



EFFECT OF SUBSTITUTING ALFALFA HAY WITH GRADED LEVELS OF FENNEL AND BASIL STRAWS IN GROWING RABBIT DIETS

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ABSTRACT

The aim of this study was to investigate the effect of replacing alfalfa hay with graded levels of fennel and basil straws in the diets of growing rabbits aged from 5 to 11 weeks. Eighty-four unsexed, weaned New Zealand white rabbits, aged 5 weeks, were randomly assigned to seven dietary treatments (12 rabbits/treatment): A control diet; three diets the basil hay substituted for 25%, 50% and 75% of alfalfa straw; and three diets the fennel hay replaced 25%, 50% and 75% of alfalfa straw. Results obtained showed that replacement of alfalfa hay with 25 % fennel straw significantly reduced average daily gain compared with the other experimental treatments, while no significant difference was observed among the other experimental treatments during the stage 5-8 week. On the contrary, the animals fed diets contained 25 % fennel straw gave significantly higher average body weight gain compared with the other experimental groups and no significant differences were observed among the other experimental treatments during 8-11 weeks. Regarding body weight gain during the total period from 5 to 11 weeks of age, the result indicates that no significant differences among all treatments were detected. The values of FCR showed no significant differences within all tested groups. Rabbits group fed B50% recorded the highest significant digestibility coefficients of dry matter, organic matter, crude protein, ether extract, neutral detergent fiber, acid detergent fiber, TDN and DCP when compared to

all groups. Levels of basil straw and fennel straw in rabbit diets induced an insignificant effect on hemi-cellulose. There were higher dressing and hot carcass percentages were recorded with rabbits fed B50%. Plasma values of total protein, albumin, globulin, cholesterol or Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) concentration were not significantly affected due to adding basil straw and fennel straw to rabbit diets. Replacement alfalfa hay with fennel and basil straw resulted in decrease feed cost. Rabbits fed B25% showed higher economic efficiency percentage compared to the other treatments. The results revealed that using basil straw and fennel straw at 25% in growing NZW rabbit diets had no detrimental effects on productive performance, the physiological and biochemical status and it could be used economically instead of alfalfa hay.

Keywords: Fennel straw, Basil straw, Rabbit, Performance, Carcass traits, Economic efficiency

INTRODUCTION

The high cost of concentrate feed mixtures and alfalfa hays and unavailability of fresh Egyptian berseem (*Trifolium alexandrinum*) during the summer season are the major problems confronting the development of livestock. Therefore, it is believed that the inclusion of some agricultural by-products to replace a part of a conventional diet for animals has become an obligation (El-Tahan et al 2003). Also

using fennel hay in rabbit diets can be one of the alternative solutions to environmental problems in some regions as an Al Fayoum, where the Agriculture Wests accumulated and caused many environmental hazards.

Egypt likes other developing countries suffering from a deficiency in animal protein sources. So, emphasis should be placed on producing animals less competitive to man. The rabbit, being a non-ruminant herbivore, can efficiently utilize different sources of roughage and convert them into high-quality animal protein for human consumption.

Medicinal and aromatic plants are cultivated in large areas in Egypt about 48 thousand feddans were cultivated with medicinal and aromatic plants in Egypt (**Agriculture Economic, 2005**). Fennel (*Foeniculum vulgare Mill*) is cultivated in 2207 feddans and produced 3394 tons seeds and an average of 15-18 tons of green forages/feddan (**Abo-Zeid, 1988**). Basil (*Ocimum basilicum*) cultivated mainly to produce dry leaves and seeds in about 5300 feddan to yield about 13500 ton and 159000 tons of wastes (**Agriculture Economic, 2005**). Recently, **Radwan and Khalil (2002)** and **Abo Sekken et al (2008)** suggested that fennel hay (FNH) could be used in the rabbit diet up to 50% without any adverse effects on the performance of growing rabbits. Finally, **Abdel-Azeem et al (2010)** revealed that using fennel hay at a level 10.6% in growing NZW rabbit diets had no deleterious effects on physiological and biochemical status and it could be used economically instead of 33.33% clover hay in growing rabbit diets.

The aim of this study, therefore, was to evaluate effect of replacement of alfalfa hay with ascending levels of fennel hay and basil hay in rabbit diets on its productive performance.

MATERIALS AND METHODS

The present experiment was carried out at Rabbit Experimental Station, Faculty of Agriculture, Cairo University, Giza, the Labs of Regional Center for Food and Feed and Labs of Animal Nutrition, Faculty of Agriculture, Ain Shams University.

Experimental materials: The crop residuals of *Foeniculum vulgar* and *Ocimum basilicum* were used in this study. So we called them Fennel straw and Basil straw the materials were collected after harvesting the seeds and the straw were shopped before using in the diets

The fennel and basil straw were obtained from the private farm belonging to El-Qaliubiya governorate. The chemical compositions of both by-products in comparison with alfalfa hay are presented in **Table (1)**.

Experimental animals and diets

A total number of 84 unsexed, weaned New Zealand White (NZW) rabbits of 5 weeks old were randomly divided into seven equal groups, with four replicates of 3 rabbits with an average initial body weight of 625.42 ± 18.25 were used. The rabbits were assigned randomly to 28 experimental replicates.

Seven pelleted experimental diets were formulated to be approximately isocaloric, isonitrogenous and iso-fibrous. All experimental diets were formulated and pelletized at commercial feed plant belong to Egyptian Canadian (EGYCAN) Company to meet the recommended nutrient requirements of rabbits according to **NRC (1977)** and **Cheeke (1987)**, but with replacement of alfalfa hay with 0, 25, 50 and 75% of fennel or basil by-products. The experimental diets were formulated to contain 16.84 to 16.97% crude protein and 2502 to 2555 DE kcal/kg. The formula and chemical composition of the experimental diets are shown in Tables 2 and 3.

Animals management

The experimental rabbits were housed in metal battery cages (measuring 45 cm x 54 cm x 35 cm, four cages, each battery) supplied with separated feeders and automatic nipple drinkers. The experimental diets and clean water were offered daily, ad libitum, throughout the experimental period (6 weeks). Rabbits in all treatments were kept under similar conditions of management. Individual live body weight and feed consumption were recorded at weekly intervals during the experimental period (5-11 weeks of age).

Digestion trial

Digestion trials were conducted at the end of growth trial to determine the digestibility values and nutritive value of the experimental diets expressed as total digestible nutrients (TDN, %), digestible energy (DE, Kcal/Kg feed) and digestible crude protein (DCP, %). Four animals representing each group were individually housed in metabolic cages equipped with a stainless-steel screen and 4 mm mesh to retain feces but allow free passage of urine. Feed and water intake were offered to rabbits ad-

libitum during the digestion trial. The digestion trial lasted for 10 days as preliminary period while the collection period lasted for 5 days in which feces was collected daily before the morning meal, weighed fresh and sprayed with 2% boric acid for trapping any ammonia released from feces and dried at 60 °C for 24 hrs in an air drying oven. The feces were then ground, mixed, and stored for subsequent chemical analysis. Samples of diets and feces were chemically analyzed to determine the digestibility coefficients and nutritive values of the experimental diets. The digestible energy (DE) of the experimental diets was calculated according to **Fekete and Gippert (1986)** by applying the equation:

$$\text{DE (kcal/kg)} = 4253 - 32.6 (\text{CF}\%) - 144.4 (\text{total ash}\%).$$

Analytical methods

The proximate chemical analysis of experimental diets and dried feces samples for dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), and ash was carried out according to the Association of Official Analytical Chemists (**A.O.A.C. 2002**). Nitrogen free extract (NFE) of both feed and feces was determined by difference. Neutral detergent fiber (NDF), acid detergent fiber (ADF), and acid detergent lignin (ADL) were analyzed according to **Van-Soest et al (1991)**. Cellulose, hemicellulose and lignin were calculated according the following equation:

$$\text{Cellulose} = \text{ADF} - \text{ADL} \quad \text{Hemicellulose} = \text{NDF} - \text{ADF}.$$

The total digestible nutrients (TDN) were calculated according to the classic formula (**Cheeke et al 1982**).
 $\% \text{TDN} = \% \text{DCP} + \% \text{DCF} + \% \text{DNFE} + (2.25 \times \% \text{DEE})$.

Blood sampling and analysis

Blood samples were collected at slaughtering in heparinized glass tubes (6 samples per each treatment group). Blood plasma was separated by centrifugation at 4000 rpm for 15 minutes. The collected plasma was stored at -20°C until analysis. Total protein of blood plasma was determined as described by **Armstrong and Carr. (1964)**. Albumin was determined as described by **Doumas et al (1971)**. Globulin was calculated by difference. A: G ratio was calculated by dividing the value of albumin on the value of globulin. Cholesterol according to **Pisani et al (1995)**. Triglycerides according to **Greiling and Gressner (1995)**. Urea was determined using

Berthelot method according to **Fawcett and Soett (1960)**. Creatinine was determined by the method of **Husdan (1968)**. ALT and AST were determined by the method of **Reitman and Frankel (1957)**. Cholesterol in blood plasma was measured by quantitative enzymatic colorimetric determination according to **Stein (1986)**.

Cholesterol, triglycerides and urea are mentioned in Table 6 but not in methodology, please add them here. Add the source of kits, and system you have used for analysis (spectro or elisa version, and company).

Slaughter trial

At the end of the experimental period, four rabbits were selected from each treatment for slaughter test. The assigned rabbits were fasted for about 12 hours, after which they individually weighed and slaughtered to complete bleeding. The slaughter weight of each rabbit was recorded, and the skin was immediately loosened and removed. Liver, kidney, heart, head and the rest of the body were weighed to determine carcass weight dressing weight, total edible parts and non-edible parts. All records were related to the live body weight of the animal.

Caecum characteristics

After slaughtering, gastrointestinal tracts were individually removed from four rabbits from each group, the caecum was weighted and the pH value of the caecal content was measured using pH-meter.

Economic evaluation

The economic efficiency (EEF) was calculated according to the following equation: $\text{EEF} = \text{A-B/B} \times 100$. Where A is selling price of obtained gain (LE) and B is the feeding cost of this gain. The performance index (PI) was calculated according to the equation described by **North (1981)** by applying the equation:

$$\text{PI} = \text{Live body weight (Kg)} / \text{Feed conversion} \times 100$$

Statistical analysis

Data collected in this study were statistically analyzed using the general liner models (GLM) of (**SAS, 2002**). One-way model was used to study the

effect of treatment on different parameters, the used model was as follows:

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

Where:

Y_{ij} = The observation on the i^{th} treatment, μ = Overall mean

T_i = Effect of the i^{th} treatment and e_{ij} = Random error treatment.

Duncan's Multiple Range test (Duncan, 1955) was also used for the comparison among means of the experimental groups.

RESULTS AND DISCUSSION

1. Chemical composition of basil straw, fennel straw and alfalfa hay (% on DM basis)

The data of **Table (1)** showed that the alfalfa hay had relatively higher OM, CP, EE, DE than those in basil straw and fennel straw. On the contrary, the fennel straw had higher CF while, DM, OM, Ash content is close in the two fiber sources (basil straw and Fennel straw). Thus, that the fennel straw had higher NDF, ADF while basil straw had lower ADL than alfalfa hay and fennel straw. The same trend was obtained by **Ibrahim (2000)** who observed that DM in fennel straw was (92%) and ADL (14.18%). On the other hand, **Abdel-Azeem et al (2010)** found that the chemical composition of fennel hay contains 87.6, 11.6, 1.03, 13.5, 32.97 and 1375 for DM, CP, EE, Ash, NFE and DE (Kcal/kg).

2. Effect of replacement alfalfa hay with ascending levels of basil and Fennel straws in rabbit diets on ration formulation and its chemical analysis

The data of **Table (2)** showed that the different ingredients especially yellow corn, soybean meal, and wheat bran were used at different ratios to formulate the experimental diets to be approximately iso-caloric, iso-nitrogenous and iso-fibrous as possible. Additionally, they, approximately, contained similar levels of calcium, phosphorus, methionine + cysteine, and lysine.

Moreover, the data showed that the replacement of alfalfa hay with ascending level of basil and fennel straw resulted in gradually increased soybean meal % parallel to gradually decrease in wheat bran %. These actions have been done to get ap-

proximately isocaloric and iso-nitrogenous experimental diets. The previous data revealed theoretically that, it is possible to use basil straw and fennel straw as replacer to alfalfa hay with some modification in diet formula.

Table 1. Chemical composition of basil straw, fennel straw, and alfalfa hay meal (% on DM basis)

Items	Basil straw	Fennel straw	Alfalfa hay
Dry matter	92.25	92.42	88.95
Organic matter	80.41	80.71	87.87
Crude protein	11.23	7.00	20.85
Crude fiber	27.00	37.13	30.88
Ether extract	1.04	0.71	2.84
Ash	19.29	15.51	12.13
Nitrogen free extract	41.44	39.65	42.85
Neutral detergent fiber	40.43	59.54	46.06
Acid detergent fiber	37.5	50.31	35.97
Acid detergent Lignin	9.20	14.92	41.60
Hemicellulose	2.96	9.24	10.10
Cellulose	28.2	35.39	31.81
Lignin	7.95	11.93	8.20
Calcium(mg/kg)	5.018	3.035	3.07
Phosphors(mg/kg)	18.32	23.5	0.03
Digestible energy (Kcal/gm)	587.324	257.08	1494.74

The digestible energy (DE) was calculated according to **Fekete and Gippert (1986)** by applying the equation:-

$$DE \text{ (kcal/kg)} = 4253 - 32.6 \text{ (CF\%)} - 144.4 \text{ (total ash\%)}$$

The data of **Table (3)** showed that the control diet (Con0) showed the highest numerical values of CF, ADF and ADL contents, and the lowest value of EE contents. On the other hand, diet contained basil straw with 75% replacement level instead of alfalfa hay (B75) was numerically highest EE content, and lowest CP and DE contents, Furthermore, diet contained fennel straw with 75% replacement level (F75) was the highest CP component. Moreover, diet contained fennel straw 50% (F50) was the highest DE content. And, fennel straw diet (F25) was the lowest in CF component and by fiber fraction analysis the results concluded that: Control diet (Con0) was the highest ADF and ADL contents. Moreover, B75 treatment was the highest NDF content while F25 treatment was the lowest ADF and ADL contents.

Table 2. Formulation of experimental diets

Ingredients	Replacement level						
	(Con0)	Basil straw			Fennel straw		
		(B25)	(B50)	(B75)	(F25)	(F50)	(F75)
Barley grains	20	20	20	20	20	20	20
Yellow corn	10	10	10	10	10	10	10
Soybean meal	17.35	17.95	18.55	20.38	17.95	18.55	20.38
Wheat bran	20	19.5	19	17.6	19.5	19	17.6
Alfalfa hay	30	22.5	15	7.5	22.5	15	7.5
Basil straw	0.00	7.5	15	22.5	0.00	0.00	0.00
Fennel straw	0.00	0.00	0.00	0.00	7.5	15	22.5
Vegetable oil	0.3	0.3	0.3	0.2	0.3	0.3	0.2
Limestone	0.7	0.6	0.5	0.3	0.6	0.5	0.3
Salt (Nacl)	0.4	0.4	0.4	0.2	0.4	0.4	0.2
Methionine	0.1	0.1	0.1	0.17	0.1	0.1	0.17
Premix	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Calcium phosphate, dibasic	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Total	100	100	100	100	100	100	100
Price/ton	5170	5090	4990	4860	5070	5000	4870

*Each Kilogram of premix contains: 2000.000 IU vit. A, 150.000 IU vit. D, 8.33g vit. E, 0.33g vit K, 0.33g vit. B1, 1.0g vit. B2, 0.33g vit. B6, 8.33g vit. B5, 1.7 mg vit. B12, 3.33g Pantothenic acid, 33mg Biotin, 0.83g Folic acid, 200g Choline chloride, 11.7g Zn, 12.5g Fe, 16.6 mg Se, 16.6 mg Co, 66.7g Mg and 5g Mn.

Table 2. Formulation of experimental diets

Items	Replacement level						
	(Con0)	Basil straw			Fennel straw		
		(B25)	(B50)	(B75)	(F25)	(F50)	(F75)
Dry matter	91.56	92.48	92.25	92.18	92.35	92.37	91.41
Organic matter	92.5	92.5	92.19	91.65	91.77	91.87	91.39
Crude protein	16.96	16.93	16.92	16.84	16.94	16.97	16.96
Crude fiber	13.39	12.60	12.40	12.04	12.96	13.00	13.02
Ether extract	2.66	3.26	3.12	3.57	3.01	2.84	3.19
Ash	7.5	7.5	7.81	8.35	8.23	8.13	8.61
Silica	1.26	1.31	1.19	1.58	1.46	1.88	1.64
Nitrogen free extract	59.49	59.71	59.75	59.20	58.86	59.06	58.22
Neutral detergent fiber	26.62	24.8	25.27	26.81	23.6	24.76	26.76
Acid detergent fiber	18.72	16.35	17.06	18.19	18.3	16.55	17.99
Acid detergent Lignin	5.01	4.63	4.09	4.66	3.58	4.24	4.56
Hemicellulose	7.87	8.45	8.21	8.62	5.34	8.21	8.77
cellulose	13.74	11.72	12.97	13.53	14.76	12.31	13.43
Lignin	4.09	3.7	2.94	3.78	2.46	2.93	3.32
Digestible energy (Kcal/kg)	2552	2550	2529	2502	2550	2555	2538

3. Effect of basil straw and fennel straw inclusion in rabbit diets

3.1. Feed consumption (g/rabbit/day)

The data of daily feed consumption (DFC) presented in **Table (4)** showed that the group received F75 diets recorded numerically highest DFC, while the lowest DFC recorded for B50 treatment followed by F50, B75, B25, F25, respectively compared to the control group (Con0) during 5 to 8 weeks. On another hand, the groups order changed in the following periods (From 8 to 11 Weeks).

The data of **Table (4)** clearly showed that rabbit groups received a B75 diet recorded the highest DFC during 8-11 weeks of age followed by F50, B50 while the lowest DFC was recorded for Con0 treatment. Moreover, during the entire experimental period (5-11 weeks of age), the data revealed that the average DFC of B75 recorded the highest DFC followed by F25 and F75, compared to the control group (Con0), while the lowest DFC recorded for B25 followed by B50. These results may be attributed to that the different diets are approximately iso-caloric, iso-nitrogenous and iso-fibrous and contain a similar percentage of calcium, phosphorus, methionine + cysteine and lysine. These findings may be considered practical evidence that basil and fennel straw can be used as replacers to alfalfa hay as a source of fiber without any adverse effect on feed consumption. In this connection, **Abdel-Azeem et al (2010)** found that fennel straw increase daily feed consumption when it is replaced for clover hay at rate up to 33%. Also, they found that the mean feed consumption was low during the first period (6th and 7th weeks of age) then increased during the following periods up to the last period (9th and 11th weeks of age). Rabbits, like most animals, adjust their voluntarily feed intake to meet their needs. In addition, all experimental diets have a similar percentage of methionine **NRC (1977)** however, **Colin et al (1973)** reported that the increase in methionine percentage causes a large decrease in feed intake.

The digestible energy (DE) was calculated according to **Fekete and Gippert (1986)** by applying the equation: $DE \text{ (kcal/kg)} = 4253 - 32.6 \text{ (CF\%)} - 144.4 \text{ (total ash\%)}$.

3.2. Nutrients digestibility and nutritive values

The data of nutrient digestibility coefficients and feeding values as total digestible nutrients (TDN) and digestible crude protein (DCP) are shown in **Table (5)**. The data clearly indicated that replacing (25, 50, and 75 %) of alfalfa hay with basil straw caused a significant increase in DM, OM, CP, EE and NDF digestibility in comparison with the group fed the control diet (Con0). While the group fed B50 diet recorded significantly higher NFE digestibility compared to the group fed Con0 diet. Replacement alfalfa hay with fennel straw in rabbit diets at levels (25, 50 and 75%) significantly ($p \leq 0.05$) increased EE digestibility and significantly decreased NFC digestibility compared to control group (Con0) while no significant differences were observed between Fennel diets and control diet in NDF, hemicellulose and cellulose digestibility. The rabbit's group fed F50 diet recorded significantly lower ADF digestibility compared to control while the groups fed F25 and F75 diets not significantly affected. On another hand, the group fed F25 diet recorded significantly higher DM, OM and CP digestibility compared to control. While the groups fed F50 and F75 diets recorded lower DM digestibility as compared to control. Furthermore, no significant differences were observed among the different experimental treatments in TDN and DCP values, except the group, fed B50 diet recorded higher TDN and DCP values compared to the control group. **Abdel-Azeem et al (2010)** found that Rabbits group fed 31.6% Fennel hay (As 50% of the components of the diet or 100% of alfalfa hay substitution) was significantly ($p < 0.05$) highest in EE digestibility than other groups. Moreover, **Radwan and Khalil (2002)** showed that the digestibility values of diets tend to improve as fennel straw levels increased and, the digestion coefficient of EE and CF were significantly ($p \leq 0.05$) higher than those of clover hay, while digestibility coefficients for OM, CP, and NFE insignificantly differed. Treatments had no significant effect on CP and EE digestibility. On the other hand, dietary treatments improved both TDN and DCP values. **Abou Sekken et al (2008)** reported that digestibility coefficients values of OM, CP, CF, and NFE did not differ significantly when rabbits fed on diets contained 18, 36 or 54% FNH and marjoram hay mixture.

Table 4. Effect of replacing alfalfa hay with basil and fennel straw on daily feed consumption (g/day) of growing rabbits

Items	Replacement level							±SEM	p-value
	Con0	Basil straw			Fennel straw				
		B25	B50	B75	F25	F50	F75		
Daily Feed consumption (DFC) from									
5 to 8 weeks	70.09	66.36	56.67	65.95	69.43	57.60	73.33	8.27	0.95
8 to 11weeks	115.15	108.57	120.24	129.63	119.97	126.53	115.48	2.70	0.82
5 to 11weeks	92.62	87.46	88.45	97.79	94.70	92.06	94.40	1.37	0.79

Mean within the same row with different superscripts are significantly different (p≤0.05).

Table 5. Effect of replacing alfalfa hay with basil and fennel straw on nutrient digestibilities and nutritive values for rabbits at 10 weeks old

Item	Replacement level							SEM	P-value
	con0	Basil straw			Fennel straw				
		B25	B50	B75	F25	F50	F75		
A-Nutrients digestibility Coefficients:									
DM	60.01 ^e	63.56 ^c	71.32 ^a	65.11 ^b	60.99 ^d	59.53 ^f	57.28 ^g	0.18	<0.0001
OM	62.20 ^e	65.80 ^c	72.68 ^a	66.83 ^b	63.96 ^d	62.24 ^e	59.67 ^f	0.16	<0.0001
CP	69.44 ^c	72.41 ^{cb}	79.98 ^a	75.24 ^b	71.97 ^{cb}	72.39 ^{cb}	68.58 ^c	1.31	0.0005
EE	74.90 ^e	83.08 ^{dc}	88.03 ^a	87.38 ^{ba}	81.16 ^d	81.78 ^d	85.02 ^{bc}	0.85	<0.0001
NFE	73.62 ^b	72.60 ^{cb}	81.37 ^a	74.33 ^b	69.26 ^{cd}	67.08 ^{ed}	65.10 ^e	1.22	<0.0001
NDF	29.45 ^c	37.67 ^{ba}	44.85 ^a	40.32 ^{ba}	33.49 ^{bc}	33.39 ^{bc}	33.64 ^{bc}	2.42	0.0091
ADF	25.75 ^a	23.17 ^{ba}	31.68 ^a	24.85 ^{ba}	30.22 ^a	14.61 ^b	20.98 ^{ba}	3.17	0.0316
Hemicellulose	48.85	65.75	48.93	73.01	53.46	71.27	59.67	5.92	0.2297
celluloses	31.56 ^{bc}	27.27 ^c	47.55 ^a	32.58 ^{bc}	42.34 ^{ba}	23.08 ^c	28.07 ^c	2.70	0.0040
B-Nutritive values:									
DCP	13.46 ^b	14.01 ^b	15.73 ^a	13.46 ^b	13.87 ^b	14.02 ^b	13.73 ^b	0.25	0.0003
TDN	60.55 ^b	63.32 ^b	69.60 ^a	65.01 ^b	61.57 ^c	59.91 ^b	57.76 ^e	0.153	<0.0001

Mean within the same row with different superscripts are significantly different (p ≤ 0.05) Non fibrous carbohydrates (NFC) were calculated according to (Calsamiglia et al. 1995) using the following equation: $NFC = 100 - \{CP + EE + Ash + NDF\}$. Hemicellulose = NDF – ADF. Cellulose = ADF – ADL. The total digestible nutrients (TDN) were calculated according to the classic formula (Cheeke et al 1982).

3.3. Plasma analysis variables

The data of **Table (6)** showed the effect of replacing alfalfa hay with ascending levels of basil and fennel straw of growing rabbits on blood plasma constituents. The data showed that, blood plasma total proteins, albumin and globulin (g/dl) for all dietary treatments are lies within the normal range reported by **Melby and Altman (1974)**. There were no significant differences among all experimental treatments in blood plasma total proteins, albumin, ALT and AST. This result may be due to that all experimental diet was approximately iso caloric, iso-nitrogenous and iso-fibrous (**Table 3**). In this connection, **Kumar et al (1980)** postulated that blood total plasma protein concentration reflects the nutritional status of the animal and reported a positive correlation between blood total protein concentration and dietary protein level. Also, **Bush (1991)** reported a positive correlation between dietary protein and plasma protein concentration. Also, the same author stated that the low level of plasma proteins may be attributed to a decrease in the protein absorbed and synthesized and an increase in protein losses. In consist of the present results, **Abdel-Azeem et al (2010)** found that total protein concentration was not significantly affected by replacing clover hay with different levels of fennel straw in growing rabbit diets.

The data of **Table (6)** clearly showed that there were no significant differences among all experimental treatments in cholesterol (mg/dl). Also, **Abdel-Azeem et al (2010)** found that cholesterol concentration was not significantly affected by replacing clover hay with fennel straw in growing rabbit diets.

The data of **Table (6)** pointed that replacement alfalfa hay with 50 and 75 % basil straw (diets B50 and B75) resulted in decreased blood urea concentration compared with all experimental treatments, while replacement alfalfa hay with 25 % basil straw and 25, 50 and 75 fennel straw (B25, F25, F50, and F75 diets) not significantly affect urea concentration.

The data of alkaline phosphatase activity (ALP) (U/L) (**Table 6**) clearly showed significant differences between rabbit groups received B75 and F50 diets and those rabbit group consumed F75 diet, while no significant differences were recorded among the rabbits received con0, B25, B75, F25, and F5 diets.

The data of **Table (6)** clearly showed that the rabbits received B50 and F75 diets recorded significantly lower creatinine concentration compared to

the other experimental treatments. Creatinine concentration for animals received Con0, B25, B75, F25 and F50 showed insignificant differences. **Özkanel et al (2012)** showed that no statistically significant difference for creatinine between male and female animals. **Abou Sekken et al (2008)** reported that rabbit feeding 36% mixture of fennel hay and marjoram hay recorded the highest values of plasma total protein and globulin compared to other treatments. They also found significantly decreased in values of plasma cholesterol, AST and ALT when the clover hay is replaced by FNH in rabbit diets.

3.4. Live body weight, daily weight gain and feed conversion ratio (FCR)

The data of body weight changes and body weight gain are presented in **Table (7)**. The data showed that, insignificant differences were observed in live body weight at 5 weeks of age (beginning time of the fattening experiment). During the first period (3 weeks after weaning) as well as during the entire of the experimental period (5-11 weeks of age), it could be observed that rabbits fed on diets containing (B25, B50, and B75) and fennel straw as a replacer for alfalfa hay as the main source of fiber, grew convergent with the control group. While insignificant effects were observed in live body weight at 5, 8 and 11 weeks of age.

Concerning to body weight gain in the first period (5-8 weeks of age) the results showed that replacement of alfalfa hay with 25 % fennel straw (F25) significantly reduced average daily gain compared with the other experimental treatments (**Table 7**), while no significant difference was observed among the other experimental treatments. On the contrary, the animals fed diets contained 25 % fennel straw (F25) gave significantly higher average body weight gain compared with the other experimental groups and no significant differences were observed among the other experimental treatments. Regarding body weight gain during the total period from 5 to 11 weeks of age, the result indicates that no significant differences among all treatments were detected. This may be due to the similar values of nutrients digestibility for the groups received B25, B50, B75 and F25, F50, F75 compared to the con0 group (**Table 3**), parallel to the insignificant differences observed in DFC. In this connection, **Abdel-Azeem et al (2010)** indicated that growing rabbits fed on a diet containing fennel straw replaced clover hay up to 33.33%, had insignificantly higher live body weight.

Table 6. Effect of graded substitution of alfalfa hay with basil and fennel straw on plasma analysis of rabbits aged 11 weeks

Item	Replacement level							±SEM	p-value
	Con0	Basil straw			Fennel straw				
		B25	B50	B75	F25	F50	F75		
Total proteins (g/dl)	6.9	6.88	6.68	6.34	6.48	6.64	6.48	0.20	0.39
Albumin(g/dl)	4.7	4.94	4.48	4.62	4.8	4.77	4.78	0.10	0.11
Globulin(g/dl)	2.18	1.94	2.2	1.81	2.18	1.66	1.865		
A/G ratio	2.17	2.55	2.04	2.55	2.17	2.90	2.56		
Cholesterol (mg/dl)	47.12 ^a	53.62	57.44	53.98	47.1	60.2	53.26	6.37	0.80
Triglycerides (mg/dl)	40.84 ^b	63.66 ^b	58.86 ^b	44.16 ^b	40.84 ^a	110.96 ^{ba}	77.26 ^{ba}	12.88	0.01
Creatinine (mg/dl)	0.68 ^a	0.64 ^a	0.46 ^b	0.58 ^a	0.58 ^a	0.58 ^a	0.46 ^b	0.03	0.001
AST(U/L)	27.6	34.5	24.00	23.00	31.00	27.4	26.2	4.24	0.60
ALT (U/L)	30.8	32.75	25.00	24.2	35.00	28.00	27.00	4.28	0.53
Urea (mg/dl)	23.48 ^a	24.94 ^a	13.48 ^b	10.98 ^b	23.48 ^a	23.88 ^a	25.34 ^a	2.95	0.004
ALP (U/L)	130.6 ^{ba}	117.2 ^{bac}	105.2 ^{bc}	144.8 ^a	124 ^{bac}	142.2 ^a	93.6 ^c	11.22	0.02

Mean within the same row with different superscripts are significantly different (p ≤ 0.05).

Table 7. Effect of replacing alfalfa hay with basil and fennel straw on growth performance variables of rabbits aged 5-11 weeks

Items	Replacement level							±SEM	p-value
	Con0	Basil straw			Fennel straw				
		B25	B50	B75	F25	F50	F75		
Live body weight (g) at:									
5 weeks	625.00	631.43	625.00	622.78	637.50	612.78	623.50	18.25	0.98
8 weeks	1345.6	1291.70	1242.50	1235.00	1123.10	1240.70	1234.00	66.04	0.52
11 weeks	2050.56 ^a	2065.00	2002.50 ^a	2008.33 ^a	2037.50 ^a	2043.33 ^a	1855.00 ^a	67.72	0.40
Daily weight gain(g) from:									
5 to 8 weeks	34.31	31.44	29.40	29.15	23.13	29.90	29.07	2.92	0.37
8 to 11 weeks	33.57 ^b	36.82 ^{ba}	36.19 ^{ba}	36.83 ^{ba}	43.54 ^a	38.22 ^{ba}	29.57 ^b	2.48	0.02
5 to 11 weeks	33.94	34.13	32.798	32.99	33.33	34.06	29.32	1.02	0.34
Feed conversion ratio (FCR) from									
5 to 8 weeks	2.41	2.45	2.25	2.31	4.6623	2.55	2.54	0.65	0.37
8 to 11 weeks	3.48 ^{ba}	3.06 ^b	3.53 ^{ba}	3.62 ^{ba}	2.78 ^b	3.74 ^{ba}	4.71 ^a	0.44	0.02
5 to 11 weeks	2.79 ^b	2.58 ^b	2.75 ^b	2.99 ^{ba}	2.89 ^{ab}	2.82	3.33	0.05	0.34
Mortality rate	4	2	4	1	1	1	1		

Mean within the same row with different superscripts are significantly different (p ≤ 0.05).

Regarding the feed conversion ratio (FCR) the data presented in **Table (7)** showed that during the first period from 5 to 8 weeks of age, the best FCR was observed for rabbits fed B50 diet. On the other hand, the result showed no significant differences among all experimental treatments. During the second period from 8 to 11 weeks of age, the best FCR was observed for rabbits fed F25 diet. While the worst ratio was recorded for those fed F75. During the total period from 5 to 11 weeks of age, the best FCR was observed for rabbits fed B25 followed by B50 and control, where the worst ratio is was recorded for those fed F75. On the other hand, the results showed that significant differences between F75 from side and B25 and B50 from the other side while no significant differences between F25, F50, F75, B75 and con0. Furthermore, **Radwan and Khailil (2002)** found that the best FCR (feed/gain) 3.76 kg feed/kg gain was recorded by rabbits fed 34 and 50% fennel by-product, while the poorest one 4.16 and 4.08 were achieved by rabbits fed 0 and 17% FNH levels. Also, they found that feed intake of rabbits received diets containing different levels of FNH was not significantly different. **Abd El-Azeem et al (2010)** showed that rabbits fed on diet containing FNH replaced clover hay up to 33.33%, were insignificantly higher live body weight and body weight gain and significantly ($p < 0.05$) higher daily feed consumption compared with the other experimental diets. Values of FCR showed not significant differences within all tested groups. While, **Trebusak et al (2011)** showed that there were on significant differences in the final body weight.

The data presented in **Table (7)** showed that replacing alfalfa hay with B25, B75, F25, F50 and F75 decreased mortality rate compared to con0. This may be due to effect of the residual of essential oil in Basil and fennel straw which may be have a positive effect on rabbit's health and viability. **Omer et al (2013)** concluded that adding 0.5% fennel seeds with 0.5% oregano leaves as feed additives to rabbit diets contained 2% oil improved daily gain; both nutrient digestibility coefficients and nutritive values as well as realized the highest value of relative economic efficiency and lowered value of feed cost/ kg live body weight.

3.5. Carcass traits

The data of **Table (8)** clearly showed no significant effects ($p > 0.05$) were detected in absolute or relative weights for most of the carcass traits due to feeding diets containing different basil and fennel straw levels. Rabbit groups the received a B50 diet were recorded higher dressing percentage, kidney weight, liver weight and spleen weight followed by the group received F50 diet than all treatments. Rabbits fed B 25 diet had the weights of the hot carcass, and head weight and heart weight than the B50 diet. On the other hand, **Abdel-Azeem et al (2010)** recorded that higher dressing and hot carcass weight percentages were recorded with growing rabbits fed fennel straw, but carcass fat (%) was not significantly decreased by using fennel straw levels. **Radwan and Khalil (2002)** found that dressing percentage, liver, and heart, as a percent to the body weight of rabbits fed FNH diets insignificantly improved with raising FNH levels. While **Abou Sekken et al (2008)** observed that a group fed a diet containing 54% FNH and marjoram hay mixture achieved significantly ($P < 0.05$) higher carcass, dressing percentage, edible giblets percentage than the control group.

3.6. Economic efficiency (EEF)

The data of **Table (9)** showed that the increase in replacement level of alfalfa with basil or fennel straws caused a gradual decrease in kg feed cost, due to the low cost of basil straw and fennel straw (1500 L.E/ton) compared to the cost of alfalfa hay which is (3200 L.E/ton). Replacing alfalfa hay with (25, 50, 75%) for either basil hay or fennel hay caused a gradual decrease in total feed cost, while the inclusion of B75 slightly decreased feed cost as a result to increasing daily feed consumption for this group. Values of economic efficiency, relative economic efficiency and performance index were improved with partial replacement of alfalfa hay by basil hay and fennel hay in the growing rabbit diets. The present results show that, EEF, and REEF of the rabbits were highest with B25 and F50 being (119.10 and 104.67), respectively. **Abdel-Azeem et al (2010)** found that, rabbits fed 21.0% FNH (a diet containing FNH replaced clover hay up to 66.66% gave the highest economic efficiency percentage.

Table 8. Effect of replacing alfalfa hay with basil and fennel straw on carcass traits of rabbits aged 11 weeks

Item	Replacement level							±SEM	p-value
	Con 0	Basil straw			Fennel straw				
		B25	B50	B75	B25	B50	B75		
Dressed weight (g)	1225.26	1274.43	1278.58	1234.94	1237.56	1233.67	1137.61	66.92	0.42
Dressing percentage	61.07	61.68	63.67	61.12	60.75	60.42	58.15		
Hot carcass (g)	1058.75 ^a	1102.85 ^a	1084 ^a	1065.62 ^a	1053.8 ^a	1042.9 ^a	906 ^a	40.98	0.05
(%)	52.77	53.33	54.13	52.70	51.72	51.04	48.84		
Head weight (g)	97.25 ^{ab}	101.43 ^a	100 ^a	100 ^a	98.75 ^{ab}	101.11 ^a	89 ^b	3.03	0.10
(%)	4.85	4.91	4.99	4.99	4.85	4.95	4.80		
Heart weight (g)	6.87 ^{ba}	7.64 ^a	7.08 ^{ba}	6.50 ^{ba}	6.75 ^{ba}	7.00 ^{ba}	6.25 ^b	0.34	0.21
(%)	0.65	0.69	0.65	0.61	0.64	0.67	0.69		
Heart fat (g)	0.75 ^a	1.14 ^a	0.91 ^a	1.06 ^a	1.12 ^a	1.16 ^a	0.75 ^a	0.19	0.44
%	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Kidneys weight (g)	10.87 ^c	12.25 ^{bc}	19.25 ^a	14.31 ^{bc}	14.5 ^{bc}	16 ^b	13.3 ^{bc}	1.16	0.003
%	1.03	1.11	1.78	1.34	1.38	1.53	1.47		
Kidneys fat (g)	11 ^a	10.74 ^a	10.75 ^a	9.37 ^a	7.81 ^a	14.27 ^a	7.8 ^a	2.11	0.44
%	1.04	0.97	0.99	0.88	0.74	1.37	0.86		
Liver weight (g)	62.38 ^b	62.5 ^b	87.5 ^a	62.81 ^b	78.31 ^{ba}	82.66 ^{ba}	64.85 ^b	6.03	0.03
%	5.89	5.67	8.07	5.89	7.43	7.93	7.16		
Spleen weight (g)	1.75 ^{ba}	1.07 ^c	2.17 ^a	2 ^a	1.18 ^{bc}	1.38 ^{bc}	1.4 ^{bc}	0.16	0.001
%	0.17	0.10	0.20	0.19	0.11	0.13	0.15		
Cecum pH	6.3 ^a	6.06 ^a	5.99 ^a	6.48 ^a	6.14 ^a	6.71 ^a	6.03 ^a	3.32	0.54

Mean within the same row with different superscripts are significantly different ($p \leq 0.05$).

Table 9. Economic traits of NZW rabbits aged 11 weeks as affected by dietary replacement of alfalfa hay with basil straw and fennel straw

Item	Replacement level							±SEM	p-value
	Con0	Basil straw			Fennel straw				
		B25	B50	B75	F25	F50	F75		
Total FI/rabbit Kg	3.89	3.67	3.72	4.11	3.98	3.87	3.97		
price /kg FI (L.E)	5.17	5.09	4.99	4.86	5.07	5.00	4.87		
feed cost/rabbit (L.E)	20.10	18.69	18.54	19.96	20.16	19.32	19.30		
Total cost (L.E) ^{+(a)}	80.10	78.69	78.54	79.96	80.16	79.32	79.30		
Body weight (Kg)	2.05	2.07	2.00	2.01	2.04	2.04	1.86		
Cost /kg BW (L.E)	39.06	38.10	39.23	39.82	39.35	38.83	42.75	1.49	0.4071
Total revenue (L.E) ^(b)	92.27	92.93	90.09	90.36	91.67	91.94	83.48	3.21	0.401
Net revenue (L.E)	12.17	14.24	11.55	10.40	11.51	12.62	4.18	3.21	0.4396
Economic efficiency	15.19	18.10	14.70	13.01	14.36	15.90	5.27	4.11	0.4354
Relative Economical efficiency	100.00	119.10	96.76	85.59	94.48	104.67	34.68		

(a) Including fixed cost (60 L.E/rabbit), (b) Assuming that the selling price (is (45) L.E), Price /ton of basil straw or fennel straw =1500L.E Price /ton of alfalfa hay =3200 L.E.

CONCLUSION

The results of this study revealed that basil and fennel straw can successfully replace up to 75 % of alfalfa hay in NZ rabbit diets between 5 and 11 weeks of age, without adverse effects on their performance. It can be useful in reducing rabbit feed costs.

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تأثير إستبدال دريس برسيم الحجازي بمستويات متدرجه من أتبان الشمر والريحان فى علائق الأرناب النامية

[46]

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الموجز

والمادة العضوية والبروتين الخام والمستخلص الاثير والبروتين الخام المهضوم وبالمقارنة بالمجموعة الضابطة وعلى العكس فالعلائق التي تحتوي على 75% تبين الشمر كان لها أقل معدل هضم للمادة الجافة والمادة العضوية. كان هناك زيادات معنوية في متوسط الزيادة المكتسبة لوزن الجسم وكانت أعلى نسبة زيادة في الوزن في العلائق التي غذيت على 25% تبين ريحان ويليها 50% تبين شمر وكانت أقل زيادة 75% تبين شمر وكذلك هناك تحسن معنوي في معدل التحويل الغذائي للمجموعة التي غذيت على 25% تبين ريحان والأسوأ في معدل التحويل الغذائي للمجموعة التي غذيت على 75% تبين الشمر. لم يلاحظ أي تأثير معنوي لاستبدال دريس البرسيم بتين الريحان وتين الشمر على مواصفات وخصائص الذبيحة فيما عدا وزن القلب والكلى والكبد والطحال. استبدال دريس البرسيم ب 25% تبين ريحان و 50% تبين شمر أدى الى تقليل تكلفة التغذية، بينما استخدام تبين الريحان بنسبة 75% في العليقة قلل من تكلفة التغذية وذلك نتيجة زيادة الاستهلاك اليومي.

يحتوي تبين الشمر وتين الريحان على نسبة مرتفعة من الألياف والتي تقترب من مثيلاتها في محتوى دريس البرسيم الحجازي منها، وعليه فيمكن احلال دريس البرسيم الحجازي بتبن الشمر وتبن الريحان في أعلاف الأرناب النامية. ولهذا تمت هذه الدراسة لتقييم تأثير استخدام تبين الشمر وتين الريحان كمصدر للألياف كبديل للدريس في علائق الأرناب النامية. تم استخدام عدد 84 أرناب ذكر من سلالة النيوزيلاندي الأبيض في عمر 5 أسابيع وقسمت عشوائيا على سبع مجموعات (12 أرناب لكل مجموعة). تم تركيب وإعداد سبع علائق تجريبية لتكون متماثلة في محتواها من الطاقة والنيروجين تقريبا: عليقة المقارنة، وثلاثة علائق استبدل فيها 25%، 50%، و 75% من الدريس بتبن الشمر، بالإضافة إلى ثلاثة علائق أخرى استبدل فيها 25%، و 50%، و 75% من الدريس بتبن الريحان.

وكانت أهم النتائج المتحصل عليها كما يلي

الكلمات المفتاحية: تبين الشمر، تبين الريحان، الأرناب، الأداء، سمات الذبيحة، الكفاءة الاقتصادية

إحلال تبين الريحان محل الدريس بنسبة 50% من الدريس أدى الى تحسن في معاملات هضم المادة الجافة

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