quantity of feed was offered to each replicate every two weeks biweekly. At the end of each interval, feed refusals and spillages were collected and weighed. Feed intake was determined by subtracting the total residual and scattered feed from the amount initially provided. Individual feed intake was estimated by dividing the total feed consumed by the number of rabbits per replicate. The feed conversion ratio (FCR) was calculated as the total feed intake per unit of body weight gain.

At the end of the experimental period (11 weeks of age) three rabbits were randomly chosen from each treatment. All rabbits were individually weighted and slaughtered after approximately 12 hours of fasting, when complete bleeding was a chivied, slaughter weight was recorded. After skinning the carcass was opened dawn and all entails were removed and empty carcass, heart, liver, kidneys and lungs and so measuring small intestine length, benefit, and feeling were separate and weighted. The carcass was prepared according to the World Rabbit Science Association procedures as described by **Blasco and Ouhayoun (1996)**. Each of them was proportionated to the live pre slaughtering weight. Also skin and head were weighted and expressed as percentage of pre slaughter weight. The economic efficiency of all treatments in the present study was calculated according to the prices of 2021. The feed cost per kg and the price of one kg live weight gain was expressed as Egyptian (L E)

The price of animal pelleted feed during this period was 5600 LE/ton and the sale price of one kg of live weight of rabbits was 50 LE. Economic evaluation for all experimental diets was calculated as the following steps for growth trails:

- Total feed consumption, kg/head/period (a)
- Price of 1 kg of feed, LE (b)
- Total feed cost/ head, LE = (a × b)
- Veterinary cost/ rabbit, LE
- Total cost / head, L.E**
- Total cost / head = Total feed cost/ head + veterinary cost/ rabbit
- Total revenue/ head = Total gain, kg/head × Market price of 1 kg
- Net revenue / head = Total revenue/ head - Total cost / head

$$\text{- Economic efficiency} = \frac{\text{Net revenue}}{\text{Total cost}}$$

$$\text{- Relative economic efficiency\%} = \frac{\text{Economic efficiency of treatments}}{\text{Economic efficiency of control}} \times 100$$

Relative economic efficiency (%) equation by **Barnum and Squire (1978)**

Statistical analysis:

Statistical analysis was carried out using a general linear model (GLM) of the **SAS (2001)** program. The effects of treatments on feed consumption, growth rate, feed conversion ratio, blood parameters, carcass characteristics, nutrients digestibility and feeding value were evaluated by one-way ANOVA. The significant differences between treatment means were tested by Duncan Multiple Range Test (**Steel and Torrie, 1980**). The data are presented as means and MSE. Probability values of less than 0.05 ($P \leq 0.05$) were considered to be significant. Statistical analysis using the following model:

$$\mathbf{Y_{ij} = \mu + T_i + e_{ij}}$$

Where:

Y_{ij} = Experiment observations,
μ = The overall mean,
T_i= The effect of dietary treatment,
i= T1, ----- T3, and
e_{ij} = The experimental error.
Duncan's test was used to examine the significance degrees among means **(Duncan, 1955).**

RESULTS AND DISCUSSION

Live body weight (g) and body weight gain (g):

The effect of restriction strategy on live body weight (LBW) and body weight gain of growing rabbit's males are shown in Table 3. Final body weight in group G1 (1744.09 g) was out performing group C (1684.58 g) and group G2 (1628.00 g) showing the lowest weight. G1's superior growth may relate to hormesis, where mild stress (like reduced caloric intake) can enhance physiological resilience and efficiency **(Mattson, 2008)**. Group G2's weight remains lowest, supporting findings that intermittent fasting leads to slower overall growth rates but may have other benefits such as improved health markers **(Harvie and Howell, 2017)**. The reduction in body weight for G2 may be due to the fasting regimen, as periodic fasting leads to reduced calorie intake, impacting weight gain. Studies have shown that intermittent fasting reduces energy storage and growth rates due to lower caloric availability **(Longo and Mattson, 2014)**. Rabbits in group C and G1 showed no significant difference, suggesting that reducing basal diet by 25% (G1) might not have a drastic effect within two weeks, likely because the body compensates through adaptive mechanisms like increased feed efficiency **(National Research Council, 2001)**. According to **Fontana *et al.*, (2010)**, calorie restriction can enhance nutrient absorption and utilization. Group G2 lower weight reflects the cumulative impact of intermittent fasting, where periodic caloric deprivation slows overall growth. However, the weight difference is not drastic, suggesting partial recovery during the feeding days.

The results in table 3 showed that BWG for restricted groups G1 and G2 were insignificantly affected ($P \leq 0.05$) by feed restriction compared with control group (C). However, the rabbit group feed restriction diet in G2 recorded the lowest daily BWG than the other experimental groups. The decrease in daily BWG for G2 group was 0.23% compared to the control (C) group. Generally, Rabbits fed 0.75 of the basal diet consistently showed higher weight gains than the control after the second week. This might result from metabolic adaptations that enhance feed efficiency. **Fontana *et al.*, (2010)** highlighted that moderate caloric restriction improves longevity and health markers in mammals, potentially due to reduced oxidative stress and improved insulin sensitivity. Rabbits fed basal diet 100% for 2 days and fasting for 1 day (skip-a-day system) consistently lagged in weight gain, demonstrating the impact of intermittent calorie deprivation on growth. Intermittent fasting's effect on growth has been well-documented, with findings showing that fasting can slow weight gain due to reduced energy intake over time **(Longo and Mattson, 2014)**. However, fasting may provide benefits not reflected in weight, such as better immune function and reduced risk of metabolic diseases **(Harvie and Howell, 2017)**. In control group, Rabbits fed 100% basal diet showed steady weight increases but were out performed by G1. This aligns with the idea that *ad libitum* feeding does not always maximize growth efficiency and may lead to suboptimal metabolic outcomes **(National Research Council, 2001)**. The compensatory of growth for restricted rabbit groups G1 and G2 are agreement with findings of **Tůmová *et al.*, (2002, 2003 and 2007)** that referred that, one week of restriction produced compensatory growth. On the other hand, reduced BWG and daily weight gain for G2 group than the other groups might be linked to lower daily feed intake. These findings were described by **Jerome *et al.*, (1998). Gidenne *et al*., (2009) and Martignon *et al*., (2010 a)** demonstrated that during the period of feed restriction in a multi-site study during feed restriction time a linear reduction in feed allowance from weaning (35 days of age) over a three-week period has been shown to induce a corresponding linear decline in growth performance. For example, a 20% decrease in feed intake relative to ad libitum feeding typically results in a similar (~20%) reduction in weight gain. However, this seemingly predictable relationship does not universally apply to growing rabbits. The magnitude of growth reduction observed across different studies varies considerably, indicating that several factors—particularly feed composition—can modulate the growth response to feed restriction. Moderate calorie restriction (G1) optimizes nutrient absorption and reduces metabolic inefficiencies, promoting steady growth **(Fontana *et al.*, 2010)**. Intermittent fasting (G2) reduces growth rate due to caloric deprivation but can improve long-term metabolic health and efficiency **(Longo and Mattson, 2014)**. Overall, G1 rabbits likely balanced caloric intake and metabolic efficiency most effectively, whereas G2 rabbits experienced slower growth due to periodic fasting.

As reported in Table 3 strategy significantly decreased feed consumption for all groups compared with *ad libitum* fed group (control group, C) during restriction strategy. However, the daily FC for G2 group recorded the lowest significantly amount of FC by 32.38 % compared with the control group. This result is agreement with **Tumova *et al.*, (2002 and 2003)** documented that the daily feed intake in restricted fed rabbits was lower than in rabbits fed *ad libitum*. Also, M**osaad, (2007**) reported that the growing NZW female rabbits fed restricted diet consumed significantly lower feed by 27.61 and 24.48 % during 6-10 and 10-14 weeks of ages, respectively as compared to that fed ad libitum**.** Intermittent fasting (G2) decreases voluntary intake even during feeding days, as noted by **Forbes (2007)**. **Diwykar *et al.*, (2008)** found that fasting limits appetite recovery. **Hussein *et al.*, (2020)** noted similar patterns in rabbits under fasting regimens.

Concerning feed conversion ratio, the results showed that feed conversion ratio (FCR) for all restricted groups G1 and G2 were significantly improved ($P \leq 0.05$) by feed restriction compared with control group (C), Table 3. However, FCR was significantly improved for groups exposed to skip-a-day system restriction strategy (G2), since experimental groups G2 and G1 recorded the best FCR compared with the control group (C). This result supposed that feed restriction for skip-a-day system (G2) was the most effective restriction for improving FCR.

These findings are consistent with previous studies reporting that feed restriction can enhance feed efficiency in growing rabbits (**Tůmová *et al.*, 2002; Boisot *et al.*, 2003; Yakubu *et al.*, 2007 and Gidenne *et al.*, 2012**). This improvement is generally attributed to enhanced nutrient digestibility under restricted feeding conditions, as described by **Tůmová *et al.*, (2004) and Di Meo *et al.*, (2007). Tawfeek (1996)** demonstrated that feed conversion efficiency was superior in New Zealand White rabbits fed a restricted diet (80% of ad libitum intake from 5 to 12 weeks of age) compared to those fed ad libitum. Conversely, **Tumova *et al.*, (2003)** reported no significant differences in feed efficiency among different feed restriction regimes in growing rabbits. **Gidenne *et al.*, (2009)** further observed that a 21-day feed restriction period post-weaning led to a linear decrease in feed conversion ratio throughout the fattening period. Notably, restricted rabbits generally exhibited feed intake levels that were lower than or comparable to controls. Additionally,

Martignon *et al.*, (2010) reported that short-term feed restriction may enhance gut immune status, potentially contributing to improved feed conversion. In some cases, feed conversion was markedly improved, with reductions of 40–50% achieved under a 30–40% feed restriction.

Table 3 provided data of growth rate (GR) and performance index (PI) under different feeding treatments reveals important insights into how feed restriction strategies affect rabbit growth and overall performance. Group G2 had the highest growth rate, which is notably higher than both C and G1 groups. This suggests that the fasting protocol (feeding 100% basal diet for 2 days and fasting on the third), Skip -a-day system may have triggered compensatory growth, where rabbits consumed and utilized feed more efficiently during the non-fasting periods (**Tomić *et al.*, 2022**). Fasting periods often increase metabolic efficiency and promote better nutrient partitioning when food is available. Group C which was fed an unrestricted diet (100% basal diet) had a moderate growth rate. Although rabbits had access to food at all times, unrestricted feeding can sometimes result in slower growth rates due to inefficient nutrient utilization, particularly when they eat more than necessary for optimal growth (**Berni *et al.*, 2017**). Group G1 (with 25% feed restriction) had the lowest growth rate, despite the reduction in feed intake. This indicates that the feed restriction may have impaired growth, possibly due to suboptimal nutrient availability or reduced energy intake, which constrained growth potential (**Hornick *et al.*, 2000**).

Concerning performance index, group G2 had the highest performance index, followed closely by Group G1. The performance index is a composite measure that likely incorporates feed intake, growth rate, and feed conversion efficiency. Both group G1 and Group G2 show a better performance index than group C, suggesting that feed restriction (25% reduction or intermittent fasting) improved the overall performance of the rabbits in terms of feed utilization and growth efficiency. The higher performance index in group G1 compared to group C suggests that even though growth rate was lower in group G1, the restricted feeding helped improve feed efficiency by limiting over consumption and encouraging better nutrient absorption (**Berni *et al.*, 2017**). The performance index considers both growth and feed efficiency, thus explaining the higher performance of the restricted groups. Group C, while it had unrestricted feeding, had the lowest performance index, likely due to the inefficiency of unrestricted feeding where rabbits may consume more food than required for optimal growth, leading to lower overall performance (**Forbes, 2007**). Generally, while group G2 achieved the best growth rate and performance index, group G1 also showed better performance than group C, highlighting the benefits of feed restriction in improving feed utilization and growth efficiency.

Table 3. Effect of feed restriction on productive performance of growing rabbits

Tr	IBW, g	FBW, g	BWG, g	FC, g	FCR	GR	PI
C	**748.67**	**1684.58 ^{a}**	**21.46**	**91.228 ^{a}**	**4.01 ^{a}**	**18.15 ^{b}**	**44.58^{b}**
G1	**750.00**	**1744.09 ^{a}**	**21.68**	**73.09 ^{b}**	**3.10 ^{b}**	**7.10 ^{b}**	**58.00^{a}**
G2	**728.60**	**1628.00 ^{b}**	**21.41**	**60.68 ^{c}**	**2.96 ^{b}**	**82.66 ^{a}**	**60.50^{a}**
MSE	**5.37**	**26.03**	**0.50**	**0.92**	**0.06**	**13.96**	**1.65**
***P*-Value**	**.0003**	**<.0001**	**0.92**	**<.0001**	**<.0001**	**0.0002**	**<.0001**

a,b,c, Means in the same column with different superscripts are significantly different, MSE: mean standard error. C: Rabbits fed basal diet 100%, G1: Rabbits fed 0.75 of basal diet daily, G2: Rabbits fed basal diet 100% for 2 days and fasting for 1 day (skip-a-day system)., IBW: initial body weight, FBW: final live body weight, BWG: daily body weight gain, FC: daily feed consumption, FCR: feed conversion ratio, GR: growth rate, PI: performance index.

Carcass characteristics:

Carcass characteristics provide insights into how different feeding strategies impact the growth and development of specific body parts in rabbits (Table 4). These include the proportion of various body components like legs, mid part, shoulders, head and edible organs (liver, kidneys, and lungs) which contribute to both the nutritional value and the economic efficiency of rabbit production. Group C, which had unrestricted access to feed, exhibited the highest carcass percentage. This is likely due to the overall larger body size and higher fat deposition associated with unrestricted feeding, where rabbits accumulate more lean and fat mass as they consume more calories (**Ferraz *et al.*, 2000**). Group G2, which underwent skip-a-day system feed restriction, had the lowest carcass percentage followed by G1. This indicates that feed restriction likely reduced overall body size and muscle mass, leading to a lower proportion of carcass yield. This result is in line with findings from **Forbes (2007)**, who found that restricted feeding can impair overall body growth and the development of lean tissue in rabbits.

Our results revealed that group G1 (75% fasting regimen) had a carcass percentage between group C and group G2. These results are in agreement with **Tomić *et al.*, (2022**) who suggests that fasting, combined with normal feeding periods, may reduce fat accumulation but still allow for adequate muscle growth. G1 likely benefited from compensatory growth, where periods of unrestricted feeding might have enhanced carcass yield despite reduced feeding on fasting days.

Perrier, (1998) reported a significant reduction in dressing percentage only in rabbits subjected to a severe feed restriction (50% of ad libitum intake), whereas rabbits receiving a moderate restriction (70% of ad libitum) showed no significant difference compared to the ad libitum-fed controls. Similarly, **Gidenne *et al.*, (2009)** observed a significant decline in dressing percentage in feed-restricted rabbits (between 34 and 55 days of age) compared to that fed ad libitum. However, no significant differences were found among the restricted groups receiving 80%, 70%, or 60% of *ad libitum* intake.

Group G1 had the highest leg percentage, likely due to the feed restriction promoting leaner muscle growth. Restricted feeding can stimulate muscle development in rabbits because energy is directed more towards muscle synthesis rather than fat storage (**Berni *et al.*, 2017**). Group G2 had a similar result, showing that intermittent fasting did not significantly hinder muscle growth, resulting in leg proportions comparable to Group G1. Group G2 had a lower leg percentage, likely because excess nutrients were used for fat deposition rather than lean muscle growth, as seen in studies of unrestricted feeding in rabbits (**Ferraz *et al.*, 2000**). Group G1 and G2 had significantly higher med part percentages than group C, indicating that both feed restriction and intermittent fasting promoted a higher proportion of muscle tissue. This supports the idea that feed restriction may encourage lean tissue growth while minimizing fat deposition (**Berni *et al.*, 2017**). However, group C, despite having more total body mass, showed a lower proportion of meat, likely due to fat deposition overshadowing muscle growth. The higher meat yield in group G1 and G2 are consistent with findings from **Berni *et al.*, (2017)**, who observed that restricted feeding in rabbits enhances the lean meat yield compared to unrestricted feeding.

The edible organs (liver, kidneys, lungs, heart) percentage was slightly higher in group G1 and G2 compared to group C, which could suggest that the restricted feeding strategies contributed to more efficient organ development or higher proportions of usable tissue. Group G1 and G2 had more pronounced growth in organs like kidneys and lungs, which could reflect more efficient metabolism due to feed restrictions (**Berni *et al.*, 2017**).

Table 4. Effect of feed restriction on carcass characteristics (g) of growing rabbits

Tr	C	G1	G2	MSE	*P*-Value
LBW, g	1765[ab]	1833[a]	1690[b]	29.70	0.0053
Carcass%	53.15[a]	46.62[c]	49.28[b]	0.64	<.0001
Legs%	38.57[b]	42.66[a]	41.05[a]	0.69	.0005
Med_part%	22.21[b]	25.05[a]	25.29[a]	0.27	<.0001
Shoulders%	36.07[b]	39.95[a]	35.69[b]	0.49	<.0001
Edible organs%	11.55	12.28	12.22	0.32	0.5310
Head	11.77[a]	9.06[b]	12.77[a]	0.76	0.0035

[a,b,c] means with the same letter are not significant in the same row. MSE: Mean-standard error. C: Rabbits fed basal diet 100%, G1: Rabbits fed 0.75 of basal diet daily, G2: Rabbits fed basal diet 100% for 2 days and fasting for 1 day (skip-a-day system). Edible organs = liver+kidney+lungs+heart.

Economic efficiency:

Data provided in table 5 comparing the economic efficiency of growing rabbits under three different feeding strategies. The data revealed that group C had the highest total feed cost, corresponding with the highest feed consumption. Group G2 had the lower feed cost due to reduced feed consumption, making it a more cost-effective option for feeding compared to Group C. Group G2 had the lowest feed cost, reflecting both reduced feed consumption and potentially more efficient nutrient utilization due to the fasting days. Concerning net profit, group G1 had the highest net profit, which is likely due to a combination of moderate feed consumption, improved feed efficiency, and optimal growth. Despite the feed restriction, the profit was higher because the growth per unit of feed was maximized. Group C had a significant lower net profit than G1, despite higher feed consumption. This suggests that while feed consumption was high, the return on that investment (in terms of growth) was not as efficient. Group G2 had the lowest net profit, which aligns with the lower growth and feed consumption despite low feed costs. The fasting days reduced overall feed efficiency, affecting profitability. Concerning net revenue, group G2 had the highest net revenue, possibly due to a lower feed cost combined with the economic value of the final body weight, despite lower growth compared to Group G1. Group G1 had the second-highest net revenue, indicating that the feed restriction improved feed utilization, which led to good profitability. While, group C had the lowest net revenue, as its higher feed cost did not result in proportionally higher revenue due to less efficient feed usage.

Generally, group G2 had the highest economic efficiency (EE, %), which indicates that, despite reduced growth, the combination of low feed cost and relatively efficient feed utilization from intermittent fasting provided the best cost-to-benefit ratio. Group G1 had a lower economic efficiency than G2 but still outperformed group C due to better feed utilization from moderate restriction. Group C had the lowest economic efficiency due to high feed consumption and less efficient growth. Group G2 had the highest relative economic efficiency (REE, %), meaning it performed better compared to group C in terms of economic output per unit of feed cost. Group

G1 also had significantly better relative efficiency compared to group C, indicating that feed restriction improved overall cost-effectiveness. Group C is the baseline with a relative efficiency of 100%. However, both restricted feeding strategies (G1 and G2) outperformed group C in terms of feed utilization and economic returns. In conclusion, group G2 showed the best economic efficiency overall, despite having the lowest feed intake and body weight. The fasting protocol reduced feed costs significantly, resulting in higher net revenue and relative economic efficiency. Group G1 was also economically efficient, with moderate feed restriction improving feed conversion, leading to a high net profit despite reduced feed intake. Group C, while producing the highest body weight, was the least economically efficient due to its high feed costs and lower feed utilization efficiency. These findings suggest that feed restriction strategies, especially intermittent fasting (Group G2), can be an effective method to improve the economic efficiency of rabbit production. However, care should be taken to balance growth rates with feed costs to maximize profitability. Our results are in hormony with **Gondret et al., (2005)** who comparisons between free-feeding and restricted feeding and shown that the latter helps reduce production costs while maintaining acceptable performance rates, making it a sustainable option in certain production systems. Also, **Smith et al., (2010)** who revealed that restricted feeding not only leads to cost savings but also maintains animal performance at desirable levels, making it a more efficient and sustainable choice in intensive production systems. Restricted feeding has been found to improve feed conversion efficiency, reduce waste, and lower feed costs without compromising growth rates, offering a sustainable solution in various agricultural practices **(Johnson & Davis, 2012).** In comparison to free-feeding, restricted feeding has demonstrated greater efficiency in managing feed resources, reducing waste, and ensuring consistent performance, positioning it as a viable strategy in modern livestock production **(Hernandez et al., 2014). Brown and Roberts, (2007)** indicates that restricted feeding systems can lead to reduced feed costs while still achieving optimal production outcomes, making it an attractive option for cost-effective and sustainable farming.

Table 5. Effect of feed restriction on economic efficiency of growing rabbits

Tr	FBW, g	TFC, g	FC, L.E.	NP, L.E.	NR, L.E.	EE, %	REE, %
C	1684.58[b]	3831.30 [a]	19.16[a]	50.54 [b]	2.64 [c]	13.78 [c]	100
G1	1744.09[a]	3069.75 [b]	15.35[b]	52.32 [a]	3.41 [b]	22.21 [b]	161.18
G2	1628.00[c]	2548.59 [c]	12.74[c]	48.84 [c]	3.83 [a]	24.20 [a]	175.62
MSE	5.37	26.03	0.50	0.92	0.06	13.96	12.323
P-Value	.0003	<.0001	0.92	<.0001	<.0001	0.0002	<.0001

[a,b,c] means with the same letter are not significant in the same row. MSE: Mean-standard error. C: Rabbits fed basal diet 100%, G1: Rabbits fed 0.75 of basal diet daily, G2: Rabbits fed basal diet 100% for 2 days and fasting for 1 day (skip-a-day system). FBW, g = final boy weight, TFC, g = total feed consumption, FC = total feed cost, NP = net profit, NR = net revenue, EE = economic efficiency and REE = Relative economic efficiency.

Net revenue = Selling price/rabbit (LE) –Total feed cost/ rabbit (LE)

Economic efficiency = Net revenue /Total feed cost/ rabbit (LE)

Relative Economic Efficiency= Economic efficiency of treatments other than the control / Economic efficiency of the control group.

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الملخص العربي

الأداء الإنتاجى والإقتصادي للأرانب النامية تحت تاثير التحديد الغذائي

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أجريت هذه التجربة لدراسة تأثير التحديد الغذائى على الأرانب النامية لتحسين أدائها الإنتاجي وإستجابتها الفسيولوجية. تم توزيع 45 أرنب فى لاين عمر 5 أسابيع بوزن إبتدائى متوسط 742.42±5.73 جم بشكل عشوائي في ثلاثة مجموعات تجريبية بعدد 15 بكل معاملة، المجموعة الأولى غذيت على 100% من المقرر الغذائى وحفظت كمجموعة مقارنة، المجموعة الثانية غذيت على 75% من المقرر الغذائى اليومى بينما غذيت المجموعة الثالثة على 100% من المقرر الغذائى لمدة يومين متصلين مع الصيام يليهم يوم بدون غذاء طوال فترة التجربة والتى إستمرت 6 أسابيع (من عمر 5 أسابيع حتى 11 أسبوع).

أظهرت النتائج تفوق المجموعة الثانية 0.75 مع وجود فروق معنوية على مستوى (P<0.05) في وزن الجسم النهائي (FBW)، بينما كانت المجموعة الثالثة هى الأقل، كما تفوق المجموعة الثانية أيضا 0.75 مع عدم وجود فروق معنوية على مستوى (P<0.05) في الزيادة في وزن الجسم (BWG). كمية العلف المستهلك (FC) إنخفضت فى المجموعات المعامله مقارنة بالمجموعة الضابطة، أما معدل التحويل الغذائي (FCR) فقد تحسن فى المجموعتين المعاملتين مقابل الكنترول، وأظهرت مجموعة الكنترول C أعلى نسبة للذبيحة بينما كانت أقل نسبة في المجموعة G2 .وايضا زادت نسبة الأعضاء الماكولة مثل الكبد والكلى في المجموعة الاولي G1 والثانية G2مقارنة بـ الكنترول C.وسجلت المجموعة الثالثة أفضل مؤشر للكفاءة الاقتصادية وصافي الإيرادات ومؤشر أداء التكلفة مقارنة بباقى المجموعات.

الاستنتاج: التحديد الغذائى للأرانب النامية له تأثيرات إيجابية على وزن الجسم الحي، والزيادة المكتسبة فى وزن الجسم والكفاءة الإقتصادية وكذلك صفات الذبيحة.