UTILIZATION OF SPROUTED FENUGREEK AND/ OR SPROUTED BARLEY IN RABBIT FEEDING.

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SUMMARY

This study was carried out to investigate the possibility of using vegetated fenugreek seeds and /or barley grains on rice straw as a bedding material in growing rabbit's diet. A total number of sixty growing New Zealand White (NZW) rabbits at 7- weeks of age (with an average weight of 1138 ± 32g) were randomly divided into 6 equal groups, 10 for each in 2 replicates. Rabbits were fed control diet and 5 experimental diets contained hydroponically sprouted fenugreek seeds (SF) or/ and hydroponically sprouted barley grains (SB) and their mixtures at different levels (0, 25, 50, 75 and 100%, respectively) from dietary clover hay. The experimental diets were fed for 10-weeks. The results showed that: rabbits fed D_2 and D_6 (28% SF and 28% SB) recorded the highest body weight gain being 1370 and 1325g, respectively compared with 1320g for control. Feed intake was the lowest for D_3 and D_2 which contained 21% and 28% SF, respectively. While, D_4 (14% of both SF and SB mixture) recorded the highest feed intake. Rabbit fed D_2 (28%SF) recorded better feed conversion followed with D_6 (28%SB). The results indicated that OM, CP and NFE digestibility values of the experimental diets were higher than values of clover hay (control). Also, OM digestibility for D_2, D_3, D_4, D_5 and D_6 were improved by 14.5, 10.9, 6.9 14.7 and 12.2%, respectively compared with clover hay diet. The nutritive value as TDN and DCP was improved in all experimental groups compared to the control. Nitrogen balance percentages were positive in all diets, where, D2 (28%SF) and D_6 (28%SB) had the highest nitrogen balance value. The groups fed diets D_2 (28% SF) and D_6 (28% SB) recorded the best economical efficiency values (2.25 and 1.96, respectively), the least value was detected for D_4 (1.52). The present results showed that the highest relative economical efficiency (146.10%) was for group D_6 followed by those fed D_2 (127.27%).

From the results of the present study and economical point of view, It can be concluded that, rabbits could be fed on diets containing sprouts fenugreek seeds or/and sprouts barley grains completely replacing for clover hay without any bad effect on growth and feed utilization.

Keywords: *hydroponic; barley; fenugreek; rice straw; digestibility; growth performance; economical efficiency.*

INTRODUCTION

Limited research has been conducted on the feeding value of either sprouted grains or legume seeds and their mixtures for growing rabbits under desert environmental conditions.

Today, hydroponics is an established branch of agronomy. Progress has been rapid, and results obtained in various countries have proved it to be thoroughly practical and to have very definite advantages over conventional methods of horticulture. The two chief merits of the soil-less cultivation of plants are, first, much higher crop yields, and second, hydroponics can be used in places where in-ground agriculture or gardening is not possible (Dung *et al.*, 2010).

Hydroponically sprouted grains (barley) and legume seeds (fenugreek) contain higher CP, CF, ash, minerals, and vitamins contents (Morgan *et al.*, 1992).

A marked increase has been observed in both NPN and free amino acid as well as in-vitro digestibility and anti nutritional factors (namely trypsin inhibitor and hemoglutin). Vegetating some seeds or grains on some agricultural by-products is a type of hydroponics without soil which includes water or sand culture, gravel culture or any agricultural by-products (rice straw) as bedding material. (Bustos *et al.*, 2002).

Plaza *et al.* (2003); Nutrigrass (2007); Koehler *et al.* (2007) and Abbase (2009) indicated that the hydroponically sprouted grains and seeds leads to the activation of hydrolysis enzymes such as β-gluconase which led to hydrolysis of complex carbohydrates and protein to simpler components leading to an increase in quality of amino acids as well as the concentration of vitamins.

Abd El-Nabi (2007) showed that, using barley grains during vegetation (sprouted barley) and sprouted mix of 50% fenugreek seeds and 50% barley grains were significantly higher in CP and OM content by 118% and 84.9%, respectively and lower CF and ADF content by 44.4% and 27.5%, respectively compared with the control. On the other hand, on large scale, the DM losses by sprouting process could add to the cost of animal production (Dung *et al*, 2010).

The objective of this study is to evaluate both of sprouted fenugreek seeds and sprouted barley grains using rice straw as a bedding material and to study the ability to replace clover hay with different levels of each and their mixture on growing rabbits performance, carcass characteristics, blood parameters and economical efficiency under desert environmental conditions.

MATERIALS AND METHODS

The present study was carried out at Rabbit Research Station belonging to Environmental Studies and Research Institute, Minufiya University, Sadat City, Minufiya Governorate, Egypt.

Experimental animals:

A total number of sixty males New Zealand White (NZW) rabbits at 7 weeks of age (average body weight1138±32g) were used. Rabbits were randomly divided into 6 equal groups, 10 for each in 2 replicates (5 for each).

Feeding trial:

Rabbits were housed in galvanized wires cages batteries and kept under similar managerial conditions. Diets were offered to rabbit's *ad libtium* and fresh water was automatically available all time.

Preparing of hydroponically- sprouted plants:

Rice straw, as the bedding material was chopped (2- 4cm) and soaked in water for one hr. Two types of vegetation being barley grains and fenugreek seeds were soaked in the same time for 24 hrs. The soaked rice straw was furnished as a bedding material .Barley grain and fenugreek seeds were vegetated on this bedding at ratio of 1:1.5 fenugreek seed or barley grains and rice straw, respectively. The growing time of hydroponic plants takes as little as 15 days from seed germination to a fully grown plant as at a height of 20 – 25 cm ready for harvest. Then, the sprouted hydroponic complete plant were dried manually till complete dryness and assigned to chemical analysis .The chemical composition of the sprouted hydroponicaly plants are shown in Table (1).

Table (1): The chemical composition of clover hay, sprouted barley grain (SB) and sprouted fenugreek seeds (SF). (On DM basis).

Item	CH%	SF%	SB%
OM	88.94	88.18	87.23
CP	15.46	26.25	15.38
CF	27.81	16.84	20.25
EE	1.82	1.51	1.70
NFE	43.85	43.58	49.90
Ash	11.06	11.82	12.77
**Cell wall constituents:*			
NDF	52.56	42.21	38.86
ADF	35.12	27.19	22.06
ADL	5.75	5.12	4.80
H .Cellulose	17.44	15.02	16.80
Cellulose	29.37	22.07	17.26

*CH = clover hay, SB = sprouted barley, SF= sprouted fenugreek, CF=crude fiber. *NDF: Neutral detergent fiber; ADF: Acid detergent fiber; ADL: Acid detergent lignin; Hemi cellulose = NDF – ADF; Cellulose = ADF – ADL.*

Formulation of the experimental diets:

Six experimental diets (one served as control and five diets contained five hydroponically sprouted barley grain and/or fenugreek seeds and their mixtures) which were replaced dietary clover hay at levels (0, 25, 50, 75 and 100%), respectively within experimental treatments as follow:

D_1: Control (commercial pelleted basal diet). ; D_2: (100% of clover hay replaced with Hydroponically sprouted fenugreek (SF); D_3: (75% of clover hay replaced with (SF) +25% of clover hay replaced by hydroponically sprouted barley (SB) ; D_4: 50% of clover hay replaced with (SF) +50% of clover hay replaced with (SB). ; D_5: (25% of clover hay replaced with (SF) +50% of clover hay replaced with (SB)and D_6: (100% of clover hay replaced with (SB).

The diets were prepared in a pelleted form, iso-nitrogenous, iso-caloric and had nearly equal level of CF to cover requirements of growing rabbits according to NRC (1977) Table (2). Live body weight and feed consumption were recorded at weekly intervals. Feed conversion ratio (FCR) was also calculated. Performance Index % (PI) was calculated as: "PI% = LBW (kg) / FCR X100" according to (North, 1981). The biological value (BV) was calculated as nitrogen retained (NR)/ nitrogen intake (NI) according to following procedures of AOAC (2000) and Van Soest *et al.* (1991).

Table (2): Formulation of the experimental diets*.

Ingredient	Control	100%SF	75%SF +25%SB +7%SB	50%SF+ 50%SB +14%SB	25%SF+ 75%SB +21%SB	100% SB
	D_1	D_2	D_3	D_4	D_5	D_6
Clover hay (CH)	28	-	-	-	-	-
Sprouted Fenugreek (SF)	-	28	21	14	7	-
Sprouted barley (SB)	-	-	7	14	21	28
Wheat bran	28	37	35	35	30	25
Barley	20	15	15	15	15	15
Soybean meal (44%CP)	12	15	15	15	18	20
Yellow corn	10	3	5	5	7	10
Limestone	1	1	1	1	1	1
NaCl	0.5	0.5	0.5	0.5	0.5	0.5
Vit & Min. premix**	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100
Proximate analysis(%) of experimental diets (On DM basis):						
DM	91.00	89.00	88.00	88.90	90.10	91.00
OM	86.96	86.72	85.57	85.23	85.19	85.68
CP	18.11	17.95	18.00	18.05	18.18	18.15
CF	14.69	15.21	14.98	14.99	16.64	15.63
EE	7.24	6.36	6.98	6.56	6.82	5.88
NFE	46.92	47.20	45.61	45.63	43.55	46.02
Ash	13.04	13.29	14.43	14.77	14.81	14.32
DE(Kcal/Kg) diet) ****	2470	2451	2457	2452	2401	2440
Price of 1kg feed (P.T) (PT)***	220	205	200	196	194	189

* *Calculated according to NRC (1977).*

** *Each one kg of vitamin & mineral mixture contains: Vit. A 4000000 IU; Vit D_3 50000IU; Vit E 16.7g; Vit K_3 0.67g; Vit.B_1 67g; VitB_2 2.00g; Vit. B_6 0.67g; Vit B_{12} 3.33mg; Cholin chloride 400g.; Biotin 0.07g ;Niacin 16.7g.; pantothenic acid 6.7g; Folic acid 1.7g;; Copper 1.7g; Iron 25.00g; Manganese 10.00g; Iodine 0.25g; Selenium 33.3g; Zinc 23.3g and Magnesium 133.3g.*

*** *According to the local prices of these ingredients at the experiment time (during 2005).The prepared diets were iso-nitrogenous, iso-caloric and had nearly equal level of CF.*

*****DE (Kcal/g)=4.36-0.0491xNDF%&.NDF, %=28.924+0.657xCF%. (Cheeke, 1987)*

D_1: Control diet; D_2: Diet contained 28% HFM; D_3: Diet contained 21% HFM+7% HBM; D_4: Diet contained 14% HFM+14% HBM; D_5: Diet contained 7% HFM+21% HBM; D_6: Diet contained 28% HBM

Digestibility trials:

At the last week of experimental period, a digestibility trial was carried over a period of 5 days with 3 rabbits per treatment housed individually in metabolic cages. The feed intake, total collection of feces and urine were conducted to determine the digestion coefficients of nutrients and feeding values of the experimental diets.

Carcass traits:

At the end of the feeding period, three representative rabbits from each treatment were randomly chosen and fasted for 12 hours before slaughtering according to Blasco *et al.* (1993) to determine the carcass traits.

Caecum samples:

After slaughtering, the content of caecum of the three rabbits from each treatment was obtained to determine the pH values and volatile fatty acid (VFA) content. Caecum pH value was measured using pH meter (model HI8428). Diluted cecal content and VFA concentration was determined by steam distillation as mentioned by Eadie *et al.* (1967).

Blood plasma analysis:

Blood samples were collected from the slaughtered rabbits (3 bucks within each treatment) for determination of plasma total protein, albumin; total cholesterol; creatinine (mg/dl); triglycerides; AST and ALT using commercial Kites.

Proximate composition:

Proximate analysis of diets, dried feces and urine contents were carried out according to AOAC (2000). Digestible energy (DE) was calculated according to Cheeke (1987). The fiber fractions of the experimental diets were determined according to Goerging and Van Soest (1970).

Economical efficiency (%):

Economical efficiency (%) of experimental diets was calculated according to the local market price of ingredients and rabbit live body weight. Net revenue = Total revenue – Total feed cost. Economical efficiency (%) = Net revenue / Total feed cost.

Statistical analysis:

Data were statistically analyzed according to SAS (1999). The significant differences between means were tested by using Duncan's multiple range test (Duncan, 1955). The statistical model used was the one way analysis of variance as follows: $Y_{ij}=u+A_i+e_{ij}$, Where: Y_{ij} = Represented observation, u = Overall mean, A_i = Effect of diets, e_{ij} = Experimental random error.

RESULTS AND DISCUSSION

Chemical composition:

The chemical composition of clover hay (CH), sprouted barley grain (SB) and sprouted fenugreek seeds (SF), using rice straw as bedding material are presented in Table (1). The data indicated that SF had the highest CP content and lowest contents of CF, NDF, ADF, ADL and cellulose, while the content of OM, NFE and hemicellulose were close to CH. Similar percentage of CP was detected in both SB and CH, while SB contained lower percentage of CF and cell wall constituents than CH. These results may be due to the vegetation processes of both SB and SF. In this connection, El Mahdy and El-Sebaiy (1982) designed to determine the effect of germination on nitrogenous constituents', protein fraction, *in vitro* digestibility and anti nutritional factors (namely trypsin inhibitors and hemoglobin) of the Egyptian fenugreek seeds after 96 h of germination, there was 18% decrease in dry weight of seeds , a slight increase in total nitrogen. Plaza *et al.* (2003) and Koehler *et al.* (2007) indicated that the hydroponically sprouted of grains and seeds leads to the activation of hydrolysis enzymes which cause the inter conversion of carbohydrate and protein to simpler components leading to increase in quality of amino acids as well as the concentration of vitamins. Also, Abd El-Nabi (2007) showed that all type of vegetation (barley, fenugreek and their mixtures) significantly ($P<0.05$) decreased DM amount, this decrease may be due to respiration of plants and loss part of organic matter as CO_2 .

Also, the results obtained were in agreement with those found by Dung *et al.* (2010) who showed that CP, ash and all minerals except potassium were lower in the barley grains than in the 7-day sprouted barley, being 12.6 *vs.* 15.4% for CP and 2.0 *vs.*4.3% for ash .The values of the calculated analysis of the experimental diets showed iso-caloric and almost iso-nitrogenous values. Crude protein was ranged from (17.95-18.15%), and digestible energy was ranged from (2401-2470 Kcal/Kg). In this connection, Intssar Eshtayeh (2004) found that vegetation of barley grains gave a higher percentage of vitamin E and beta

carotene and increased CP% from 11.1to16.9 %. The same trend was reported by Fathia Ibrahim *et al.* (2001) who found that vegetation barley grains on rice straw for 7-10 days increased CP and ash content by 210 and 4.93%, while decreased DM, OM, CF and NFE content by 0.88, 1.14, 30.44 and 15.65%, respectively compared with raw straw.

Growth performance:

The effect of replacing clover hay with either sprouted fenugreek seeds or sprouted barley grains and their mixture on growing rabbit performance are illustrated in Table 3. The average initial live body weight was 1138±32g. The final body weight and weight gain of rabbits fed D_2 was significantly ($P<0.05$) higher than the other experimental groups. These improvements may be due to increasing of nutrients bioavailability. In this respect, Shippared (2005) reported that when seeds or grains are sprouted, mineral chelate or merge with protein in away that increased their function and their bioavailability. Also, Abbase (2009) reported that, vegetated barley is rich in β-gluconase enzymes which led to hydrolysis complex carbohydrates to simpler nutrients.

Table (3): Growth performance as affected by using sprouted Fenugreek (SF), sprouted barley (SB), and their mixture. (Means ± SE).

Item		100%SF	75%SF + 25%SB	50%SF + 50%SB	25%SF + 75%SB	100%SB	Sig.
		D_2	D_3	D_4	D_5	D_6	
Initial weight (g)	1127.50 ± 34.82	1117.5 ± 11.19	1133.5 ± 41.77	1147.0 ± 32.74	1179.50 ± 32.38	1124.00 ± 36.46	NS
Final weight (g)	2448.00^{a} ± 83.65	2488.00^{a} ± 66.87	2188.57^{b} ± 83.04	2333.5^{ab} ± 61.27	2290.50^{ab} ± 70.23	2449.29^{a} ± 96.40	*
Total gain (g)	1320.50^{a} ± 72.7	1370.50^{a} ± 62.34	1054.50^{b} ± 70.2	1186.50^{ab} ± 46.18	1111.00^{b} ± 67.21	1325.30^{a} ± 94.64	*
Total Fl (g) 0-10 wks	5914.15^{a} ± 165.17	5635.15^{ab} ± 176.54	5179.57^{b} ± 263.06	6034.30^{a} ± 150.96	5559.20^{ab} ± 110.24	5423.07^{ab} ± 392.87	*
Daily gain (g)*	18.86^{a} ± 0.35	19.58^{a} ± 0.40	15.06^{b} ± 0.62	16.95^{ab} ± 0.50	15.87^{b} ± 0.33	18.93^{a} ± 0.45	*
Daily feed intake(g)	84.49^{a} ± 0.52	80.50^{a} ± 0.54	73.99^{b} ± 0.62	86.20^{a} ± 0.57	79.42^{ab} ± 0.56	77.47^{ab} ± 0.25	*
Feed Conversion (g. feed/g gain)	4.48^{ab} ± 0.25	4.11^{b} ± 0.22	4.51^{ab} ± 0.32	5.08^{a} ± 0.17	5.00^{a} ± 0.26	4.16^{b} ± 0.10	*
Total (PI %)	54.64^{ab} ± 4.28	45.83^{b} ± 2.34	45.80^{b} ± 3.62	55.14^{ab} ± 1.72	45.80^{b} ± 3.62	55.14^{ab} ± 1.72	*

^{a,b} Means in the same row with different superscripts differ significantly ($P\leq0.05$). NS: not significant.

**Experimental period (70 days).*

Data presented in Table 3 showed that substitution of CH (Control , D_1)with SF and SB vegetated on rice straw at the level of 28%SF and 28%SB of the diets D_2 and D_6, respectively were comparable to D_1 in total weight gain, being (1370 and 1325 *vs.* 1320g) . In this connection, Ibrahim *et al.* (2001) and Abd El-Nabi (2007) indicated that feeding lambs with vegetated barley recorded higher gain than lambs fed barley grains without vegetation. On the other hand, there was a decrease in total weight gain by feeding rabbits D_3 and D_5 by 20.1 and 15.8%, respectively compared with rabbits fed D_1 as control diet (Table 3). This decrease may be due to lower feed conversion (g feed/g gain) in D_3 and D_5 being 4.51 and 5.00 *vs.* 4.48 for group D_1, respectively.

Feed consumption is presented in Table 3. Daily feed intake during the experimental period was slightly low with rabbit on groups D_2, D_3, D_5 and D_6 compared with clover hay D_1. These results agree with the findings of Nava Zavaleta *et al.* (2004) who reported that, rabbits fed hydroponic barley or hydroponic wheat gained better than those fed unhydroponic barley or wheat grain. However, it showed that animals fed D_4 (14% SB +14% SF mixture) consumed higher than other Experimental groups. This may be due to the process of vegetation which makes roughage more softness and more palatable (El-Ashery *et al.*, 2001 and Abbase, 2009). Moreover, animals which fed D_2, D_3 and D_5 received more TDN intake than D_4, where they were higher in TDN% than D4 by 4.7, 2.2, and 4.4%, respectively (Table4).

Data in Table 3 indicated that the best feed conversion(FCR) (g feed/g gain) was observed with feeding rabbits D_2 followed by D_6 being 4.11 and 4.16, respectively ,while the worst feed conversion was found for rabbits fed D_4(5.08)followed by those fed D_5(5.00). This improvement in FCR for such diets ($D_2$and D_6) may be due to the higher body weight gain and lower feed intake, beside their higher NB

(Table5). These results agreed with the findings of Ibrahim et *al.* (2001); Mahrous and Abo Ammou (2005). Also the result of Abd El- Nabi (2007), who indicated that feed conversion of lambs fed vegetated barley or fenugreek was better than those fed un- vegetated barley grains.

Digestion coefficients, nutritive values and nitrogen balance:

Data in Table 4 indicated that OM, CP and NFE digestibility values of the experimental diets were higher than values of clover hay (control).This increase may be due to the improvement of chemical composition of vegetated diets (increasing OM, CP, NFE and decreasing the content of CF (Table1).These results agree with that obtained by El-Ashery *et al.*(2001) as well as Abd El-Nabi (2007),who reported that biological treatments of straw led to an increase of CP content and nutrient digestibility. In this respect, Abo-Donia *et al.* (2005) mentioned that the improvement of nutrients digestibility with fenugreek and its mixture could be illustrated on basis that fenugreek contain saponins which stimulate anaerobic fermentation of OM that improve efficiency of utilization of nutrients. Moreover, Abbase (2009) reported that vegetated barley is rich in *β–gluconase* enzymes which led to hydrolysis of carbohydrates complex to simpler nutrients.

Also, there was an increase in OM digestibility for D_2, D_3, D_4, D_5 and D_6 by 14.5, 10.9, 6.9 14.7 and 12.2%, respectively compared with clover hay diet .While, there were no significant differences in the OM digestibility among the five tested groups. This could be explained on the basis that vegetation process improved the digestibility and nutritive value of rice straw as bedding material (El-Ashery *et al.*, 2001 and Abbase, 2009) So that, it gave the best results and emphasize the ability of replacing clover hay by the sprouted materials as good quality roughage. Similar findings had been obtained by Koehler *et al.* (2007) who reported that, this improvement may be due to the enzyme activity of many bacteria and fungi which depend on association with plants that often regulated by root exudates . The present data support those obtained by Ibrahim *et al.*(2001), who noticed an increase in the digestibility of DM ,OM , CP ,CF ,EE and NFE by 51.3, 37.7, 103.3, 44.6, 9.6 and 27.7%, respectively when sheep were fed diet contained sprouted barley-straw compared with those fed diet contained raw rice straw.

Table (4): Digestion coefficients, nutritive values and nitrogen balance of rabbit fed tested diets (Means ± SE).

Item	Experimental Diets							
	D_1	D_2	D_3	D_4	D_5	D_6	±SE	Sig.
Digestibility%								
DM	71.20	74.68	71.04	69.79	74.66	72.41	2.82	NS
OM	63.03^{b}	72.15^{a}	69.69^{ab}	67.37^{ab}	72.32^{a}	70.67^{ab}	3.32	*
CP	83.50^{b}	85.62^{ab}	85.15^{ab}	85.32^{ab}	85.63^{ab}	87.31^{a}	1.67	*
CF	42.25	50.50	47.10	40.32	51.62	48.71	7.21	NS
	81.82^{ab}	78.53^{b}	84.93^{ab}	87.31^{a}	83.17^{ab}	85.64^{ab}	3.11	*
	62.31^{b}	73.85^{a}	68.12^{ab}	66.1^{ab}	72.53^{ab}	71.76^{ab}	3.31	*
Nutritive value %								
TDN	63.88^{b}	67.62^{a}	65.96^{a}	64.57^{ab}	67.43^{a}	69.34^{a}	2.95	*
DCP	15.12^{b}	15.53^{ab}	15.39^{ab}	15.65^{ab}	15.64^{a}	15.67^{a}	0.27	*
Nitrogen balance (g/h/d)								
N. Intake (N I)	3.15	2.99	3.00	3.42	2.81	3.42	0.3	NS
Fecal N.(F N)	0.50	0.43	0.38	0.51	0.36	0.50	0.08	NS
Urinary N (UN)	0.76^{ab}	0.59^{b}	0.99^{a}	0.68^{ab}	0.95^{a}	0.82^{ab}	0.23	*
N. retained (NR)	1.89^{ab}	1.97^{ab}	1.64^{b}	2.24^{a}	1.51^{b}	2.10^{a}	0.11	*
Biological value (NR/NI)	59.93^{ab}	65.74^{a}	54.60^{b}	65.23^{a}	53.26^{b}	61.44^{ab}	2.10	*

^{a,b} Means in the same row with different superscripts differ significantly ($p \leq 0.05$).

NS not significant.

Table (4) showed the nutritive values expressed as TDN and DCP. There was a significant increase among the range of tested groups compared to D_1being (63.88%) vs. (64.57 to 69.30 %). Values of DCP showed the same trend. The data also showed that all tested groups (from D_2 to D_6), which contained vegetated diets were higher than the un vegetated diet (D_1). This increase may be due to the significantly improvement in digestion coefficient of most nutrient of such vegetated diets. It also could be due to the improvement of nutrients quality, because of the ability of sprouted germinated plants to transport nutrients to the roots to meet the requirement for strong healthy vegetative growth, besides increasing protein, vitamins and minerals content during vegetation process (Shippared, 2005 and Dung *et al.*, 2010).

In this respect, Ibrahim *et al.* (2001) found that, there was an increase in nutritive value as TDN and DCP by 34.1 and 166.8%, respectively for sprouted barley compared with raw straw. Moreover, results of Abd El-Nabi (2007) found that using sprouted barley with sprouted fenugreek mixture in sheep diet improved TDN and DCP values, compared with diet contained unvegetated barley and fenugreek seeds.

Data of nitrogen balance (NB) (Table 4) showed that there was a significant ($P<0.05$) increase in NB with D_4 and D_6 compared with other diets. Highest values of nitrogen intake was found in D_6 followed by D_4 (contained vegetated fenugreek and barley) . These results agreed with those obtained by Ibrahim *et al.* (2001) and Abd El-Nabi (2007). The biological value (BV) (NB/NI) presented in (Table 4) cleared the same trend.

Blood parameters:

Blood constituents as affected by the different experimental diets are shown in Table (5). The decrease in blood cholesterol of all tested diets was mainly due to the effect of vegetated plants on degradation of cholesterol to bile salts and lowering its deposition in blood vessels (Ginter, 1975 and John and Sons, 1996). These results insure the beneficial effect of sprouted plants on lowering the cholesterol and ALT in blood plasma by adding vegetated fenugreek and barley with different levels to rabbit diets .This result agreed with Ibrahim *et al.* (2001) who reported that liver enzyme concentration reduced by using sprouted barley in sheep diets. Also, Sharma (1986) showed that Fenugreek increased excretion of bile acids and neutral sterols in feces and depleting the cholesterol stores in the body in experimental rat. Moreover, Awal *et al* (1999) showed that fenugreek significantly reduces the blood lipid level.

Carcass characteristics:

Data presented in Table (5) indicated that Dressed carcass were significantly ($P<0.05$) higher in all tested diets than control. Data indicated also that group fed D_1 (control) had significantly ($P<0.05$) higher abdominal fat (34.13 g) while D_2 and D_3 had the lowest values of abdominal fat (14.00 and 19.53 g), respectively while, the other experimental diets did not significantly differ from each other and had intermediate values .These results are in agreement with those obtained by khalifa (2010) who fed rabbits on *Nigella Sativa* meal.

Caecal activity:

Caecal activity as affected by dietary vegetated barley grains and fenugreek seeds, are present in Table (5). Data showed that the caecal weight percentage of rabbits fed D_6 was higher than control, being 10.13% *vs.* 8.55 %. Also, the same trend had been observed with the caecal length, being (11.50 cm) for D6 compared with (10.33 cm) for D_1, with no significant differences. Similar results were obtained by Ahmed (2010) who found that caecum length ranged from 9.5–14.0 cm. Also, El-Sayaad *et al.* (1996) reported that the caecal volume increased in rabbits fed different CF levels, with no significant differences.

Data in Table 5 showed that rabbits fed dietary sprouted-barley grains and fenugreek seeds significantly ($P<0.05$) achieved less caecal pH values than control diet. (6.95 and 6.94 for D_2 and D_6 *vs.* 7.50 for D1, respectively). These results causees higher fermentation rate and explained higher digestibility's and nutritive values of rabbits fed such tested diets. (El-Ashery *et al.*, 2001; Musa, 2008 and Abbase, 2009)

Data in Table (5) showed the effect of dietary experimental diets on microbial activity represented on TVFA's production in the caecum. Total VFA's tended to be significantly ($P<0.05$) higher in caecum content of rabbits fed D2 and D6 diets, than other diets including D_1. These results are in accordance with those obtained by Abd El-Nabi (2007) who reported that dietary sprouted-fenugreek, barley mixture increased TVFA's in rumen of sheep. It is obvious from the data presented herein that the VFA's concentration was in opposite trend with pH values, which were expected. Similar findings was reported by Musa (2008) who indicated that the progress of increasing caecum VFA's concentration paralleled reduction in pH values. The VFA's are produced as an end products of bacterial fermentation in the rabbit caecum (Cheeke, 1987). Using VFA's as source of energy has been estimated to provide 40% of the maintenance energy source for metabolism of the hind gut tissue (Marty and Vernary, 1984).

From these results , it could be concluded that rabbits fed sprouted barley grains and fenugreek seeds contained diets, have the highest weight and longest ceca and produce more VFA's concentration (Table 6) ,which indicate the higher fermentation rate and explained higher digestibility's and nutritive values of rabbits fed such tested diets.

Table (5): Blood plasma constituents, Carcass characteristics and Caecum activity of growing NZW rabbits as affected by feeding different levels of sprouted Fenugreek (SF) ,Sprouted barley(SB) and their mixture (Means ± SE).

Parameter	Control	Tested diets					Sig.
	D_1	D_2	D_3	D_4	D_5	D_6	
Blood plasma constituents:							
Cholesterol (mg/dl)	84.41^{a} ±1.8	36.32^{c}±3.33	60.44^{b}±5.99	40.52^{c}±1.95	42.93^{c}±2.11	36.74^{c}±1.90	*
Triglycerides (mg/dl)	140.3^{ab}±6.4	133.8^{b}±1.07	133.36^{b}±1.43	150.74^{a}±2.58	140.5^{ab}±2.02	133.7^{b}±1.71	*
(AST) (u/L)	2.06^{b}±0.13	2.18^{b}±0.132	3.63^{a}±0.56	2.26^{b}±0.19	2.15^{b}±0.171	2.14^{b}±0.14	*
(ALT) (u/L)	7.15^{a}±0.10	6.29^{ab}±0.22	7.02^{a}±0.21	6.51^{ab}±0.41	6.03^{bc}±0.22	5.24^{c}±0.36	*
Carcass characteristics:							
Empty carcass t. (g)	1169^{b}±8.28	1180^{b}±14.2	1194.1^{b}±4.1	1315.2^{ab}±55.3	1273.87^{ab}±98	1374.6^{a}±40	*
Dressing %	50.73±0.92	54.35±1.15	53.38±1.88	52.86±0.45	53.37±2.36	52.31±0.20	NS
Deboning%	83.3±2.36	83.63±1.39	79.43±4.38	78.83±4.14	81.95±1.76	76.33±1.60	NS
Abdominal fat wt. (g)	34.13^{a}±6.81	14.00^{c}±2.06	19.53^{bc}±2.91	29.43^{ab}±5.35	21.77^{abc}±4.87	24.93^{abc}±1.0	*
Edible giblets wt. (g)	110.2^{ab}±7.9	97.03^{b}±6.7	115.0^{ab}±4.17	124.59^{a}±10.3	112.0^{ab}±11.3	123.5^{ab}±5.4	*
Caecum activity:							
Caecum weight%*	8.54±087	7.07±0.07	7.41±0.10	8.13±0.07	7.91±0.51	10.13±1.29	NS
Caecum length, cm	10.33±0.93	10.00±0.29	10.73±0.23	10.58±0.8	10.10±0.86	11.50±0.29	NS
Caecum pH	7.50^{a}±0.24	6.95^{bc}±0.28	7.08^{b}±0.29	7.26^{ab}±0.65	7.07^{b}±0.28	6.94^{c}±0.2	*
TVFA meq/100 ml cecal juice	2.24^{c}±0.11	4.73^{a}±0.41	2.80^{bc}±0.19	2.26^{c}±0.12	3.08^{b}±0.05	4.85^{a}±0.20	*

**a. b. c. d Means in the same row with different superscripts differ significantly ($p \leq 0.05$). NS not significant.*

**As a % of body weight.*

D_1: Control diet; D2: Diet contained 28% HFM; D3: Diet contained 21% HFM+7% HBM; D4: Diet contained 14% HFM+14% HBM; D_5; Diet contained 7% HFM+21% HBM; D_6: Diet contained 28% HBM

Table (6): Economical efficiency of growing rabbits as affected by feeding dietary levels of sprouted fenugreek (SF), sprouted barley (SB) and their mixture.

Item	Control	Tested diets				
	D_1	D_2	D_3	D_4	D_5	D_6
Av. Total feed intake (Kg/rabbit) a	5.91	5.64	5.18	6.03	5.56	5.42
Price/ Kg feed (PT)* b	220	205	200	196	194	189
Total feed cost (LE) a x b = c	13.00	11.56	10.36	11.82	10.79	10.24
Av. Body weight gain (Kg/rabbit) d	1.32	1.37	1.06	1.19	1,11	1.33
Price / Kg live body weight (LE)** e	25	25	25	25	25	25
Total revenue (LE) (d x e = f)	33.00	34.25	26.50	29.75	27.75	33.25
Net revenue (LE) (f-c = g)	20	22.69	16.14	17.93	16.96	23.01
Economic efficiency *** (g/c)	1.54	1.96	1.56	1.52	1.57	2.25
Relative economic efficiency****	100	127.27	101.30	98.70	101.95	146.10

* *According to the price of different ingredients available in the market (2012).*

** *According to the local market price at the experimental period* *** *Net revenue per unit cost.*

**** *Compared to the economical efficiency of the control group.*

Economical efficiency:

Economical efficiency of tested diets is presented in Table 6. The profitability of using either sprouted fenugreek seeds or barley grains or their mixture in diets for growing rabbits depend upon their price and the growth performance of rabbit fed these sprouted products.

Data indicated that the highest economical efficiency value was for the group fed diets D_2 and D_6 which contained 28% SF and 28% SB, respectively, followed by those fed D_5 (14% of each) and D_3(21% SF +7% SB) . The least value was detected for D_4 (1.52). The present results showed that the highest relative economical efficiency (146.10%) was for group D_6 followed by those fed D_2 (127.27%), accordingly, under the condition of this study, those two groups could be recommended.

CONCLUSION

From the results of the present study, rabbits could be fed on diets containing sprouts fenugreek seeds or/and sprouts barley grains replacing for clover hay without any bad effect on growth and feed utilization.

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الاستفادة من بعض النباتات المستنبتة بدون تربة فى تغذية الأرانب.

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تهدف هذه الدراسة الي تقييم إمكانية استخدام كل من حبوب الشعير المستنبتة او بذور الحلبة المستنبتة علي قش الأرز بعد تجفيفها ، أو مخلوطهما في علائق الأرانب النامية كبديل لدريس البرسيم. استخدم في هذه الدراسة عدد 60 ذكر ارنب نيوزيلندي ابيض نامي في عمر 7 اسابيع بمتوسط وزن(1138 ± 32) جرام قسمت عشوائيا الي 6 مجموعات بكل مجموعة 10 أرانب نامية في مكررين بكل مكرر خمسة أرانب. غذيت الارانب علي 6 علائق تجريبية . عليقة الكنترول وعدد 5 علائق اخري تحتوي علي نبتة الحلبة او الشعير المستنبت (مضاف إليها طبقة قش الأرز الذي تم الإنبات عليها) ومخلوطهما بنسب (صفر , 25, 50, 75, 100%) بالإحلال محل دريس البرسيم في عليقة الكنترول وذلك لمدة 10 اسابيع ،وذلك لدراسة تأثير هذه العلائق التجريبية علي كل من: النمو – الغذاء المستهلك – الكفاءة الغذائية – معاملات الهضم والقيم الغذائية وميزان النيتروجين. وأوضحت نتائج هذه الدراسة الاتى :

سجلت مجموعة الارانب المغذاة علي العليقة المحتوية علي (100% إحلال نبتة الحلبة محل دريس البرسيم فى العليقة) اعلي معدل زيادة في الوزن يليها التي تغذت علي العليقة المحتوية على (100% إحلال نبتة الشعير محل دريس البرسيم فى العليقة) ثم عليقة الكنترول بينما كانت اقل المجموعات زيادة في الوزن التي تغذت علي العليقة المحتوية علي مخلوط (75% نبتة حلبة +25% نبتة شعير محل دريس البرسيم فى العليقة). كانت كمية الغذاء المستهلك خلال فترة التجربة اقل في المجموعة التي تغذت علي العليقة المحتوية علي مخلوط(75% نبتة حلبة +25% نبتة شعير محل دريس البرسيم فى العليقة). يليها المجموعة التي تغذت علي العليقة المحتوية علي (100% إحلال نبتة الحلبة محل دريس البرسيم فى العليقة) تليها المجموعة التي تغذت علي العليقة المحتوية على مخلوط (25% نبتة حلبة +75% نبتة شعير محل دريس البرسيم فى العليقة). بينما كانت أكثر المجموعات استهلاكا للغذاء تلك التي غذيت علي العليقة المحتوية علي مخلوط (50% نبتة حلبة+50%نبتة شعير محل دريس البرسيم فى العليقة) مقارنة بمجموعة الكنترول.كما اظهرت مجموعة الارانب التي تغذت علي العليقة المحتوية علي (100% إحلال نبتة الحلبة محل دريس البرسيم فى العليقة) اعلي كفاءة تحويل غذائي بينما كانت اقل المجاميع للتحويل الغذائي هي التي تغذت علي المخلوط (50% نبتة حلبة+50%نبتة شعير محل دريس البرسيم في العليقة). أظهرت نتائج معاملات الهضم ارتفاع معاملات الهضم للمادة العضوية والبروتين الخام, المستخلص الخالي من النيتروجين في جميع المعاملات المحتوية علي نبتة كل من الحلبة والشعير او مخلوطهما مقارنة بدريس البرسيم بينما ارتفع معامل هضم الألياف في جميع المعاملات التجريبية مقارنة بدريس البرسيم ماعدا المجموعة المغذاه على مخلوط (50% نبتة حلبة+50%نبتة شعير محل دريس البرسيم في العليقة). وكان اعلاها في المعامله الثانية (100% إحلال نبتة الحلبة محل دريس البرسيم فى العليقة) . كانت القيمة الغذائية في العلائق التجريبية (على صورة المركبات الغذائية المهضومة والبروتين المهضوم) أعلي من عليقة المقارنة . كان المحتجز النيتروجيني موجبا في كل المجاميع المغذاة علي العلائق التجريبية وقد أظهرت المجاميع المغذاة علي العلائق المحتوية علي (100% احلال نبتة الحلبة محل دريس البرسيم فى العليقة) , (50% نبتة حلبة+50%نبتة شعير محل دريس البرسيم في العليقة) , (100% إحلال نبتة الشعير محل دريس البرسيم فى العليقة)اعلي نيتروجين محتجز مقارنة بالكنترول والعلائق الاخري.حققت كل من المجموعة الثانية (100% إحلال نبتة الحلبة محل دريس البرسيم فى العليقة) والمجموعة السادسة (100% إحلال نبتة الشعير محل دريس البرسيم فى العليقة) اعلى كفاءة اقتصادية (1,96، 2,25 على الترتيب) بينما حققت المجموعة الرابعة اقل قيم الكفاءة الاقتصادية .وكانت احسن قيم الكفاءة الاقتصادية نسبيا (عليقة المقارنة) أيضا تم تحقيقها بواسطة السادسة (100% إحلال نبتة الشعير محل دريس البرسيم فى العليقة) بنسبة 146,1% من عليقه المقارنة تلاها المجموعة الثانية (100% إحلال نبتة الحلبة محل دريس البرسيم فى العليقة) بنسبة 127,27 % 0

من نتائج تلك الدراسة ووجهة النظر الاقتصادية يمكن التوصية بأنه يمكن إحلال الشعير المستنبت او الحلبة المستنبتة على طبقة من قش الأرز إحلال كاملا محل دريس البرسيم في علائق الارانب النامية بدون حدوث اى أى أضرار على كل من النمو وأداء الإنتاج والقيمة الغذائية لتلك العلائق .