PRODUCITIVE AND ECONOMIC EFFICIENCY OF GROWING RABBITS FED TWO LEVELS OF PROTEIN

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ABSTRACT
Eighty male New Zealand White (NZW) rabbits aged 5 weeks, with average body weight 823.17±11.13 g were randomly distributed into two experimental groups (40 each) till 10 weeks of age. The 1⁰ group (T₁) received diet contains 17% CP (low) vs. 19% CP (high) for 2⁰ group (T₂), respectively. Initial and final body weight (IBW and FBW), feed intake (FI), daily body weight gain (DBWG), feed conversion ratio (FCR), and an economic evaluation were determined.

Results showed that the rabbits in T₁ group significantly improved FBW, DBWG and performance index (PI) in T₁. However, daily feed intake (DFI), and FCR were increased in T₁ compared with T₂. Feed intake cost was significantly lower in T₁ than T₂. While, net profit (LE) was significantly higher in T₂. Finally, Rabbits in T₁ were significantly higher in net revenue and relative economic efficiency than rabbits in T₂.

Conclusively, from these results it could be concluded that using 19% CP in growing rabbits diet improved productive performance but 17% CP achieve good economic efficiency.

Key words: Crude protein levels, economic efficiency, growing rabbits.

INTRODUCTION
Protein is an important component for life processes, as a material for renewing and repairing tissues (Wang et al., 2019). Nowadays, the rabbits industry is facing several challenges perhaps the most prominent is the increasing price of protein sources in feedstuff. Reducing the cost of feedstuff has become a primary goal for producers, provided that achieving production efficiency.

Feed accounts for the largest part of the production costs in animal production, and could reach up to 70% of total costs according to the investments. Therefore, feed efficiency is a key criterion to improve the sustainability of the farm, both to improve economic balance and to reduce the environmental releases. During last year, rabbit meat production is progressively declining in Egypt due for increasing the price of feedstuff materials as a result of repercussions of Russian-Ukrainian war. Reducing the
cost of feedstuff has become a primary goal for producers, provided that achieving production efficiency. The main challenge facing rabbit producers is realizing the balance between decreasing cost and maintaining or increasing benefits (Krupovà et al., 2020). Replacing and reducing protein source is the modern research direction that is carried out to reduce the level of protein in diets for achieving the economic benefit by minimizing the input (Ros-Baró et al., 2022). Feeding low levels of crude protein caused of the reduction of nitrogen excretion, this is of special importance to decreasing the environmental pollution in areas with a high density of animal production (Birolo et al., 2022).

Protein sources are the most expensive component in animals and poultry diets, so the try to reduce the level of protein in diets may be achieve economic benefit because the reduction in protein level will be reduce total cost of diets. In addition to the negative effects on rabbits that related to increasing protein levels in diets such as caecal fermentations and alter gut microflora composition and that considered to be among the causes of increased mortality in rabbits (Caraban et al., 2009 and De Blas and Mateos 2010).

Hemid et al. (2015) reported that productive performance hadn’t affected significantly with weaned rabbits when fed diets with different levels of protein. The growth rate of rabbits fed the protein 14.6% diet was close to that of rabbits fed the protein 16.5% diets and FCR was not significantly affected by the different protein levels in diet (Berchiche et al., 1995).

Therefore, the aim of this study is to investigate the impact of two protein levels (17 and 19%) in growing rabbit diets on productive performance and economic evaluation of New Zealand White (NZW) growing rabbits.

MATERIALS AND METHODS

Animal and diets:

This experiment was carried out at a private farm of rabbit’s production, Menia El-Kamh, El-Sharkia Governorate, Egypt. Experimental design and protocol within this study were conducted according to ethical guidelines approved by the experimental animal care and research ethics Committee of Ain Shams University, Agriculture sector Committee (Approval No 5-2023-3).

Eighty weaning males of New Zealand White (NZW) rabbits about 5 weeks of age with average initial body weight 823.17±11.13 g were randomly distributed into two experimental groups (40 each) till 10 weeks of age during December 2022 to January 2023. The basal diet composition was formulated to cover all essential nutrient requirements for growing rabbits according to NRC (1977). Feed were allowed to a standard pelleted diet all times containing 17% (T1) or 19% (T2) crude protein (Table 1). Fresh water was
**Table 1.** Composition and calculated chemical analysis of the diets fed to rabbits during the experimental period

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>( T_1 ) (low)</th>
<th>( T_2 ) (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow corn</td>
<td>24.00</td>
<td>22.40</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>27.00</td>
<td>20.00</td>
</tr>
<tr>
<td>Soybean meal (44%)</td>
<td>9.00</td>
<td>17.00</td>
</tr>
<tr>
<td>Sunflower meal (36%)</td>
<td>9.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Alfalfa (17%)</td>
<td>19.85</td>
<td>18.00</td>
</tr>
<tr>
<td>Wheat bran hay</td>
<td>7.30</td>
<td>10.00</td>
</tr>
<tr>
<td>Molasses</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>D-Calci um Phosphate</td>
<td>1.55</td>
<td>1.60</td>
</tr>
<tr>
<td>Lime stone</td>
<td>1.10</td>
<td>0.80</td>
</tr>
<tr>
<td>Salt</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Premix(^1)</td>
<td>0.30</td>
<td>0.30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

**Calculated chemical analysis of diets on DM basis**

<table>
<thead>
<tr>
<th></th>
<th>( T_1 ) (low)</th>
<th>( T_2 ) (high)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE (Kcal/Kg)</td>
<td>2595</td>
<td>2600</td>
</tr>
<tr>
<td>CP%</td>
<td>17.00</td>
<td>19.00</td>
</tr>
<tr>
<td>CF%</td>
<td>12.23</td>
<td>12.11</td>
</tr>
<tr>
<td>EE%</td>
<td>2.90</td>
<td>3.06</td>
</tr>
</tbody>
</table>

\(^1\) Each 1 Kg of the Premix contains: Vit. A 2000000 IU; Vit. D\(_3\) 150000 IU; Vit. E 8.33 g; Vit. K\(_1\) 0.33 g; Vit. B\(_1\) 1 g; Vit. B\(_2\) 1.09 g; Vit. B\(_3\) 0.33 g; Vit. B\(_5\) 8.33 g; Vit. B\(_6\) 1.7 mg; Pantothenic acid 3.33 g; Folic acid 0.83 g; Biotin 33 mg; Choline chloride 20 g; Mg 66.79 g; Zn 11.79 g; Fe 12.5 g; Cu 0.5 g; I 0.3 g; Se 16.6 mg; Co 1.33 mg and carrier CaCO\(_3\) up to 1000 g.

\(^2\) According to NRC (1977).

automatically offered all times. Animals were kept under similar management and hygienic conditions and were healthy and clinically free of external and internal parasites. The lighting program provided was 16 hrs. light per day.

**Data collection:**

Initial and final live body weight (IBW and FBW), feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) was recorded. The price of weaning litter (PWL), total feed intake cost (TFIC), total cost (TC), net profit (NP), net revenue (NR), economic efficiency (EE) and economic efficiency (EE) were estimated according to Egyptian marketing price and determined according to El-Speiy et al., (2015).

**Statistical analysis:**

All data were subjected to analysis of variance according to Snedecor and Cochran (1982), using the general linear model (GLM) procedure of base SAS® (SAS, 2002).
The differences among groups means were Duncan's multiple range test (Duncan, 1955).

**RESULTS AND DISCUSSION**

**Growth performance:**

Table 2 showed the effects of crude protein levels in rabbit's diets on LBW, DBWG, DFI, FCR and PI. The results showed that FBW, DBWG and PI significantly (P≤0.05) increased in T2 compared to T1 group. DFI and FCR were significantly lower in T2 than T1.

Many researchers have studied the effect of dietary protein levels on productive performance of growing rabbits. Although protein levels were different, all researchers thought that low dietary protein levels can reduce productive performance and high dietary protein levels can increase economic profit and gain.

Results agreed with Lie et al., (2004) found that the average daily gain was the highest and feed conversion rate was the lowest when dietary CP reached 20%, namely 34.9 g/d and 2.74:1, respectively. Maximum CP digestibility was 72.1% in the 18% CP group, maximum crude fiber digestibility of 28.4% occurred in the 16% CP group and was significantly different from other treatments (P≤0.05). Lang (1981) and Tang (1987) who reported that the feed conversion ratios for dietary 17%-20% crude protein were higher than that for 16%. Also, Omole (1982) reported that the appropriate crude protein level for meat rabbits was 18%-22%. It is believed that the dietary crude protein requirement of growing rabbits is 16%, which comes from NRC (1977). Wang (1991) pointed out that the average daily gain and feed conversion ratio were the best when the dietary crude protein level was 15.3%-17.9%. Also, Wang (1999) reported that the body gain and feed consumption were ideal when the dietary crude protein level was only 16.5%. Xu (1982) reported that many traits were the best for 6 to 14 week-old rabbits when dietary protein was 17%.

On the other hand, Abo El-Maaty et al., (2023) showed that rabbits fed diet containing low crude protein (15%) supplemented with 3 kg of probiotic ZADO/ton feed had significantly heavier final body weight and increased DBWG, PI and FI compared with control group (17% CP) while, FCR was decreased by 4.46% compared with control group. Birolo et al., (2022) who showed that the different levels of protein in rabbit diets didn’t affected significantly in LBW and BWG of rabbits. Xiccato et al., (2011) who reported that the reducing in protein level in rabbit diets hasn’t significant effect on FCR.
PRODUCTIVE EFFICIENCY OF RABBITS FED TWO LEVELS OF PROTEIN

Table 2. Growth performance of NZW rabbits fed two protein levels

<table>
<thead>
<tr>
<th>Items</th>
<th>Experimental groups</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T₁ (low)</td>
<td>T₂ (high)</td>
</tr>
<tr>
<td>IBW, g</td>
<td>837.11 ± 10.08</td>
<td>809.23 ± 12.18</td>
</tr>
<tr>
<td>FBW, g</td>
<td>2161.58 ± 17.15</td>
<td>2221.92 ± 20.73</td>
</tr>
<tr>
<td>DBWG, g</td>
<td>37.84 ± 0.46</td>
<td>40.36 ± 0.56</td>
</tr>
<tr>
<td>DFI , g</td>
<td>125.06 ± 9.13</td>
<td>121.71 ± 9.05</td>
</tr>
<tr>
<td>FCR</td>
<td>3.35 ± 0.04</td>
<td>3.03 ± 0.05</td>
</tr>
<tr>
<td>PI</td>
<td>65.88 ± 1.33</td>
<td>73.96 ± 1.61</td>
</tr>
</tbody>
</table>

a, b Means bearing different litter superscripts in the same row differ significantly (P≤0.05).
NS= Non-significant, *= Significant (P≤0.05) and **= Significant (P≤0.01).
IBW= Initial body weight, FBW= Final body weights, DBWG= Daily body weights gain, DFI= Daily feed intake, FCR= Feed conversion ratio and PI= Performance index.

Economic evaluation:

The economic efficiency (EE) of using two levels of crude protein in rabbits diet showed that the rabbits which received low crude protein (T₁) achieved the best significant EE (17.20%) in compared to high crude protein (T₂) (15.40%) because of the price of protein source. We found that significant differences in the most economic traits (Table 3 and Figures 1 and 2). Data presented in Table (3) showed that no significant differences in the price weaning litter (PWL) and price of body weight gain (PBWG). Total feed cost (TFC) in T₁ had a positive difference in compared to T₂. Net profit (NP) and net revenue (NR) which is considered a positive indicator that T₁ better than T₂ economically (Table 3). T₁ showed significant differences in economic efficiency (EE) which a good evidence for the high benefits occurred than T₂. Marginal cost to produce 1 kg of meat was reduced by 4.00 LE (7.69%) in rabbits group T₁ compared with T₂ (Fig. 1) and total cost was reduced 5460 LE for produced one ton of meat rabbits in T₁ compared with T₂ (Fig. 2).

Results agreed with Abo El-Maaty et al. (2023) who found that net profit, net revenue and relative economic efficiency were the highest when the dietary crude protein level was only 15% with multi enzymes supplementation compared with that 17% crude protein in control group. Sara (2021) obtained that final weight of rabbit was recovered and feed conversion ratio was improved by feed restriction. She concluded that feed restriction at levels of 30 or 40% during the first two weeks after weaning had beneficial effects on rabbit growth performance, improved feed conversion and economic efficiency. Birolo et al., (2016) reported that restriction program (93% of ad libitum) during the first period improved rabbit health status in the fattening sector without negative effects on growth performance. The EE can be improved with decreasing feeding cost through using strategy of feed restriction which gave a
Table 3. Economic efficiency of NZW growing rabbits fed two protein levels

<table>
<thead>
<tr>
<th>Items</th>
<th>( T_1 )</th>
<th>( T_2 )</th>
<th>SEM</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>live body weight, g (A)</td>
<td>2161.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2221.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>102.6</td>
<td>*</td>
</tr>
<tr>
<td>body weight price, L.E./kg (B)</td>
<td>60.00</td>
<td>60.00</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Net profit, L.E./rabbit (C)**</td>
<td>129.69&lt;sup&gt;b&lt;/sup&gt;</td>
<td>133.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>11.6</td>
<td>*</td>
</tr>
<tr>
<td>Total feed intake, kg (D)/5 weeks</td>
<td>4.38&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.9</td>
<td>*</td>
</tr>
<tr>
<td>Price of kg feed, L.E. (E)</td>
<td>13.80</td>
<td>15.72</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Feed intake cost, L.E. (F)**</td>
<td>60.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>66.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.7</td>
<td>*</td>
</tr>
<tr>
<td>Weaned rabbits cost, L.E. (J)</td>
<td>50</td>
<td>50</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total cost, L.E. (H)**</td>
<td>110.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>116.98&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.4</td>
<td>*</td>
</tr>
<tr>
<td>Net revenue L.E. (I)**</td>
<td>19.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.35&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.8</td>
<td>*</td>
</tr>
<tr>
<td>Economic efficiency (G)**</td>
<td>17.43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.98&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.8</td>
<td>*</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> Means in the same row with the same letters are not significantly different (P≤ 0.05)

SEM: Mean standard error NS: Non-significant, *: (P≤ 0.05) and **: (P≤ 0.01).

*calculations included period from 35 to 70 day-old, fixed cost = Price of weaning live rabbit + care + electricity + vaccination ….ect according to price in January 2023.

** \( C= \text{A\times B, F=} \text{D\times E, H=} \text{F+J, I=} \text{C-H, G=} \text{I/H\times 100}. \)

beneficial effect of feeding utilization and weight gain (Sara, 2021). Birolo <i>et al.</i> (2017) found that growth rate of rabbits did not affect by rabbits exposed to feed restriction. Gidenne <i>et al.</i>, (2003) observed that feed restriction for rabbits caused to an improvement in weight gain and marketing weight. Tumova <i>et al.</i>; (2003) demonstrated that FBW of rabbits did not affect by feed restriction.

Sara (2021) found that EE values were significantly high when feed restricted by 40% compared with control group. Romero <i>et al.</i> (2010) observed that rabbits exposed to feed restriction (fed 8 hours daily at 2 weeks after weaning) had low mortality rate because of feed restriction reduced bloated abdomen, relatively low body weight, diarrhea. Oliveira <i>et al.</i> (2012) found that feed restriction had best EE of growing rabbit compared with the control group. Also, Gidenne <i>et al.</i> (2003) reported that weaning rabbits fed restricted diets reduced feeding cost and decreased the health risk which leads to the beneficial effect on EE.

Amer and Fox (1992) derive economic weights from marginal costs curves. Marginal economic values have been estimated predominantly using a profit function developed by Armero and Blasco (1992) and adapted for specific conditions (Cartuche <i>et al.</i>., 2014).
PRODUCTIVE EFFICIENCY OF RABBITS FED TWO LEVELS OF PROTEIN

Conclusively, from these results it could be concluded that using 19% CP in growing rabbits diet improved productive performance but 17% CP achieve good economic efficiency.

ACKNOWLEDGEMENT:
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REFERENCES


الكفاءة الإنتاجية والأقتصادية للأرانب النامية المغذاة على نسبتين من البروتين الخام

محمد عبد العزيز الصاوي٣ - أحمد مصطفى إمام٣ - أحمد محمد تمام٢

١. معهد بحوث الأنتاج الحيواني – مركز البحوث الزراعية – مصر.
٢. كلية الزراعة – جامعة عين شمس – قسم تغذية الدواجن.

١. استخدم في هذه التجربة عدد ٨٠ ذكر أربعة مقطوع عمر ٥ أسابيع بمتوسط وزن ١٧.٨٢± ١٧.٨٣ جم من سلالة البوزاتيند الأبيض، بهدف دراسة تأثير نسبة البروتين الخام في الفعلي على الكفاءة الإنتاجية والأقتصادية للأرانب النامية، حيث تم توزيعهم عشوائيا على مجموعتين (٠٠) بكل معاملة) حيث تلقىت المجموعة الأولى علقة تحتوي على ١٨% بروتين خام (T١) والمجموعة الثانية (T٢) تم تقدير وزن الجسم الإيدادي ثم أسبوعيا حتى عمر ١٠ أسابيع، وكمس العلب بالأكل والزيادة المكنتسة في وزن الجسم ومعدل التحويل الغذائي كما تم تقييم إقتصادي في نهاية التجربة.

٢. وقد أوضح النتائج مايلي:

- زيادة نسبة البروتين الخام في علقة الأرانب النامية إلى ١٦% (T٢) كان لها تأثير دافع لأداء النمو مثمناً في زيادة وزن الجسم النهائى مقارنة بالمجموعة الأولى التي تم تغذيها على علقة تحتوي ١٦% بروتين خام.

- المجموعة الثانية (T١) توقفت معنويًا على مستوى ٠.٠٥% في متوسط الوزن اليومي المكاسب على المجموعة الأولى (T١)

- إنخفضت كمية الغذاء المكمل يوميًا في المجموعة الثانية (T١) مقارنة بالمجموعة الأولى (T٢) (FCR).

(PI) - لوحظ تحسن معنوي في دليل الكفاءة (PI) بالمجموعة الثانية (T٢) مقابل المجموعة الأولى (T١).

- انخفضت كفاءة معنوي على مستوى ٠.٠٥% بالمجموعة الأولى (T١) مقابل المجموعة الثانية (T٢).

- انخفضت كفاءة الإقتصادية بالمجموعة الأولى (T١) مقابل المجموعة الثانية (T٢).

التوصية: تخصص الدراسة إلى أن علقة الأرانب النامية المخفضة البروتينات ١٦% كافية لتغطية احتياجات الأرانب النامية بينما، العلائق التي تحتوي على نسبة بروتين خام ١٨% لها تأثير إيجابي على كفاءة النمو إلا أنها خفضت الكفاءة الإقتصادية.