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Growth Performance, Semen Quality and Health Status as Affected by using Panicum Maximum in Rabbits Feed

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ABSTRACT

The purpose of this study was to investigate replacement of clover hay in rabbit diets with Panicum maximum hay (Pmh) and how affected digestibility, growth performance, carcass characteristics, semen quality, economic efficiency, and health status. A total of 60 New Zealand White weaned male rabbits, aged 6 weeks and weighing an average of 720±42g, were randomly classified into four dietary groups (15 rabbits each). The control group was fed a baseline diet with 36% clover hay (D1). The other three groups were provided diets with 12, 24, and 36%-Pmh to replace the clover hay in the basal diet (D2, D3, and D4 respectively). Feed intake, digestibility, CF and NFE, nutritive value (TDN and DE), daily body weight gain, FCR, and carcass percentage all decreased slightly (P<0.05) with increasing Pmh replacement up to 24 percent (D2 and D3) and significantly (P<0.05) with the highest replacement level (D4) when compared to the control. A replacement had no significant effect on semen quality. Replacement, on the other hand, increased net income by increasing Pmh levels as a result of lower overall feed costs, and the highest replacement level provided the best relative economic efficiency compared to control (114%). The hematological parameters were within normal limits and the histological alterations had no negative effect on the animals' physiological activities. Finally, using Pmh instead of clover hay in rabbit diets can be used as an alternative, save and more economical feed in rabbit diets.

Key words: Rabbit, Panicum, Performance, Semen quality, Economic efficiency, Health status.

INTRODUCTION

Commercial feed costs are extremely high in tropical and subtropical countries due to a lack of raw materials on the market and a restricted supply of raw resources. These are generally high-priced imported raw materials. It is one of the main problems in the rabbit industry (Kadi et al. 2011; Alemede et al. 2013). To formulate and manufacture balanced feeds utilizing local raw materials that are better adapted to the local environment and outperform traditional raw materials in nutritional, agronomic, and economic terms, new approaches are needed (Alemede et al. 2013; Alagón et al. 2014; Maertens et al. 2014; Strychalski et al. 2014).

Panicum maximum is a perennial tuft grass with a short, creeping rhizome that grows in warm, frost-free climates with more than 900 mm of rainfall (Humphreys and Partridge 1995). It is regarded as the most valuable fodder plant and extensively used to make hay. The leaf sheath, which is covered with microscopic hairs, is found near the base of the stems. The stem of this tough grass can grow to be up to 2m tall. Although this grass is native to Africa, it has been introduced to nearly every tropical country as a source of animal forage (Van Oudtshoorn 1999).

There have been several cases of illness and mortality in experimental and commercial farms, resulting in low output and considerable financial losses (Alemede et al. 2013). Body's physiological, pathological, and nutritional state may be determined by the blood components (Ewuola and Egbunike 2008). Hematological parameters indicated the animal's physiological response to internal or external stimuli, including food, pathogenic microbes, and housing circumstances, and many others (Amata 2010). In general, blood analysis allowed professionals to scientifically evaluate the quantities of numerous components in an animal's body to identify their health, nutrition and pathology (Melillo 2007; Archetti et al. 2008). This seems to be especially important in rabbits since their clinical signs are frequently complicated and illness symptoms are often hidden (Melillo 2007). Likewise, histology testing of vital organs is an essential technique for determining an animal's health condition since it may identify alterations in associated with a number of illnesses. As a result, the

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purpose of this research was to evaluate how replacing Clover hay for Panicum maximum hay influenced rabbit digestibility, growth performance, carcass characteristics, semen quality, economic efficiency and health status.

MATERIALS AND METHODS

Animals, Feed and Management

The current study's care and experimental procedures, including test animals, were carried out at the Rabbit Research Farm, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, in accordance with the scientific and ethical regulations recommended by the European Parliament Directive (2010/63/EU).

A total of 60 New Zealand White weaned male rabbits (6 weeks old; average initial body weights 720±42) were picked and randomly assigned to four groups (15 animals in each). All of the animals were kept in individual cages. The experimental groups were fed a 36% clover hay diet (D1), while the other three were fed graded Pmh levels of 12 percent, 24 percent, and 36 percent of the total diets to replace the clover hay in the baseline diet by approximately 33, 66 and 100%, respectively (D2 and D3 and D4, respectively).

The tested diets were given in pelted form *ad libitum*. In a naturally ventilated area, the animals were reared individually in galvanized wire cages (diameters of each cage were 35x40x60cm). Manual feeders and automated nipple drinkers were installed in the cages to ensure that clean, fresh water was available at all times. The rabbits were kept under hygienic, managerial, and environmental settings that were identical. Before beginning the experiment, all animals were acclimatized for one week and fed the control food until the trial began. According to **(**De Blas and Mateos 2010), the rabbits were fed formulated diets to meet their nutrient requirements.

Panicum Hay Preparation

Every five weeks, the *panicum maximum* was collected (about 100cm in length), air-dried in the shade, milled, then combined with the other materials and pelted.

Performance Measurements

The growth performance experiment was extended for an additional eight weeks. Each animal's feed consumption was documented by measuring the residual food amounts and subtracting them from the provided before delivering the following quantities. At the start of the trial (42 days), all rabbits were weighed individually and then every week after that. To calculate the feed conversion ratio (FCR), divide the feed intake (g) by the body weight gain (g).

Nutrients Digestibility

On the final seven days of the feeding study, the digestibility trials were carried out. Each group was given four rabbits. The animals were housed separately in metabolism cages to enable for independent feces collecting. Feed and feces were quantitatively recorded every day during the collecting period. The feces were dried and examined in accordance with guidelines (2006).

Carcass Traits

Four rabbits per treatment were weighed and slaughtered at the conclusion of the feeding trial to evaluate carcass characteristics. After thorough bleeding, the skin and all guts were removed, and the carcass weight and certain carcass organs were weighed (Blasco et al. 1993). All organs were weighed and stated in grams/kilogram of pre-slaughter weight (SW), including the heart, liver, spleen, kidneys, and lungs. By dividing carcass weight by pre-slaughter weight and turning the result to a percentage, carcass yield was calculated.

Semen Collection and Evaluation

A total of 20 male NZW rabbits 5 animals in each group from the previous growth experiment were fed the same previous tested diets until reached puberty. Sperm was collected once a week for the duration of the 16-week experiment. A teaser doe and an artificial vagina were used to collect ejaculates. After removing the gel mass from each ejaculate, the volume of each was measured. The enhanced Neubauer Hemocytometer slide (GmbH+ Co., Germany) was used to assess sperm concentration using a weak eosin solution (Smith and Mayer 1955). An eosin–nigrosine blue staining combination was required to evaluate if spermatozoa were alive or normal (Blom 1950). Phase-contrast microscope on heated stage was used to assess the percentages of motile sperm visually at low magnification (10x). The buck's reaction time is estimated as the time it takes to mount a doe till full ejaculation, and it's timed in seconds with a stopwatch.

Chemical Analysis

The Pmh and tested diets were 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 evaluate crude protein (UDK 129 model, VELP Scientifica, Usmate Velate, Italy; method 984.13). Diethyl ether was used to test the ether extract level using the Soxhlet apparatus (method 954.02). The ash content was determined via incineration in muffle (Barnstead/Thermolyne Benchtop 47900, Thermo Scientific, Massachusetts, United States; method 942.05). In accordance with (Van Soest et al. 1991) procedure's the fiber content of neutral and acid detergents was determined (1991). Analysis of neutral detergent fiber was carried out using heat-stable -amylase.

Hematology

At the end of the feeding study, blood samples were taken from slaughtered rabbits in sterile tubes. The blood was taken in EDTA-coated tubes in order to examine the possible influence of the treatments on hematological parameters. Erythrocytes such red blood cells (RBCs), HGB (hemoglobin), platelets, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), and leucocytes such white blood cells (WBCs), and Lymphocytes (LYM) were determined using a Sysmex XN-2000 automated hematology analyzer (Sysmex America Inc., USA) according to the previously method reported by (Schalm 1975).

Histopathological Investigation

Each group received liver, kidney, lungs, and testes specimens from slaughtered rabbits. Paraffin embedding was used to fix the samples for 48 hours in neutral buffered formalin (10%). Tissues specimens were dehydrated in ascending grade of ethyl alcohol, cleaned in two changes of xylol, embedded in paraffin blocks, microtomed into 4µm thick sections using a microtome (Leica RM 2155, England) and stained with hematoxylin and eosin. Circulatory disturbances, inflammation, neoplastic, degenerations, necrosis, and any other pathological alterations in the investigated tissues were evaluated using stained sections. A digital camera (Leica EC3, Leica, Germany) attached to a microscope was used to capture representative photomicrographs (Leica DM500).

Statistical Analysis

The data was statistically evaluated using SAS and a totally randomized design (2004). Duncan's multiple range tests was used to find significant differences across diets (Duncan 1955). The following was the model used: $Yij = \mu + Di + eij$

Where:

Yij = individual observation, µ= the overall mean, Di = is the fixed effect of i th diet effect and eij = is the random error.

RESULTS

Digestibility and Nutritive Values

Except for D4 (100 percent replacement), the digestibility of DM, OM, CF, and NFE reduced insignificantly (P<0.05) with increasing the replacement level of Pmh for clover hay (Table 2). Replacement levels had no effect on the digestibility of the other nutrients. The acquired results reflected on nutritive values such as TDN, DCP and DE, which had no significant impacts between different diets except for D4, which had significantly (P<0.05) lower values (Table 2).

Growth Performance Traits

Table 1 shows the results of average daily feed intake (DFI), daily body gain (DBG) and daily feed conversion ratio (FCR) as impacted by Pmh replacement levels of clover hay (3). The DFI results revealed no significant differences across treatments, with the exception of the diet with the greatest amount of Pmh (D4) having the lowest (P<0.05) DFI value (116.13g) compared to the control (124.16g), D2 (124.81) and D3 (119.23 g). On the other hand, the final body weight and DBG values showed the same trend of DFI results which decreased insignificantly (P<0.05) with increasing replacement level (D2 and D3) and significantly (P<0.05) with D4 than the control one.

When compared to the control value, the acquired DFI and DBG results matched the FCR results, which were insignificantly positively impacted by increasing the replacement level of clover hay by Panicum hay (D3 and D4) (Table 3).

Carcass Traits

The carcass characteristics of rabbits given various levels of Pmh (Table 4) showed insignificantly (P<0.05) lower values of carcass percent, edibal giblts percent and dressing percent than the control group. Internal organs, on the other hand, seemed to be normal in size, had no abnormal indications and were not significantly affected by dietary treatments.

Table 1: Formulation and chemical composition of experimental diet

Items	Experimental diets				
	D1	D2	D3	D4	Pmh
clover hay	36	24	12	0	
Panicum	0	12	24	36	
Soybean meal (44%)	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	87.29
Crude protein (CP)	16.34	15.42	15.14	15.16	12.18
Crude fiber (CF)	13.16	14.56	14.51	14.85	28.30
Ether extract (EE)	2.32	2.45	2.82	2.39	1.40
Nitrogen free extract (NFE)	56.81	57.36	56.82	57.28	45.49
Neutral detergent fiber (NDF)	40.90	48.60	57.95	67.45	64.90
Acid detergent fiber (ADF)	24.03	24.00	23.83	23.72	40.11
*Digestible energy (Kcal/kg dry matter)	2294	2304	2218	2310	1538

[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).

Table 2: Digestion coefficients and nutritive values of growing rabbits as affected by experimental diets

Parameter	Experimental diets					
	D1	D2	D3	D4	SEM	P-value
Digestion coefficient (%)						
DM	70.10[a]	67.21[ab]	66.50[ab]	65.54[b]	2.30	0.042
OM	71.22[a]	68.75[ab]	67.23[ab]	65.88[b]	1.82	0.046
EE	75.12	72.35	70.76	68.98	2.18	0.18
CF	45.60[a]	42.18[ab]	40.90[ab]	39.08[b]	1.41	0.050
CP	78.32	77.05	77.18	76.07	2.39	0.213
NFE	77.20[a]	74.95[ab]	74.11[ab]	72.18[b]	2.01	0.045
Nutritive values (%)						
TDN	66.25[a]	65.00[ab]	64.23[ab]	62.39[b]	1.21	0.023
DCP	12.80[a]	11.87[b]	11.69[b]	11.53[b]	0.35	0.032
*DE-Kcal/Kg DM	2935[a]	2880[a]	2845[ab]	2764[b]	3.43	0.041

SEM stands for standard error of the mean a,b Means in the same row bearing different letters differ significantly (P<0.05): *DE calculated according to Schneider and Flatt (1975) using the following equation DE (Kcal/Kg DM) =TDN x44.3.

Semen Quality

Data in Table 5 illustrated the effect of inclusion of varying levels of Panicum Maximum on sperm quality. Between the tested and control groups, no significant changes in any of the semen parameters were found. Furthermore, there were no significant changes between the three Panicum Maximum levels.

Economic Efficiency

The economic evaluation was based on the current market selling price of the tested diets and the kg 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 diet (100 percent), the results reveal that diet D4 (100 percent replacement) had the highest relative

Table 3: Growth performance of growing rabbits as affected by Panicam dietary level

Parameter	Experimental diets					
	D1	D2	D3	D4	SEM	P-value
Intial weight, g	731	718	705	700	13.30	0.895
Final weight, g	2194[a]	2151[a]	2131[ab]	2097[b]	37.10	0.048
Daily body gain, g	26.11[a]	25.59[a]	25.47[ab]	24.94[b]	0.55	0.009
Daily feed intake, g	124.16[a]	124.81[a]	119.23[ab]	116.13[b]	1.22	0.048
Feed conversion ratio	4.76	4.88	4.68	4.66	0.40	0.061

SEM=Standard error of the mean; a,b=Values bearing different letters in the same row differ significantly (P<0.05).

Table 4: Carcass traits of growing rabbits as affected by experimental diets

Parameter	Experimental diets					
	D1	D2	D3	D4	SEM	P-value
Body weight(g)	2033	2060	2040	2056	23.80	0.593
Carcass (%)	57.01	56.33	55.45	55.07	1.78	0.489
Total Edible Giblts %	4.81	3.59	3.54	3.69	0.336	0.061
Dressing%	61.81	59.92	58.99	58.76	3.11	0.096

SEM=Standard error of the mean.

Table 5: Semen characteristics of New Zealand White rabbit buck as affected by experimental diets

Parameters	Experimental diets					
	D1	D2	D3	D4	SEM	P-value
Volume (mL)	0.55	0.55	0.53	0.50	0.018	0.213
Reaction time (s)	17.50	17.75	17.50	17.75	0.19	0.493
Mass motility (%)	67.50	70.00	67.50	72.50	0.76	0.536
Individual motility (%)	65.00	67.50	65.00	70.00	0.92	0.394
Died sperm (%)	16.00	15.75	16.25	15.75	0.22	0.398
Sperm concentration (10^6/mL)	11.35	11.92	11.51	11.27	0.13	0.245

SEM=Standard error of the mean.

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

One kg panicum hay=1 LE, kg clover hay=3 LE, and kg live body weight=40 LE; Final margin LE/rabbit=-Income from gain- feed cost.

Table 7: Blood Hematology of growing rabbits as affected by experimental diets

Item	Experimental diets					
	D1	D2	D3	D4	SEM	P-value
WBC (10^3/mL)	7.11[b]	10.06[a]	10.73[a]	9.45[a]	0.783	0.043
LYM (%)	85.45[a]	86.64[a]	86.20[a]	83.80[b]	2.372	0.049
RBC (10^6/mL)	4.29	4.16	4.28	3.79	0.168	0.236
HB (g/dL)	12.23	12.40	12.86	11.72	0.762	0.069
MCHC (g/dL)	33.32	33.36	34.12	31.80	1.275	0.062
MCH (pg)	28.47[b]	29.85[ab]	30.04[ab]	31.66[a]	0.132	0.392
MCV (fL)	93.19	89.84	88.35	101.39	3.112	0.093
HCT (%)	36.64	37.17	37.65	36.78	0.514	0.072

SEM=Standard error of the mean; a,b=Values bearing different letters in the same row differ significantly (P<0.05).

economic efficiency value (114%), followed by D3 (111%). There was no discernible difference between the lowest replacement level and the control level.

Hematology

Table 7 shows the influence of dietary treatments on the hematological parameters of growing rabbits. Most of hematological parameters did not exhibit significant difference between treatments expect for WBCs, LYM and MCH. When compared to other Pmh levels and the control diet, rabbits given (D4) had the lowest LYM values (P<0.05). In D3, the greatest value of WBCs was found. Between the control and all Pmh inclusion levels, significant differences (P<0.05) were detected (D2, D3, and D4). Both D2 and D3 groups did not produce significant effect on MCH level. Among the treatment groups, D4 (31.66) had the highest level of MCH, with no statistically significant difference (P<0.05) between them.

Histopathological Evaluation

Figure 1 clarify the potential effects of Pmh on the histological alteration of some organs such as liver, kidney, testes and lungs in rabbits. In general, the liver, lung, kidney, and testes of the animals showed histologically well-structured tissues (Figure 1a, d, g and j). For liver section, it was observed normal healthy active hepatocytes and normal central vein in all experimental groups (Fig. 1a; expect D4). D4 shown mild hyperplastic changes of epithelial lining bile duct with edema in portal area (Fig. 1c) and mild congestion of central veins and sinusoids were detected in rabbits fed with 100% replacement with Pmh (Fig. 1b). Regarding kidney tissues alteration, the histological findings showed that normal nephron units with preserved glomerular structures and renal tubules, normal epithelial lining renal tubules and the stroma were within normal histomorphology (Fig. 1d). In high level of replacement (D4), while mild congested renal blood vessels and hyaline casts within renal tubules were detected**,** the kidney sections revealed apparently normal most renal tissue (Fig. 1e, 1f).

Sections from Testes revealed normal structures in all experimental groups (Fig. 1g, h) except for rabbits fed with 100% replacement with Pmh (D4); showed congested interstitial blood vessels with perivascular edema and mild atrophy of some tubules were also seen (Fig. 1i).

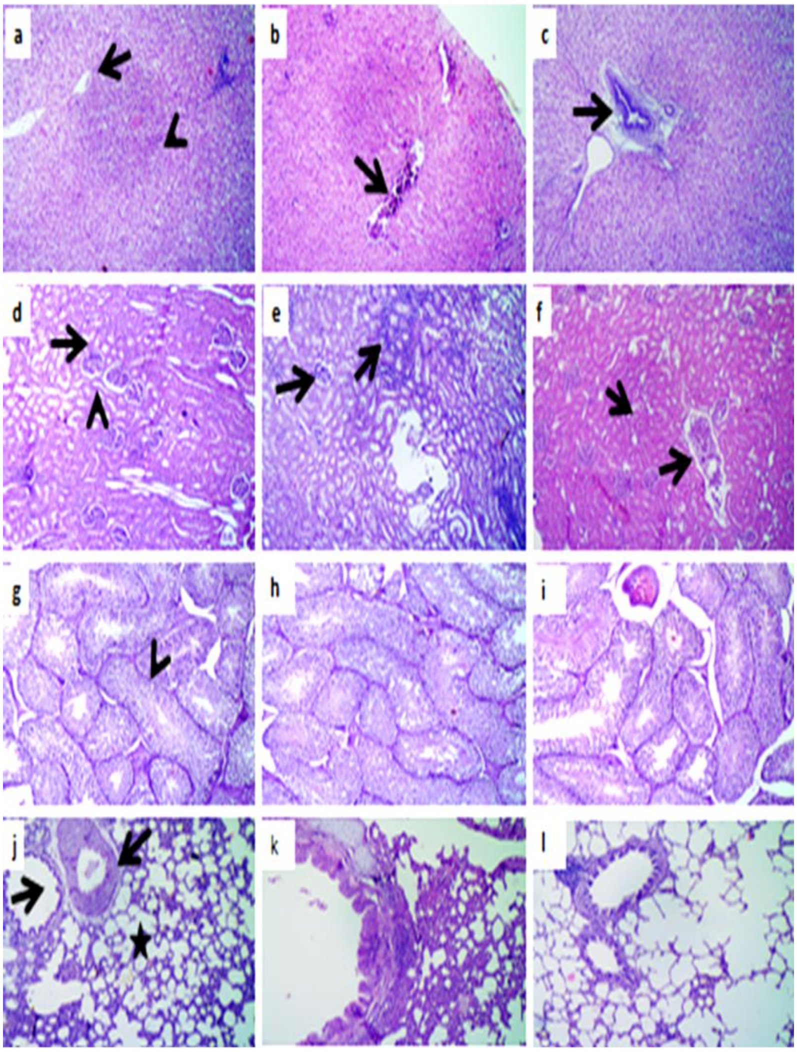

Fig. 1: Photomicrographs of histological sections of the liver (a, b and c), kidney (d, e and f), testes (e, h and i) and lung (j, k and l) of rabbits fed *Panicum maximum* (HE, 100×): (a, d, g and j) show liver, kidney, testes and lung tissues without lesions respectively. (b) Shows liver tissue with mild congestion of central veins (arrow); (c) shows liver tissue with mild hyperplastic changes of epithelial lining bile duct with edema in portal area (arrow). (e) show kidney tissue with interstitial nephritis with necrotic renal tubules and round cells infiltrations between them (arrow); (f) show kidney tissue with mild congested renal blood vessels (arrow) and hyaline casts within renal tubules (arrow head); (i) show testes tissue with Congested interstitial blood vessels with perivascular edema (arrow) and mild atrophy of some tubules (arrow head).

As shown in Fig. 1, lung tissue of control showed apparently normal epithelial lining bronchioles, alveoli and pulmonary blood vessels (Fig. 1j). moreover, the lungs of both D2 and D3 groups showing normal cuboidal to low columnar epithelial lining bronchiole with normal alveolar structures as well as normal columnar ciliated epithelial lining bronchi with cartilage within its wall and normal alveolar tree (Fig.1k). Lung of D4 treated rabbits showing normal histomorphology of alveolar structures and bronchioles with peribronchial lymphoid follicles (Fig. 1l).

DISCUSSION

The greatest replacement level (D4) substantially ($P<0.05$) negatively affected the digestibility of DM, OM, CF, and NFE compared to control (D1) and the lowest replacement level (D2), which may be associated to reduced feed intake and CP, NDF, and ADL contents (Ajayi et al. 2008). The digestibility results were reflected in the estimated nutritional values of TDN, DCP, and DE. (Sallam et al. 2019), on the other hand, found that the total replacement of sorghum with Panicum, which was fed to Barky sheep, had no effect on the digestibility of most nutrients. In addition, (Refaie et al. 2020) observed that replacing Pm up to 45 percent for clover hay in growing rabbit diets significantly ($P<0.05$) affected the digestibility of CP and CF, while the rest of the nutrient digestibility was not significantly affected. Additionally, the highest Panicum for clover hay replacement level (D4) reduced daily feed intake considerably ($P<0.05$) compared to the control and lowest replacement levels. This impact might be connected to the high NDF and ADL content and reduced CP of the studied diets compared to the control diets (Ifeanyichukwu et al. 2007 and Ajayi et al. 2008). NDF has a low voluntary intake, while feed with a high CP content stimulates more feed intake (Mupangwa et al. 2000; Ajayi et al. 2008).

According to Refaie et al. (2020), replacement levels of Pm up to 45 percent for clover hay in growing rabbit diets had no effect on feed consumption. In addition, the DFI and nutrient digestibility results had an impact on daily body gain (DBG), final body weight, and feed conversion ratio (FCR). The animals that consumed the highest replacement level (D4) had the lowest ($P<0.05$) DBG (24.94g), the better ($P<0.05$) FCR (4.66), and the lowest final body weight (2089g) when compared to the control (26.11g, 4.76g, and 2194g) and the other replacement levels D2 (25.59, 4.86, and 2132g), respectively. In compared to control value (4.76), FCR improved when the replacement level was increased to 4.88, 4.68, and 4.66 for D2, D3, and D4, respectively. (Bamikole and Ezenwa 1999) verified a similar finding, who claimed that feeding rabbits forage (Pm) with concentrate resulted in a higher FCR than feeding just forage. Also, Refaie et al. (2020)

found that feeding diets contained Pm to replace clover hay as a percentage of 15 percent, 30 percent, and 45% to growing rabbits improved FCR which indicated professional feed consumers. Furthermore, Uzegbu et al. (2010) discovered that feeding pigs with 5% fresh Pm resulted in decreased feed consumption and a better FCR of 20.2% than the control.

The treatments had no significant (P<0.05) influence on the carcass traits of rabbits given various levels of PM (P<0.05). Refaie et al. (2020) discovered that when rabbits were fed graded Pm levels up to 30% clover hay compared to control groups and the 45% Pm replacement level, the percentage of carcass and foreparts enhanced significantly (P<0.05).

There were no significant changes in sperm characteristics in all of the diets studied, indicating that Panicum maximum had no effect on sperm concentration when compared to clover hay. There is a possibility that this impact is due to an increase in testosterone synthesis (a hormone necessary for the completion of spermatogenesis (Walker 2009) or it could be due to Panicum maximum's antioxidant action (Okokon et al. 2011), which protects various stages of spermatocytes from apoptosis, resulting in increased sperm production. Panicum supplementation showed no influence on the quality of sperm cells, including motility and viability. The sperm fertilization process requires all of these characteristics to be present (Dalton 2011).

The result of economic evaluation revealed that the inclusion of Pm hay as a replacement for clover hay enhanced net revenue by lowering feed cost and showed the best relative economic efficiency value (114%) with the highest replacement level when compared to the control diet.

When comparing the results of this study to those of other researchers, the differences might be due to the experimental and environmental conditions under which the test was conducted. Rabbits' hematological parameters are affected by stress, age, season, and dietary and hormonal state (Melillo 2007; Çetin et al. 2009). The HTC and HGB of acquired values in general revealed the absence of anemia and other diseases affecting RBCs (George and Sese 2013). In addition, the WBC and its differential (LYM) levels showed that the rabbits were healthy throughout the trial (Ahamefule et al. 2008; Etim and Oguike 2011). As shown in the histology sectors, the increase in WBC in Pmh groups might be due to congestion in the liver and kidneys. Overall, replacing berseem hay with panicum maximum keeps the rabbits' hematological parameters within normal limits without affecting their health or welfare.

Histological lesions were discovered in rabbits fed (D4) diets; thus, such lesions might be caused by increasing the Pmh replacement level for clover. The liver, lung, and kidney histological evaluations and tests revealed no significant evidence of cellular atypia, demonstrating the Panicum maximum does not cause tissue injury in rabbits. The kidney and testes lesions in certain animals were consistent with heat stress-induced inflammation. Where renal insufficiency is the cause of gonadal impairment (Nakada and Adachi 1999). The liver lesions were associated with increased WBC levels and were thought to be due to biliary stasis or lipidosis (Melillo 2007). In general, Heat stress may be to blame for the rabbits' histopathological lesions (Zeferino et al. 2013).

Conclusion

The results revealed that Panicum maximum had no negative impacts on rabbit productivity or health, and that it may be utilized as an alternative feed source and economical forage in rabbit feeding.

Author's Contribution

SSB, SAS and MEAE made the research design and executed the study with correlation with statistical analysis. MMA and AMS helped in photo editing and manuscript revising. All authors helped in practical part of the research and manuscript reviewing and confirmed the last form of manuscript.

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