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IMPACT OF REPLACEMENT CLOVER HAY BY PANICUM MAXIMUM (GUINEA GRASS) HAY AS AN ALTERNATIVE FEED RESOURCE IN RABBIT FEEDING

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ABSTRACT: *This study aimed to evaluate the possibility of using Panicum maximum hay (Pmh) as an alternative to clover hay in rabbit diets. Sixty New Zealand White (NZW) weaned male rabbits, 6 weeks old with an average body weight of 720±42 g, were allotted to four dietary groups (15 rabbits in each). The control group fed a basal diet contained 36 % clover hay (D1), The other three groups were fed graded Pmh levels of 12, 24 and 36 (%) of the total diets to replace the clover hay in the basal diet, by nearly 33, 66 and 100% (D2 and D3 and D4, respectively). Rabbits were fed pelleted feed ad libitum. The experiment extended for 8 weeks.*

The chemical composition of Pmh was 12.18% CP, 28.38% CF, 1.4% EE, 12.63% ash, and 37.41% NFE. The results of the feeding trial indicated that feed intake, digestibility, of CF and NFE, nutritive value (TDN and DE), daily body gain, FCR and carcass percentage were slightly significantly (P< 0.05) decreased with increasing the Pmh replacement up to 24% (D2 and D3) and significantly (P<0.05) declined with the highest replacement level (D4) as compared with the control. On the other hand, using Pmh as a replacement for clover hay improved the net revenue by increasing the Pmh level as a result of reducing the total feed cost, and the highest replacement level gave the best relative economic efficiency than control (114%).

Conclusively, *from these results it could be concluded that inclusion of Pmh instead of clover hay can be used as an alternative and more economical feed than clover hay in rabbit diets.*

Keywords: *Rabbit, Panicum, performance, carcass, economic efficiency.*

INTRODUCTION

Global meat production is expected to be more than double in 2050 (Steinfeld *et al*., 2006). To meet such demand other alternative meat sources

production is required. Rabbit is a good potential source as part of a solution to fulfill the increasing demand for animal proteins (Daader *et al.*, 2016). One of the main problems faced by farmers to increase their livestock productivity is the gap between feeding animals available and required.

Clover hay is a common feed ingredient in rabbit feeding and the main winter forage for the other ruminant animals in Egypt. It's necessary to find other alternative forage resources to cover the shortage of green forages and to maintain the animal requirement and performance with suitable economical costs. Using alternative feed resources appears seems to be promising way to not only in overcome the limitations of native feed, but also to reduce environmental pollution (Sallam *et al*., 2019).

Panicum maximum is one of these new alternative forages is the (Pm), It may be found all across the tropics The proper management of this grass can aid in overcoming the growing gap between animal supply and demand for nutrients. Because of its high biomass and dry matter output, *Panicum maximum* is the best grass for hay production (Ajayi, *et al*., 2008). This grass was used in many countries in the west and center of Africa, Asia, and South America and used as a forage source in the feed of growing rabbits (Liu *et al*., 2018 and Refaie, *et al*., 2020). This plant has various advantages; it has a fast-growing rate, adapted to different environments. It also has high nutritional value, with 10.5 percent crude protein, 2.5 percent ether extract, 30.4 percent crude fiber, and 7.5 percent ash. (IronKwe and Ukanwoko, 2016).

Few investigators have been done on using Pm as feed for growing rabbits. In this respect, when rabbits were given a concentrate diet plus Pm in a 1:2 ratio by Amata and Okorodudu (2016), the weight gain values were greater than when rabbits were fed the same concentrate diet with *Myrianthus arboreus* or *Gmelina arborea* grass in the same ratio by Amata and Okorodudu (2016). Also, Refaie *et al*., (2020) reported that replacement of clover hay by Pm as a percentage of 15%, 30%, and 45% improved the cecum bacterial count and crude protein digestibility. The results also revealed that replacing up to 45 percent of the Pm with Pm resulted in better growth and reduced cecum coliform bacteria. Furthermore, Ezea *et al.*, (2014) found that pregnant rabbits fed a concentrate diet plus a mixed forage containing Pm gained more weight for their does and litters than those on a commercial control diet.

Therefore, the aim of this study was to evaluate how varying levels of and total replacement of clover hay with *Panicum maximum* hay affected digestibility, growth performance, carcass characteristics, and rabbit economic efficiency.

MATERIALS AND METHODS

1. Animals, feed, and management

The Rabbit Research Farm, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, was used for this investigation. All experimental methods were carried out under the supervision of the Local Experimental Animal Care Committee, and the institutional Committee accepted the ethics. Husbandry standards developed from Zagazig University standard operating procedures were used to care for the rabbits. A total of 60 weaned male New Zealand White (NZW) rabbits (6 weeks old; average starting body weights (720±42)) were randomly assigned to four groups (15 animals in each).The experimental groups were fed: basal diet (D1), which contained 36% clover hay, while the other three groups were fed graded Pmh levels of 12, 24 and 36 (%) of the total diets to replace the clover hay in the basal diet, by nearly 33, 66 and 100% (D2 and D3 and D4, respectively). Water was provided at all times and the tested diets were offered in pelted form *ad libitum.* In a naturally ventilated area, the animals were reared individually in galvanized wire cages (diameters of each cage were 35 40 60 cm). The cages were fitted with manual feeders and automatic nipple drinkers to provide clean fresh water continuously. All rabbits were kept under similar hygienic, management, and environmental conditions.

All rabbits were acclimatized for one week before starting the experiment and fed on the control diet until the start of the trial. The rabbits received formulated diets to cover their nutrient requirements according to De Blas and Mateos (2010**)** recommendations.

Panicum hay preparation:

Every five weeks, the *Panicum maximum* was cut (about 100 cm in length), air-dried in the shade, milled, then combined with the other materials and pelted. Table 1 presents the components and chemical analysis of the diets that were analyzed.

2. Performance measurements:

The growth performance trial was continued for eight consecutive weeks. Feed intake (g) was recorded for each rabbits by measuring the remaining quantities of diet then subtracting them from the supplied before giving the next quantities. All rabbits were weighed individually at the beginning of the experiment (42-d), and then every week. The feed conversion ratio (FCR) was calculated by dividing feed intake (g) by body weight gain (g).

Table 1. Formulation and chemical composition of experimental diet.

Items	**Experimental diets**			
Ingredients:	**D1**	**D2**	**D3**	**D4**
Clover hay	36	24	12	0
Panicum maximum hay	0	12	24	36
Soybean meal (44% CP)	11	11	11	11
Yellow corn	28	28	28	28
Wheat bran	23	23	23	23
Sodium chloride	0.3	0.3	0.3	0.3
Limestone	1.2	1.2	1.2	1.2
Minerals & vitamins mixture	0.3	0.3	0.3	0.3
Dl -Methionine	0.2	0.2	0.2	0.2
Total	**100**	**100**	**100**	**100**
Chemical analysis(%on DM basis) determined:				
Organic matter (OM)	89.63	89.79	89.18	89.90
Crude protein(CP)	15.34	15.42	15.14	15.16
Crude fiber (CF)	14.16	14.56	14.51	14.85
Ether extract (EE)	2.32	2.45	2.82	2.39
Nitrogen free extract (NFE)	56.81	57.36	56.81	57.50
Neutral detergent fiber (NDF)	40.90	38.60	37.95	37.45
Acid detergent fiber (ADF)	24.03	24.00	23.83	23.72
*Digestible energy (Kcal/kg dry matter)	2294	2304	2218	2310

[1]**Premix contains per kg (Minerals and Vitamins mixture):** Vit. A, 20000 IU; Vit. D3, 15000 IU; Vit.. E, 8.33 g; Vit.. K, 0.33 g; Vit. B1, 0.33; Vit.. B2, 1.0 g; Vit. B6, 0.33 g; Vit.B5, 8.33 g; Vit. B12, 1.7 mg; Pantothenic acid, 3.33 g; Biotin, 33 mg; Folic acid, 0.83 g; Choline chloride, 200; Manganese 80 g; Zinc 60 g; Iron 30 g; Copper 4 g; Iodine 0.5 g; Selenium 0.1 g; and Cobalt 0.1 g

* Calculated according to **Fekete and Gippert (1986)** as follows:

DE(Kcal/Kg DM) = 4253-32.6 (CF%)-144.4 (Total ash)

3. Nutrients digestibility:

The digestibility trails procedures were done at 14 weeks of age on the last 7 days of the feeding trial. Four rabbits of each group were used. The rabbits were kept individually in metabolism cages allowed for face collection separately. During the collection period, feed and feces were daily recorded quantitatively. The feces were dried and examined in accordance with AOAC (2006).

4. Carcass traits:

At the end of the feeding trial, four rabbits per treatment were weighed and sacrificed to assess the carcass characteristics. When complete

bleeding was reached, skin and all entails were removed, and the carcass weight (Empty body weight) and some carcass organs were weighed (Blasco *et al*., 1993). The heart, liver, and kidney weights, as well as the spleen and lungs, were weighed and represented as a percentage of the pre-slaughter weight (SW). Dressing weight was calculated as a percentage by dividing carcass weight + giblets / SW.

5. Chemical analysis

The Pmh and tested diets was oven dried and evaluated for dry matter according to AOAC (2006) standards (JSON-100, Gongju, Republic of Korea; method 930.15). The Kjeldahl unit was used to estimate crude protein (UDK 129 model, VELP Scientifica, Usmate Velate, Italy; method 984.13).Ether extract level was analyzed by Soxhlet apparatus using diethyl ether (method 954.02). Ash content was estimated by incineration in muffle (Barnstead/Thermolyne Benchtop 47900, Thermo Scientific, Massachusetts, United States; method 942.05). The neutral detergent and acid detergent fiber were determined using Van Soest *et al.* (1991) techniques. The neutral detergent fiber was analyzed with the addition of heat-stable -amylase and the results were expressed without residual ash.

Phosphorus (P) was estimated by spectrophotometer manufacturer Labomed, Inc., USA, Model spetro 22, S.N 221101 according to ISO 6491:1998. Sodium (Na) and potassium (K) contents were determined by flame photometer spectroscopy apparatus (CIBA) Corning model 410, USA, serial No. 4887) using the method of Westerman (1990).

The other elements contents were determined by atomic absorption spectrophotometer (Perkin Elmar 2380, serial No. 13186, USA using ISO 6869:2000.

Amino acids were determined by using ion-exchange chromatography on an automatic analyzer.

6. Statistical analysis

Using SAS (2004), the data were statistically evaluated using Snedecor and Cochoran (1982) fully randomized design. The following model was used:

$$Y_{ij} = \mu + Di + e_{ij}$$

Where: Y_{ij} = Individual observation, μ= Overall mean, Di = Fixed effect of i th diet effect and e_{ij} = Random error.

Duncan's multiple range tests was used to find significant differences across diets (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical analysis of Pmh:

The chemical analysis of Pmh and its minerals and amino acid contents (Table 2) revealed high nutrient contents (12,18 % CP, 28.30% CF, 1.4% EE and 37.41% NFE), which were nearly identical to the nutritive values of clover hay, indicating that it could be used as an alternative feed resource for rabbits. Sallam *et al*., (2019) and Refaie *et al*., (2020) achieved nearly identical results.

Table 2. Chemical analysis of clover hay and *Panicum maximum*

Items	Clover hay	Panicum contents					
		Fresh	Hay	Amino acids profile (%)		Minerals	
DM	91.25	32.32	91.95	**Arginine**	0.45	**Ca**	0.11 g/100g
CP	14.18	4.28	12.18	**Methionine**	0.16	**P**	0.16 g/100g
CF	27.91	9.95	28.30	**Cystine**	0.21	**Mg**	0.16 g/100g
ADF	40.90	64.10	40.11	**Histidine**	0.18	**K**	2.64 g/100g
NDF	45.94	82.81	64.90	**Leucine**	0.67	**Na**	0.69 g/100g
ADL	27.30	23.14	8.42	**Isoleucine**	0.36	**Fe**	33.21 mg/100g
EE	2.67	0.50	1.4	**Lysine**	0.49	**Zn**	31.14 mg/100g
Ash	14.97	4.44	12.63	**Phenylalanine**	0.45	**Mn**	0.90 mg/100g
NFE	40.27	13.15	37.41	**Tyrosine**	0.32	**Cu**	3.07 mg/100g
DE(Kcal/kg DM)	1416	-	1538	**Valine**	0.48	**Cr**	7.08 mg/100g

*Calculated according to **Fekete and Gippert (1986)** as follows:

DE(Kcal/Kg DM) = 4253- 32.6 (CF%)- 144.4 (Total ash)

Feed intake, digestibility and growth performance traits:

The obtained results revealed that increasing the replacement level of Panicum hay (Pmh) for clover hay did not significantly affect daily feed intake (DFI) up to a 66 percent replacement level and significantly ($P < 0.05$) decreased when Panicum completely replaced the clover hay when compared to the control (Table 3). This impact might be related to Panicum's palatability, which could be connected to the plant's high NDF and ADL content (Ajayi *et al.*, 2008). Because it occupies a significant volume in the stomach, a diet high in NDF typically has poor voluntary feed intake (Ajayi *et al.* 2008). To indicate voluntary feed intake, NDF content is utilized as an indicator of stomach fullness (Mupangwa *et al.*2000). Feed intake was not substantially impacted by varied replacement levels of Pm

Table 3. Growth performance of growing rabbits as affected by Panicam dietary levels.

Parameter	Experimental diets				Sig. test
	D1	D2	D3	D4	
Body weight, g:					
d 42 (Initial)	731±40	718±38	705±42	700±35	NS
d 77	1641^{a}±54	1600^{a}±41	1578^{ab}±49	1557^{b}±51	*
d 98 (Final)	2194^{a}±58	2151^{a}±46	2131^{ab}±52	2097^{b}±49	*
Daily weight gain, g:					
d 42- d 77	26.00±0.4	25.20^{a}±0.5	24.94^{ab}±0.3	24.49^{b}±0.5	*
d 77- d 98	26.30±0.3	26.24±0.4	26.39±0.5	25.71±0.4	NS
d 42- d 98 (Overall)	26.11^{a}±0.4	25.59^{a}±0.5	25.47^{ab}±0.4	24.94^{b}±0.5	*
Daily feed intake, g:					
d 42- d 77	107.14±7	106.81±6	104.86±5	102.37±4	NS
d 77- d 98	152.52^{a}±6	154.82^{a}±5	143.19^{b}±4	139.06^{b}±5	*
d 42- d 98 (Overall)	124.16^{a}±4	124.81^{a}±5	119.23^{ab}±4	116.13^{b}±5	*
Feed conversion ratio:					
d 42- d 77	4.12±0.5	4.24±0.3	4.20±0.6	4.18±0.7	NS
d 77- d 98	5.80±0.4	5.90±0.5	5.44±0.4	5.51±0.9	NS
d 42- d 98 (Overall)	4.76±0.5	4.86±0.4	4.68±0.5	4.66±0.8	NS

a,b Means in the same row bearing different letters differ significantly (P<0.05).
Sig. test: Significant test, NS: Not significant, * P< 0.05.

(15, 30, and 40%) for clover hay percentage in growing rabbit diets, according to Refaie *et al*. (2020). Ifeanyichukwu *et al.* (2007), on the other hand, investigated the influence of several forages, including Pm, on rabbit development performance and found that rabbits fed Pm had the highest feed intake when compared to the other forages examined and the control. In addition, Uzegbu *et al*. (2010) discovered that feeding pigs with 5% fresh Pm resulted in 20.2 percent reduced feed consumption and improved FCR than the control group.

The digestibility of CF and NFE insignificantly (P < 0.5) declined with increasing level of replacement level of Pm for clover hay except with D4 (100% replacement) which significantly (P < 0.5) decreased than the control (Table 4). The other nutrients digestibility (DM, OM, EE, and CP) did not significantly affect via different groups. The obtained results

Table 4: Digestion coefficients and nutritive values of growing rabbits as affected by experimental diets

Parameter	Experimental diets				Sig. test
	D1	D2	D3	D4	
Digestion coefficient (%)					
DM	70.10^{a}±2.84	67.21^{ab}±1.93	66.50^{ab}±2.35	65.54^{b}±1.37	*
OM	71.22^{a}±1.53	68.75^{ab}±1.86	67.23^{ab}±2.85	65.88^{b}±1.60	*
EE	75.12±2.14	72.35±1.75	70.76±1.99	68.98±2.72	NS
CF	45.60^{a}±1.50	42.18^{ab}±0.99	40.90^{ab}±1.31	39.08^{b}±0.94	*
CP	78.32±3.19	77.05±2.26	77.18±2.93	76.07±1.91	NS
NFE	77.20^{a}±2.89	74.95^{ab}±1.78	74.11^{ab}±2.72	72.18^{b}±2.30	*
Nutritive values (%)					
TDN	66.25^{a}±1.19	65.00^{ab}±0.89	64.23^{ab}±1.44	62.39^{b}±1.53	*
DCP	12.02±0.45	11.87±0.34	11.69±0.21	11.53±0.35	NS
***DE-Kcal/Kg DM**	2935^{a}±35	2880^{a}±43	2845^{ab}±62	2764^{b}±51	*

a,b Means in the same row bearing different letters differ significantly (P<0.05).

Sig. test: Significant test, NS: Not significant, * P< 0.05

*DE: It was calculated according to Schneider and Flatt (1975) using the following equation:

DE (Kcal/Kg DM) = TDN x 44.3.,

reflected on the nutritive values as TDN, DCP, and DE which had no significant effects between different diets except D4 which showed significantly (P < 0.05) lower values (Table 4). Refaie *et al*., (2020), who examined diets containing Pm to substitute clover hay as a rate of 15 percent, 30 percent, and 45 percent, found similar outcomes. Sallam *et al.* (2019) also discovered that there were no significant variations in digestibility coefficients of all nutrients in male lambs fed blue panic grass between treatments. On the other hand, Ajayl *et al.* (2008) found that goats fed various Legumes (L. purposes, L. pubescent, and (A. histrix) supplemented diets had worse nutritional digestibility than those fed a Pm alone diet (P <0.05), perhaps because Legumes contain greater amounts of CP than grasses.

The values of daily body gain and feed conversion ratio were represented in the findings of daily feed intake (DFI) and nutrients digestibility. In comparison to the control diet, DBG values dropped insignificantly (P< 0.05) with increasing replacement levels up to 66 percent (D2 and D3) and significantly (P < 0.05) with greater replacement levels (D4). However, FCR improved with increasing the replacement levels, which represents 4.88, 4.68 and 4.66 for D2, D3, and D4, respectively, when

compared with the control value (4.76). Bamikole and Ezenwa (1999) confirmed a similar results, reporting that feeding rabbits forage (pm) with concentrate resulted in higher FCR than feeding just forage. Refaie *et al*., 2020 discovered that giving Pm-containing diets to growing rabbits as a proportion of 15 percent, 30 percent, and 45 percent clover hay replacement enhanced FCR, indicating expert feed consumers. Furthermore, Uzegbu *et al.* (2010) discovered that feeding pigs with 5% fresh Pm resulted in reduced feed consumption and an improved FCR of 20.2 percent than the control.

Carcass traits:

The treatment groups had no significant (P 0.05) effect on the carcass characteristics of rabbits fed varied levels of Pm (Table 5). However, Refaie *et al.* (2020) discovered that feeding rabbits graded Pm levels up to 30% clover hay enhanced the percentage of carcass and foreparts considerably ($P < 0.05$) compared to the control group and the replacement level of 45 percent Pm for clover hay.

Table 5: Carcass traits of male growing rabbits as affected by experimental diets

Parameter	Experimental diets				Sig. test
	D1	D2	D3	D4	
Body weight (g)	2033±66	2060±20	2040±55	2056±83	NS
Carcass (%)	57.01±2.31	56.33±2.20	55.45±3.94	55.07±1.80	NS
Liver (%)	3.42±0. 61	2.78±0.13	2.69±0.19	2.88±0.53	NS
Kidneys (%)	0.62±0.15	0.58±0.05	0.60±0.09	0.56±0.05	NS
Heart (%)	0.27±0.03	0.23±0.02	0.25±0.36	0.25±0.01	NS
Lung (%)	0.57±0.14	0.56±0.04	0.63±0.17	0.65±0. 13	NS
Testis (%)	0.26±0.02	0.22±0.02	0.15±0.02	0.15±0.01	NS
Spleen (%)	0.05±0.02	0.06±0.02	0.04±0.01	0.05±0.02	NS
Cecum (%)	0.51±0.03	0.49±.005	0.50±0.03	0.50±0.03	NS

Sig. test: Significant test, NS: Not significant

Economic efficiency (%):

The economic evaluation was based on the current market-selling price of the tested diets and the kilograms of live body weight. The results showed that using Pm hay as a replacement for clover hay increased net revenue by lowering feed costs (Table 6). When compared to the control

Table 6: Economical efficiency as affected by the experimental diets

Parameter	Experimental diets			
	D1	**D2**	**D3**	**D4**
Total feed intake, kg	6.95	6.99	6.68	6.56
Price of Kg feed, LE	4.35	4.11	3.87	3.63
Feed cost rabbit, LE	30.25	28.73	25.84	23.81
Total gain , kg	1.46	1.43	1.43	1.40
Income from gain LE	58.4	57.2	57.2	56.0
Net revenue, LE	28.15	28.73	31.36	32.19
Relative economical efficiency	100	101	111	114

1. One kg Panicum hay =1 LE, Kg Clover hay = 3 LE ,and Kg live body weight = 40 LE
2. Final margin LE/rabbit=-Income from gain- feed cost.

diet, the results reveal that diet D4 (100 percent replacement) had the highest relative economic efficiency value (114%), followed by D3 (111%) when compared with the control diet (100%). There was no difference between the lowest replacement level (33%) and the control level.

Conclusively, the present results suggest that *panicum maximum* can be utilized as a new alternative and economic forage in the diets of growing rabbits.

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تأثير استبدال دريس البرسيم بدريس البونيكام كمصدر غذائي بديل في تغذية الارانب

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أجريت هذه الدراسه بهدف تقييم أثر استخدام البونيكام محل دريس البرسيم على الاداء الانتاجي للأرانب النامية. استخدم 60 أرنب فطام من ذكور الارانب النيوزيلانديه عمر سته أسابيع ومتوسط وزن 720 جم. قسمت الارانب الي أربع مجاميع تجريبيه (15 أرنب بكل مجموعه)، غذيت مجموعه المقارنه على عليقة أساسيه تحتوي على 36% دريس برسيم , واحتوت المجموعات الثلاثه الأخرى على دريس البونيكام بنسبة 12 , 24 , 36% محل دريس البرسيم . غذيت الأرانب على عليقة مصبعه حتى الشبع وامتدت التجربة لمدة 8 أسابيع.

أظهرت النتائج المتحصل عليها انخفاض نسبي غير معنوي من الغذاء المأكول , معاملات هضم الالياف الخام و الكربوهيدرات الذائبة , والقيم الغذائية في صورة مركبات كلية مهضومه وطاقة مهضومه , معدلات النمو اليومي ومعدل تحويل الغذاء وذلك مع زيادة مستوى استبدال دريس البرسيم بالبونيكام حتى نسبة 24% وكان الانخفاض معنويا مع نسبة الاستبدال الكامل لدريس البرسيم (36%). على الجانب الآخر من الناحية الاقتصاديه ادى زيادة مستوى الاحلال بالبونيكام الي زياده العائد نتيجة لانخفاض تكلفة التغذية , فكان افضل كفاءه اقتصاديه نسبية مع اعلى مستوى استبدال (114%) مقارنة بعليقة المقارنة...

التوصية: من النتائج السابقة انه يمكن استخدام دريس البونيكام كبديل جديد اقتصادي في علائق الارانب النامية.