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GROWTH PERFORMANCE, NUTRIENT DIGESTIBILITY, NITROGEN BALANCE, AND CARCASS CHARACTERISTICS IN RABBITS FED DIETS SUPPLEMENTED WITH *PANICUM MAXIMUM* CV. MOMBAÇA HAY

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ABSTRACT

The present study aimed to investigate the effects of partial replacement of berseem hay (BH) with different levels of *Panicum maximum* cv. mombaça hay (*Pm*H) in rabbit diets on growth performance, digestibility, carcass traits and economic efficiency. Sixty weaned male New Zealand White (NZW) rabbits about 6 weeks old (average body weight 701.15 g) were randomly allotted into four dietary groups in a completely randomized design experiment. The control group was fed a basal diet including 300 Kg/Ton of BH (D1); whereas, *Pm*H was incorporated into the other three experimental diets at levels 30, 60, and 90% in place of the dietary BH to represent the treatments D2, D3 and D4, respectively. The experimental period lasted for 8 weeks.

Results showed that D4 had the best ($P \leq 0.05$) final body weight, body weight gain and feed conversion ratio. Dietary *Pm*H improved digestibility coefficients of DM, OM, CP, EE and nutritive values as TDN and DCP. Including *Pm*H in the tested diets slightly improved the digestible coefficients of CF as compared with the control diet. The D4 significantly ($P \leq 0.05$) increased N-intake, digestible N, retained N, the utilization efficiency of N and TVFA's production in caecum, while it significantly ($P \leq 0.05$) decreased urinary-N (g/day) and NH_3-N (mg\100 dL) production in caecum compared with D1 (control). Also, D2 significantly ($P \leq 0.05$) increased carcass weight and total edible parts. D4 achieved the best profit per feed unit (2.01 £E/ Kg diet) and REE (136%).Conclusively, *Pm*H may become a promising unconventional feed ingredient in growing rabbits feeding.

1. INTRODUCTION

No doubt, the prices of the imported feed components were elevated in Egypt, which led to a substantial drop in rooster production and high price of meat and fish. The crucial action is therefore vital for solving the problems, plus increasing rabbit's production. Rabbit meat is high quality and safe. Rabbit is appropriate to be raised for meat production due to its high feed conversion competence, high fecundity, and short generation interval (**1**). Moreover, rabbits use the protein more efficiently than broilers and up to 20% roughage can be included in their diet (**2**). In these circumstances, it is imperative to search non-traditional feeds in animal feeding having low cost and to raise the product and decreasing the marketing price of rabbit products. On the other side, with a lack of arable land, water and feed ingredients in many countries, rabbits can help in food production by converting many agricultural by-products into meat. Generally, there is no need to use major forages for rabbit feeding, and there is no need to use grains that are fit for human consumption. The gradient of what ingredients can be combined into rabbit feed is huge and growing continuously (**3**). Rabbit diets are formulated basically with plants and soybean meals as the main source of protein. The addition of roughage, including grasses and legumes, represents approximately 350 g/kg to 400 g/kg of feed composition. Use of grasses and shrub leaves by herbivores may be limited by the adverse effects of secondary complexes on digestion (**4 -7**). Rabbits have an acute sense of smell that enables them to find accepted plants. When they find a spot with available feeds, they will come back time and again until the supply is gone.

The Egyptian *Pm* is a tall grass growing in Egypt in the early times. It is generally found in arid land, such as Nobaria. This grass was traditionally used in the west and central Africa and others in the tropical regions of South America and Asia as a fiber source in the diet of growing rabbits (**8**). It is also an auspicious feed supply because of its numerous compensations such as its high nutritive value, where it contains 10.5% CP, 2.5% EE, 30.4% CF, and 7.5% ash as reported by **(27).** Most research has discussed this material at low doses or supplemented as fresh. Rabbits fed *Pm* recorded the highest feed intake compared to other forages as *Centrosema pubescens* and *Sida acuta* was observed by (**9**). Moreover, Rabbits fed concentrate mixture plus *Pm* (1:2) had developed weight gain values compared with those received the same dietary ratio (1:2) of concentrate mixture with *Myrianthus arboreus* or concentrate mixture with *Gmelina arborea* **(10).**

The impartiality of the current work was to study the consequence of feeding of growing rabbits on graded levels of *Pm* hay partial replacer of berseem hay on growth performance, digestibility coefficient of nutrients, nitrogen metabolism, carcass traits and economic efficiency.

2. MATERIALS AND METHODS

2.1. Experimental rabbits and management

The experimental work of this study was carried out at Nobaria Animal production Research Station, Beheira Governorate, Animal Production Research Institute, Egypt from October 2020 to March 2021. Sixty male New Zealand White (NZW) rabbits aged 42 days with an average body weight of 701.15 g, were divided into four equal groups (fifteen animals per each) in a completely randomized design experiment. Rabbits were individually housed in galvanized wire cages (30 × 35 × 40 cm). Stainless steel feeders and nipples for drinkers were supplied for each cage. Feed and water were offered *ad libitum*. The feeding period was extended for 56 days. During the experimental period, both the weight and the consumed feed intake were recorded weekly per rabbit. Rabbits of all groups were kept under the same management conditions.

2.1.1. Experimental diets

Pm cultivated in the newly reclaimed land at Nobaria, Beheira Governorate, Egypt were collected, sun-dried, chemically analyzed according to (11) and kept in clean bags until diet formulation. *Pm*H was incorporated into four the experimental diets at graded levels 0,30, 60, and 90% as a partial replacer the dietary berseem hay (BH) to represent the treatments D_1, D_2 ,D_3 and D_4, respectively. The basal diet was formulated and pelleted to cover the nutrient requirements of rabbits, according to (**12**) as shown in Table 1.

Table 1. Formulation of the experimental diets (Kg/Ton)

Ingredients	Experimental diets			
	D1	D2	D3	D4
Berseem hay	300	210	120	30
Panicum maximum cv. Mombaça hay	–	90	180	270
Barley grains	220	220	220	220
Plant Concentrate	20	20	20	20
Yellow corn	80	80	80	80
Wheat bran	148.4	148.4	148.4	148.4
Soybean meal 44% CP	180	180	180	180
Molasses	30	30	30	30
Limestone	10	10	10	10
Di-calcium phosphate	5	5	5	5
Sodium chloride	3	3	3	3
Premix [1]	3	3	3	3
DL-Methionine	0.6	0.6	0.6	0.6
Price in (£E [2]/ Ton)	5900	5700	5500	5300

[1] **Premix ,Vitamins and Minerals Mixture which Each kilogram of it contains: 2000.000 IU Vit. A, 150.000 IU Vita. D, 8.33 g Vit. E, 0.33 g Vit. K, 0.33 g Vit. B1, 1.0 g Vit. B2, 0.33g Vit. B6, 8.33 g Vit. B 5, 1.7 mg Vit. B 1,2 3.33 g Pantothenic acid, 33 mg Biotin, 0.83g Folic acid, 200 g Choline chloride, 11.7 g Zn, 12.5 g Fe, 16.6 mg Se, 16.6 mg Co, 66.7 g Mg and 5 g Mn.**

[2] **Price =£E, Egyptian pounds.**

Rabbits were individually housed in galvanized wire cages (30 x 35 x 40 cm). Stainless steel nipples for drinkers and feeders allowing recording individual feed intake for each rabbit were supplied for each cage. Feed and water were offered ad libitum. Rabbits of all groups were kept under the same management conditions and were individually weighed and feed consumption was individually recorded weekly during the experimental period.

2.2. Digestibility and nitrogen balance trials:

At the end of the experimental period, all rabbits were used in digestibility trials over a period of 7 days to determine the nutrient digestibility and nutritive values of the tested diets. Amounts of daily feed intake were recorded. Feces were daily collected quantitatively. Representative samples of feces were dried at 60 °C for 48 hours, ground, and stored for proximate chemical analysis. Samples of feed and feces were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), and ash according to the (**12**) classical methods. The nitrogen-free extract (NFE) was calculated by difference. The nutritive value of the experimental diets as DCP and TDN value were calculated according to **(13)**. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were also determined in the experimental rations according to **(14).**

Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL. Gross energy [GE , kilo calories (kcal) per kg DM] was calculated according to **(15),** where: CP=5.65 kcal/g, each g of EE=9.40 kcal/g and both of CF and NFE =4.15 kcal/g. Digestible energy (DE) was calculated according to **(16)** using the following equation:

DE (kcal/ kg DM) = 4253 - [32.6 (CF %)] –[144.4 (total ash)].

Non-fibrous carbohydrates (NFC) were calculated according to **(17)** using the following equation:

NFC = 100 - (CP + EE + Ash + NDF).

The condensed tannins (CT) of *Pm*H were determined according to **(18),** phenolic compounds were determined using the high-performance liquid chromatography using the procedure **(19).**

The urine of each animal was collected in a glass recipient, containing 10 ml of a HCl: H_2O solution (1:1), to avoid bacterial production and possible losses by volatilization.

The values of nitrogen consumption, nitrogen excreted in feces, and nitrogen excreted in urine were determined. The nitrogen balance (Retained nitrogen) was calculated as a percentage of nitrogen intake.

2.3. Slaughtering and carcass traits:

At the end of the experimental period, six male rabbits were randomly taken from each treatment, fasted for 12 hours, weighed individually and slaughtered immediately. Slaughter procedure and carcass analysis were carried out as described by **(21).** After complete bleeding, pelt, viscera and tail were removed then the carcass and its components were weighed as edible parts. The non-edible parts including lung, spleen, stomach, large intestine, small intestine, and kidney fat were also weighed as a percentage of pre-slaughter weight. The dressing percentage was calculated by dividing the hot-dressed carcass weight of pre-slaughter weight and expressed as a percentage according to (**22**).

Gastrointestinal tracts were individually removed from three slaughtered rabbits from each group, weighted cecum and measured the pH of the caecal content by a digital pH meter (Model 20, Digital pH meter for Orion Research). Then, to determine total volatile fatty acids ((TVFA's ,mmol/100 ml**)** and ammonia nitrogen NH_3-N (mg\100 dL) by steam distillation (UDK 139- Semi - Automatic Distillation Unit), (**20**).

2.4. Relative economic efficiency:

The relative economic efficiencies of the experimental diets for the cost of feed required for producing one kg of body weight gain were calculated. The cost of the experimental diets was calculated according to the prevailing prices of all feed ingredients in the local market at the time of experimentation. Economic efficiency was calculated as a ratio between the profit and the cost of the consumed feed.

2.5. Statistical Analysis:

The experimental design was completely randomized using the General Linear Means of **(23).** Measured parameters were analyzed using the following statistical model:

$$Yij = \mu + di + \varepsilon ij .$$

Where yij is the value measured, μ is the overall mean effect, di is the i^{th} diet (i = 1,…., 4) effect and εij is the random error associated with the j^{th} rabbits assigned to the i^{th} diet. Significant differences of $P \leq 0.05$ among means were determined using **(24).**

3. RESULTS

3.1. Chemical analysis of berseem hay, *Pm*H and the tested diets

The proximate chemical composition and cell wall constituents (CWC) of *Pm*H ,BH and the experimental diets are presented in Table 2. Contents of DM, OM, CP, CF, EE, NFE, ash, GE, DE, NFC and CWC (hemicelluloses, cellulose, and ADL) with *Pm*H seemed to be around those with BH. The experimental diets were isocaloric and isonitrogenous. Protein contents for the four tested diets (17.11 to 17.19%), also the values of the DE (2553.7 to 2584.3 kcal/ kg DM) were similar.

The *Pm*H contained considerable concentrations of secondary metabolites including condensed tannins (CT) and other phenolic compounds (Table 2). There is no CT in BH, while *Pm*H had a relatively moderate content.

3.2. Nutrients digestibility and nutritive values of the experimental diets

Digestibility coefficients and nutritive values (%) of the experimental diets are shown in Table 3. Dietary treatments had no significant effects on CF digestibility. Significant ($P \leq 0.05$) rises in DM,OM,CP,NFE digestibilities and nutritive values as TDN and DCP were observed with D3 and D4 in comparison with D1 (the basal diet). Rabbits fed on D3 diet recorded the highest digestibility coefficients of EE followed by D4.

Table 2. Chemical analysis and cell wall constituents (%) of the berseem hay, Pm hay and the experimental diets

Item	Tested materials		Experimental diets			
	BH	*Pm*H	D1	D2	D3	D4
Chemical analysis						
Dry matter	91.25	93.47	91.5	91.22	91.27	91.23
Chemical analysis on DM basis						
Organic matter (OM)	85.03	86.21	91.29	91.58	91.37	91.41
Crude protein (CP)	12.18	12.25	17.19	17.17	17.11	17.12
Crude fiber (CF)	29.91	22.87	13.43	13.89	13.90	13.83
Ether extract (EE)	2.67	3.26	3.04	3.07	2.99	2.98
Nitrogen-free extract (NFE)	40.27	47.83	58.63	57.45	57.37	57.48
Ash	14.97	13.79	8.71	8.42	8.63	8.59
Gross energy [1] Kcal/kg DM	3851.6	1824.7	4247.5	4219.3	4206.8	4205.5
Digestible energy [2] Kcal/kg DM	1116.3	1516.2	2557.5	2584.3	2553.7	2561.8
Non fibrous carbohydrates [3] NFC	24.24	26.75	33.62	33.95	33.68	33.7
Cell wall constituents						
Neutral detergent fiber (NDF)	45.94	43.95	37.74	37.39	37.59	37.61
Acid detergent fiber (ADF)	40.9	38.7	22.5	22.2	22.4	22.4
Acid detergent lignin (ADL)	27.3	22.7	10.3	8.8	9.4	9.9
Hemicellulose	5.04	5.25	15.24	15.19	15.19	15.21
Cellulose	13.6	16.0	12.2	13.4	13.0	12.5
Phenolic compounds	Nil	8.32	ND	ND	ND	ND
Condensed tannins	Nil	3.7	ND	ND	ND	ND

D1, D2, D3, and D4 are the experimental diets that included *Panicum maximum* cv. Mombaça hay (*Pm*H) at levels 0,30, 60, and 90%, respectively, as a partial substitute of the dietary berseem hay (BH).

[1]Gross energy, calculated according to (15), where: CP=5.65 kcal/g, each g of EE=9.40 kcal/g and both of CF and NFE =4.15 kcal/g.

[2]Digestible energy, calculated according to (16) using the following equation:

DE (kcal/ kg DM) = 4253 - [32.6 (CF %)] – [144.4 (total ash)].

[3]Non fibrous carbohydrates (NFC), calculated according to (17) using the following equation:

NFC = 100 - [CP + EE + Ash + NDF].

Hemicellulose = NDF - ADF.

Cellulose = ADF - ADL.

ND, not determined.

Table 3. Digestibility coefficients and nutritive values (%) of the experimental diets

Item	Experimental diets				SEM	*P*-value
	D1	D2	D3	D4		
Digestibility:						
Dry matter	60.28^{b}	65.56^{ab}	68.12^{a}	70.83^{a}	1.48	0.0400
Organic matter	72.33^{b}	75.07^{ab}	76.62^{a}	77.56^{a}	0.90	0.0400
Crude protein	75.10^{b}	76.20^{b}	79.01^{a}	79.00^{a}	0.28	0.0003
Crude fiber	54.34	55.98	56.33	56.33	3.41	0.9858
Ether extract	65.20^{b}	66.03^{b}	70.86^{a}	67.95^{ab}	1.05	0.0500
Nitrogen-free extract	78.24^{b}	80.45^{ab}	81.61^{a}	82.37^{a}	0.70	0.0090
Nutritive values:						
Total digestible nutrient	67.78^{b}	69.97^{ab}	72.09^{a}	72.75^{a}	0.85	0.0300
Digestible crude protein	12.91^{b}	13.08^{b}	13.52^{a}	13.52^{a}	0.05	0.0001

D1, D2, D3, and D4 are the experimental diets that included *Panicum maximum* cv. Mombaça hay (*Pm*H) at levels 0,30, 60, and 90%, respectively, as a partial substitute of the dietary berseem hay (BH).

a and b ,means in the same row having different superscripts are significantly different ($P \leq 0.05$).

SEM, standard error of the mean.

3.3. Growth performance

The productive performance Data are presented in Table 4. The dietary level of *Pm*H in D4 (90%) led to significant (P=0.0001, 0.001 and 0.001) increases in the final body weight, total body weight gain and average daily gain, respectively. In comparison with the control diet (D1), all inclusion levels of *Pm*H in the tested diets marginally (P>0.05) lowered the average intake of DM, CP and DE values. On the other side, the digestible crude protein (g/h/d) and total digestible nutrient (g/h/d) with rabbits fed on D3 and D4 were better than those with D1.

Among all of the tested diets, the level of *Pm*H in D4 significantly (P≤0.05) improved the feed conversion ratio (g intake /g gain) of DM, while the best feed conversion values (g intake /g gain) of CP, DCP, TDN and (kcal intake /g gain) of DE were achieved with D2.

Table 4. Growth performance of the experimental groups

Item	Experimental diets				SEM	*P*-value
	D1	D2	D3	D4		
Initial weight g	705.8	703.8	697.5	697.5	15.84	0.9850
Final weight g	1997.1^{c}	1983.2^{c}	2052.1^{b}	2119.3^{a}	17.69	0.0001
Body weight gain g	1291.3^{b}	1279.4^{c}	1354.6^{b}	1421.8^{a}	25.34	0.0010
Feeding period days 56						
Average daily gain g	23.1^{b}	22.9^{b}	24.2^{b}	25.4^{a}	0.45	0.0010
Feed intake:						
Average dry matter g/h/d	97.3	96.3	96.3	94.9	0.94	0.3850
Crude protein g/h/d	16.73	16.53	16.48	16.25	0.16	0.4990
Digestible crude protein g/h/d	12.3^{b}	12.5^{b}	13.0^{a}	12.8^{ab}	0.13	0.0020
Total digestible nutrient g/h/d	65.9^{b}	67.4^{ab}	69.4^{a}	69.0^{a}	0.76	0.0110
Digestible energy kcal/h/d	248.8	252.1	248.1	244.9	2.44	0.2600
Feed conversion g intake/ g gain						
Dry matter	4.23^{a}	4.25^{a}	4.02^{a}	3.75^{b}	0.08	0.0008
Crude protein	0.588	0.564	0.596	0.576	0.018	0.6264
Digestible crude protein	0.442	0.430	0.471	0.455	0.014	0.2130
Total digestible nutrient	2.362	2.323	2.511	2.461	0.07	0.3020
Digestible energy Kcal intake /g gain	8.896	8.702	8.979	8.733	0.27	0.8820

D1, D2, D3, and D4 are the experimental diets that included *Pm*H at levels 0,30, 60, and 90%, respectively, as a partial substitute of the dietary berseem hay (BH).

a ,b and c ,means in the same row having different superscripts are significantly different (P≤0.05).

SEM, standard error of the mean.

3.4. Nitrogen balance and caecum activity

Effects of replacement BH by *Pm*H at different levels on nitrogen metabolism and caecum activity are illustrated in Table 5. Incorporating the *Pm*H in the experimental diets had no significant effect (*P*=0.1795) on the fecal nitrogen (FN) values. While, nitrogen intake (IN), digestible nitrogen (DN), retained nitrogen (RN), the DN/IN efficiency (%),the RN/IN efficiency (%) and the RN/DN efficiency (%) significantly increased with increasing the *Pm*H levels (*P*= 0.01, 0.001, 0.01, 0.05, 0.05 and 0.04, respectively).

During the term of cecum activity, the NH_3-N concentrations (mg\100 dL) were significantly decreased (*P*=0.04) with including and increasing the *Pm*H in the tested diets compared with the control diet. On the Other hand, values of TVFA's were significantly (P=0.01) raised D4 (6.87 mmol/100ml) compared with the other tested diets.

In comparison with D1, the highest tested level of dietary *Pm*H with the growing rabbits in D4 resulted in improving the biochemical traits of caecum content, whereas the lower NH3 (24.30 versus 34.52 mg\100 dL; P=0.04), pH values (6.07 versus 6.37; P=0.05) and the TVFA's concentration (6.87 versus 5.83 mmol/100 ml; P=0.01) indicated to a higher fermentation of gut microflora.

Table 5. Nitrogen metabolism and caecum activity of the experimental treatments

Item	Treatments				SEM	*P*-value
	D1	D2	D3	D4		
Nitrogen intake g/day (NI) [1]	3.08^b	3.17^b	3.26^b	3.65^a	0.19	0.0100
Fecal nitrogen g/day (FN) [2]	1.08	1.09	1.17	1.15	0.21	0.1795
Urinary nitrogen g/day (UN) [3]	0.97^a	0.98^a	0.81^b	0.73^b	0.11	0.0500
Digestible nitrogen g/day (DN) [4]	2.00^b	2.08^b	2.09^b	2.50^a	0.73	0.0010
Retained nitrogen g/day (RN) [5]	1.03^b	1.10^b	1.28^b	1.77^a	0.09	0.0100
DN/NI (%) [6]	64.94^b	65.62^b	64.11^b	68.49^a	1.70	0.0500
RN/NI (%) [7]	33.44^b	34.70^b	39.26^b	48.49^a	1.16	0.0500
RN/DN (%) [8]	51.50^c	52.89^c	61.24^b	70.80^a	2.99	0.0400
Caecum activity						
pH value	6.37	6.29	6.11	6.07	1.31	0.1500
NH_3-N mg\100 dL	34.52^a	29.72^b	28.41^b	24.30^c	0.59	0.0400
TVFA's mmol/100 ml	5.83^b	5.97^b	5.93^b	6.87^a	0.17	0.0100

D1, D2, D3, and D4 are the experimental diets that included *Pm*H at levels 0,30, 60, and 90%, respectively, as a partial substitute of the dietary berseem hay (BH).

a ,b and c ,means in the same row having different superscripts are significantly different (*P* ≤ 0.05).

SEM, standard error of the mean.

[4]DN = (1) – (2).

[5]RN = (1) – (2) – (3).

[6]DN/IN (%), the conversion efficiency of nitrogen intake into digestible nitrogen.

[7]RN/IN (%), the conversion efficiency of nitrogen intake nitrogen into retained nitrogen.

[8]RN/DN (%), the conversion efficiency of digestible nitrogen into retained nitrogen.

3.5. Carcass traits

The effect of *Pm*H inclusion on the carcass characteristics of NZW rabbits are displayed in Table 6 .Among all treatments, rabbits fed on D2 showed a significant (P≤0.05) improvement in hot carcass weight. Besides a significant (P≤0.05) increase in total edible parts (%) with D2 and D4 compared with D1. While, the partial substitution of dietary BH with *Pm*H had no significant (P>0.05) effects on dressing percentage, edible giblets and total non-edible parts (%).

Table 6. Carcass characteristics of NZW rabbits as affected by dietary treatments

Item	Experimental diets				SEM	P-value
	D1	D2	D3	D4		
Pre-slaughter weight g	1977.2	1975.0	1996.0	1949.0	21.35	0.5380
Hot Carcass weight[1] g	1152.5^b	1202.5^a	1205.5^b	1207.7^b	14.90	0.0352
Dressing %	58.3	61.5	60.4	62.0	1.12	0.1755
Edible Giblets [2] %	3.82	4.12	4.10	4.20	0.09	0.0686
Total edible parts [3] %	63.04^b	66.32^a	63.16^b	65.42^a	1.05	0.0111
Total Non-edible parts %	36.96	33.68	36.84	34.70	1.15	0.0812

D1, D2, D3, and D4 are the experimental diets that included *Pm*H at levels 0,30, 60, and 90%, respectively, as a partial substitute of the dietary berseem hay (BH).

a and b ,means in the same row having different superscripts are significantly different (P≤0.05).

SEM, standard error of the mean.

[1] Weight of hot carcass, including head as a percentage of pre-slaughter weight.

[2] Edible giblets (%) = [(liver g + kidney g + heart g) /pre-slaughter weight g] × 100.

[3] Total edible parts (%)=[(carcass weight g + weight of edible giblets g) /pre-slaughter weight g ×100.

3.6. Economic evaluation:

Final body weight, length of the growing period and feeding cost are major factors concerning the achievement of maximum efficiency values of meat production. The relative economic efficiency (REE) of the experimental diets is exposed in Table 7.

Table 7. Economical efficiency as affected by dietary treatments

Items	Treatment groups			
	D1	D2	D3	D4
Total average weight gain g	1997	1983	2052	2119
The price of 1 kg body weight £E	40	40	40	40
Selling price/rabbit [1] £E	79.88	79.32	82.08	84.76
Total feed intake Kg	5.45	5.39	5.39	5.31
Price/kg feed £E	5.90	5.70	5.50	5.30
Total feed cost/ rabbit [2] £E	32.16	30.72	29.65	28.14
Profit [3] £E	47.73	48.60	52.44	56.62
Profit/feed unit [4] £E/ Kg diet	1.48	1.58	1.77	2.01
Relative economic efficiency [5] %	100	106	120	136

D1, D2, D3, and D4 are the experimental diets that included *Panicum maximum* cv. Mombaça hay (*Pm*H) at levels 0,30, 60, and 90%, respectively, as a partial substitute of the dietary berseem hay (BH).

[3] profit = (1) – (2) in Egyptian pound (£E)

[4] Profit/feed unit = (3) / (2).

[5] Relative economic efficiency= [economic efficiency (Ec.Eff) of D2, D3 or D4 / Ec.Eff. of D1]×100.

Calculations were carried out according to the prevailing market prices of both rabbits selling and feeds.

Results indicated that using *Pm*H as a partial replacer of BH in diets of growing NZW rabbits enhanced the profit and reduced the total feed cost. The lowest total feed cost/rabbit (28.14 £E) accompanied with the best profit was observed in rabbits fed on diet D4. In general, all the inclusion level of *Pm*H in the tested diets led to ameliorate profit per feed unit and REE. The substitution level of 90% of the dietary BH with *Pm*H (D4) achieved the best profit per feed unit (2.01 £E/ Kg diet) and REE (136%). No available feasibility study about the cost of diets when *Pm*H was partially replaced with BH. The *Pm*H may become a promising unconventional feed ingredient in growing rabbits feeding.

4. DISCUSSION:

4.1. Chemical analysis of *Pm*H and the tested diets

All chemical analysis parameters were similar for the different experimental diets. The *Pm*H contained an adequate amount of DM, organic matter, crude protein, NDF, ADF and DE, which support moderate growth of livestock **(25).** The cellulose content in the leaf and stem of *Panicum* shrubs was 33.98%, hemicelluloses was 29.56%, lignin was 18.6% and ash was 2.21% of *Panicum maximum* (**26**). Our results on chemical analysis of *Pm*H agreed with (**27**) who recorded that the proximate analysis of *Panicum* hay was 11.65% crude protein, 2.67% crude fat, and 30.66% crude fiber.

4.2. Nutrients digestibility and nutritive values of the experimental diets

Increased digestibility and N-utilization may be due to the positive impacts of *Pm*H on the absorption and utilization of nutrients. Low to medium concentrations of CT (20–40 g/kg DM) occurred in *panicum* forages, increased the efficiency of protein digestion by increasing flow of N to the intestine relative to N intake, increased flow of essential amino acids of the monogastric by 50 % and increased net absorption of essential amino acids from the small intestine by 59–63 %, with no effect on digestibility **(28).**Also**,** rabbits have the ability to adjust its voluntary feed intake in response to changes in dietary energy concentration (**29).** These results may be due to the limited dose of polyphenol from which has the ability to inhibit alpha-amylase that may influence different steps in starch digestion in a synergistic manner (**30**).

4.3. Growth performance

Rabbits fed D4 had significantly higher final weight (by about 6.12%) than those fed the control diet. This enhancement in growth with D4 may be due to increasing the feed utilization in this group (Table 3) as elucidated by **(31)** who indicated that the high growth rate could be due to increasing digestibility and N-utilization. These results were consistent with (**27**) who found that final live body weight, average daily gain, feed intake and feed efficiency of rabbits fed *Pm*H in place of 45% of BH were higher ($P<0.05$) than those fed and 30% and the control diet. Besides, this improvement may be due to better quality of mixing *panicum* hay (grass hay) with legume hay (berseem hay) than only the berseem hay (basal diet) as documented by (**32**). In this contest, daily weight gain, daily feed intake and feed conversion ratio were significantly ($p \leq 0.05$) affected by the feeding of combinations of concentrate and/or *Pannicum maximum* or *Leucaena leucocephala* when compared to sole concentrate diet feeding **(33).**

The D4 diet increased the average daily gain by 10.10%. So, results indicate that the responses to dietary tannin are variable and depend on the type, source and concentration of tannin used, animal species and basal diet fed, which were in parallel with (**34**) who showed that rabbits fed the tannin enriched diet for 57 days reached a live weight higher by 6% ($P<0.01$) than that with the control group.

Regarding feed intake, fiber is one of dietary components which usually contain 35 to 40% neutral detergent fiber (**35**). It helps to maintain a high rate of passage, avoiding the accumulation of digesta in the caecum that reduce feed intake and impairs growth (**36**).

4.4. Nitrogen metabolism and Caecum activity

Results of nitrogen balance could be used to calculate the expected daily gain. The pH values did not ($p>0.05$) effected among all treatments. The high replacing level (90%) of the dietary BH by *Pm*H in D4 presented an improvement in nitrogen intake, digestible N, retained N, the efficiencies of nitrogen utilization. The higher nitrogen retained from the *Panicum maximum* showed that more N could be available for microbial growth and multiplication that could improve digestion of feeds, thereby improving feed intake, and consequently, animal productivity. Volatile fatty acids (VFA's) produced as a result of caecal fermentation of digestible fiber or undigested nutrients provide a vital source of energy for the rabbits (**37).** Also, decreasing acid detergent lignin linearly increased the caecal VFA's concentration of growing rabbits (بالجدول ADL راجع قيم Table 2). These values are in general agreement with those obtained by (**38**). Moreover, phenolic glycosides and salicin could be an important source of glucose which may increase the fermentation activity and synthesis of microbial protein. However, the significant decline of NH_3-N with raising the dietary level of *Pm*H may attribute to its content of CT. These results consented with those who reported that CT binding strongly to proteins to form a pH-dependent complex, which is not degradable at a high pH value (>7) in the intestine (**39**).

4.5. Carcass traits

Concerning dressing percentage and edible giblets, our results are in accordance with **(27)** who found that partial replacing of BH with *Pm*H at graded levels up to 45% in rabbits diets had no ($P>0.05$) effect on carcass traits compared to rabbits fed the control diet.

4.6. Economic evaluation:

No available feasibility study about the cost of diets when *Pm*H was partially replaced with BH. The *Pm*H may become a promising unconventional feed ingredient as a substitute for BH in growing rabbit's diets.

5. CONCLUSION

Results of this study revealed that all tested levels of *Pm*H were useful as a substitute forage of BH with maintaining the performance, digestibility, carcass traits and could enhance the REE of diets for the grower rabbits.

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النمو والهضم وميزان الأزوت وخصائص الذبيحة في الأرانب المغذاة على علائق تحتوى على دريس حشيشة البانيكم.

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استهدفت الدراسة الحالية معرفة تأثيرات الاستبدال الجزئي لدريس البرسيم بمستويات مختلفة من دريس حشيشة البانيكم في عليقة الأرانب على النمو والهضم وصفات الذبيحة والكفاءة الاقتصادية للعلائق. تم تقسيم ذكور الأرانب النيوزيلندية البيضاء المفطومة (عددها 60 وعمرها حوالي 6 أسابيع ، ومتوسط وزن الجسم 701.15 جم) بشكل عشوائي إلى أربع مجموعات غذائية في تجربة تصميم كامل التعشية. تم تغذية مجموعة المقارنة على عليقة تحتوى على 300 كجم / طن من (الأولى) ؛ بينما تم إدخال حشيشة البانيكم في العلائق التجريبية الثلاثة الأخرى بمستويات

30 و 60 و 90٪ كإحلال جزئي لدريس البرسيم لتمثل المعاملات الثانية والثالثة والرابعة على الترتيب. وقد استمرت الفترة التجريبية لمدة 8 أسابيع.

أظهرت النتائج أن الوزن النهائي للجسم والزيادة فى وزن الجسم ونسبة تحويل الغذائي كان أفضل وبصورة معنوية مع العليقة الرابعة . حسّن دريس حشيشة البانيكم من معاملات هضم المادة الجافة والمادة العضوية والبروتين الخام والدهن الخام والقيم الغذائية كمجموع مركبات غذائية مهضومة وبروتين مهضوم . حسّن دريس حشيشة البانيكم من معاملات هضم المادة الجافة والمادة العضوية والبروتين الخام والدهن الخام والقيم الغذائية كمجموع مركبات غذائية مهضومة وبروتين مهضوم. إن إدخال دريس حشيشة البانيكم فى العلائق المختبرة قد أدى إلى تحسن طفيف في معاملات هضم الألياف الخام مقارنة بعليقة المقارنة. زادت العليقة الرابعة وبشكل معنوى من النيتروجين المأكول ، والنيتروجين المهضوم، والنيتروجين المحتجز بالجسم، وكفاءة الاستفادة من النيتروجين و إنتاج الأحماض الدهنية الطيارة بالأعور ، بينما انخفض وبشكل معنوى النيتروجين المفقود فى البول (جم / يوم) وإنتاج الأمونيا في الأعور مقارنة بالمعاملة الأولى (المقارنة). وقد ارتفع أيضاً وزن الذبيحة وإجمالي الأجزاء المأكولة معنويا مع العليقة الثانية . وقد حققت العليقة الرابعة أفضل ربح لكل وحدة علف (2.01 جنيه / كجم عليقة) وكفاءة اقتصادية نسبية (136٪). وختاماً ، فقد يصبح دريس حشيشة البانيكم مكونًا واعدًا كعلف غير تقليدي في تغذية الأرانب النامية.

الكلمات المفتاحية : حشيشة البانيكم – الأرانب النامية – هضم العناصر الغذائية – الذبيحة –الكفاءة الاقتصادية.