Effect of Partial Substitution of a Commercial Feed Crude Protein by Hydroponic Barley Fodder in Diets of Apri rabbits on:
1- Digestibility, Feeding Value, some Blood Constituents and Caecum Microflora Count

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ABSTRACT

Fourty growing APRI male rabbits at the age of 5 weeks old were used to investigate the impact of partial replacement of concentrate feed mixture (CFM) CP by different levels of hydroponic barley (HB) on rabbits performance, digestibility, feeding value, some blood constituents and caecum microbial count. The changes in chemical composition of HB during 6, 7 and 8 days of growth period was also studied. Rabbits were randomly divided into four experimental groups (10 rabbits in each) and were housed in individual cages provided with continuous feeders and automatic water nipples during the experimental period (5 – 12 week of age). The first group was fed pelleted CFM diet with 16% CP (control, D1), while the 2nd, 3rd and 4th groups were fed the control diet but 20, 40 and 60% of CP was replaced by HB (D2, D3 and D4, respectively) in a feeding trial which lasted for 7 weeks. At the end of the feeding trial, four digestibility trials were carried out on three rabbits of each treatment. Animals were fed the same tested diet as that in feeding trial. Three rabbits of each treatment were slaughtered at the end of digestibility trials. The main results generally showed that there was a tendency for gradual decreases in DM and NFE content, but increases in Ash, EE, CP and CF content by advancing age of sprouting. Rabbits fed D2 recorded the highest significantly ($P < 0.05$) values of digestion coefficients of CP and CF, while the lowest significantly ($P < 0.05$) values were recorded with rabbits fed D4 diet. There were positive significant ($P<0.05$) effect of feeding HB at levels of 20 and 40 % on concentrations of blood total protein, albumin and glucose. Rabbits fed HB diets (D2, D3 and D4) had significantly ($P < 0.05$) higher total viable count of bacteria in caecum compared with those fed the control diet without HB (D1). It may be concluded that replacing of HB at the rate of 20 or 40 % of CFM protein in growing rabbit diets had beneficial effects on most criteria studied. Higher level (60% of HB) used herein in rabbit diets is not recommended since it negatively affected nutrients digestibility and feeding values of tested diets.
Keywords: rabbits, hydroponic barley, digestibility, nutritive value, blood constitues.

INTRODUCTION

In animal production enterprises, fodder production is the most important input in livestock ration and has important aspects for the sustainability of products and productivity in animal husbandry (Gupta, 2014). Feeding animals according to their requirements and avoiding wastage is the basic point in exploiting the production potential for economic growth and sustainability since feed costs are the dominant part of production that accounts more than 70% (Gupta, 2014). It is a well-accepted fact that feeding animals is incomplete without including green fodder in their diet (Shah *et al.,* 2011). Due to the lot of constraints in the conventional method of green fodder cultivation in most of the Middle East, African and Asian countries, hydroponics is now emerging as an alternative technology to grow fodder for farm animals (Sneath and Mclntosh 2003, Naik *et al.* 2011, 2012 and 2013). Thus, fodder is produced without using any soil but growing the plants in water or mineral nutrient solution is known as hydroponics fodder or fresh fodder biscuits or sprouted grains or sprouted fodder or alfa culture (Dung *et al.,* 2010 and Bakshi *et al*., 2017). The advantages of this method include: growing crops in a hygienic environment free of chemicals, and artificial growth promoters (Jensen and Malter, 1995). Hydroponic fodder has a short growth period (around 7-10 days) and requires a small piece of land for production (Mooney, 2005). In recent years, it has been a major vacancy for researchers to study the animals performance and lower feeding costs. Therefore, there are an increased interests in studying feed restriction in rabbits, which it is an excellent source of good quality meat compared with conventional sources of meat, such as beef cattle, goats and sheep (Shanti *et al.,* 2017). Research on availability of hydroponic grown forage as livestock feed, especially in rabbits is very limited needing more research to help determine their optimal level in their diets. Therefore, this study aimed to investigate the influence of feeding different levels of dietary hydroponic barley in tested diets on digestion coefficients, feeding value, some blood constituents and caecum microbial count of APTI growing rabbits.

MATERIALS AND METHODS

The present study was conducted in a private Rabbit Farm at Mansoura city of Al-Dakahlia, Egypt, during the period from March to April, 2017.

Hydroponic System and Grain Sprouting: Hydroponic barley was sprouted in a temperature controlled room at the same farm. The temperature was maintained at 24^{o}C and continuous lighting was also provided throughout the 7days growing period. Spray watering was applied for 3 minutes every 2 hours for the 7 days period of growing. A sprinkler with a timer control device was used to achieve the set interval and running time indicated above. The excess water drained freely from the growing trays between watering. Three pairs of fluorescent lamps of (Philips TLD 36W/840) were used. An air conditioner was used to control temperature inside the growth chamber which was maintained at 24˚C ± 1˚C. The relative humidity in the growth room was 54%.

Three growth periods: Barely (*Hordeum vulgare L.*) cv. Giza 123 grains were used. The grains were obtained from the Agriculture Research Center Ministry of Agriculture, Gamisa, Egypt and hydroponically grown up to 6, 7 and 8 days. The trays contained green fodder were removed from the chamber and the fresh fodder batches were weighed and sampled to measure the exchange in chemical composition through different growth period (6, 7 and 8 days of age). Representative samples (250 g each), were oven-dried at 60 °C, ground to pass a 1-mm mesh screen sieve and stored for chemical analysis.

Digestibility trails: Forty male APRI newly weaned rabbits at 5 week old of similar body weight, were randomly distributed into four experimental groups (10 rabbits in each) for a growth trail which lasted for 5-12 week of age. The data obtained for 2nd part of the present study concerning the impact of tested diets on rabbit's performance will be published later on. At the end of feeding trials, twelve male APRI rabbits were chosen from the previous herd and individually housed in cages and fed the same dietary treatments. Four digestibility trials (3 rabbits in each) were carried out to determine the digestibility of nutrients and nutritive values of the following experimental diets: group one (D1) was fed the control diet (concentrate feed mixture (CFM), groups 2, 3 and 4 were fed the control diet after replacing CFM-CP with 20, 40 and 60 % of hydroponic barley (HB-CP) and will be referred to as D2, D3 and D4, respectively. All diets covered the daily CP requirements of rabbits according to NRC (1977) and Cheeke (1987). The formulation of the pelleted basal diet is presented in Table (1). The CFM meal was offered at the morning while that of hydroponic barley fodder was given at the evening. Fresh water was provided all the time. Individual feed intake was accurately determined and quantitative collection of feces was carried out for 5 days as a collection period and feces of each animal was mixed. Samples of HB and feces were dried at 60^{o} C for 48 hours, and ground for running the chemical analysis. Chemical analysis of HB, CFM, barley grains (BG) and feces was determined using the official methods of analysis (AOAC, 2000) procedures. Apparent digestibility of nutrients as well as the nutritive values as TDN, DCP and DE were calculated for the different dietary tested diets. Chemical analysis was done at the laboratory of Anim. Prod. Dept., Fac. of Agric. at Mansoura Univ., Egypt. The total digestible nutrients (TDN) were calculated according to the formula of Cheeke *et al.* (1982), while the digestible energy (DE, Kcal/Kg) of diets was estimated according to the equation adopted by Schiemane *et al.* (1972) as follows: DE, Kcal/Kg DM = 5.28 (DCP, g/Kg + 9.51 (DEE g/Kg) + 4.2 (DCF g/Kg) + 4.2 (DNE g/Kg).

Blood parameters: After running the digestion trials, the 3 rabbits of each treatment which used before were fasted and slaughtered. A blood sample from each rabbit was collected to determine some blood metabolites. The blood samples were collected in heparinized tubes. Blood samples were immediately centrifuged at 3000 r.p.m for 15 minutes in order to separate blood plasma. Plasma samples were frozen at -20°C to be used for biochemical analysis. Commercial Kits were used for colorimetric determinations of: Glucose, Total protein (TP), Albumin (AL), Triglycerides, Cholesterol, Aspartic aminotransferase (AST) and Alanine amino transferase (ALT). The globulin value (GL) was calculated by differences (TP –AL).

Caecum microbial count: Microbial total count of the caecum from 3 rabbits/treatment after slaughtering were calculated by using swab method and cecum length of each rabbit was measured.

Statistical analysis: Data of the present study were statistically examined using complete randomized design according to SAS (2003). Dunkan's Multiple Range Test (Duncan, 1955) was performed to detect the significant differences among means. According to the following model:

$$Yij = \mu + Ti + eij$$

Where:

Yij = The individual observation
μ is the overall mean
Ti is the treatment type (D1, D2, D3 and D4)
eij is the random error term

Table 1. Formulation of the pelleted basal diet (control diet).

Ingredients %	Control diet	Ingredients %	Control diet
Wheat bran	22.00	Limestone	1.00
Soy bean meal (44%)	20.00	Common salt	0.30
Alfa alfa	20.00	Vit. & Min. Premix[§]	0.30
Caraway straw	15.00	Di calcium phosphate	1.25
Yellow corn	5.00	Anti-toxin	0.10
Barley grains	15.00	Anti – coccidian	0.05
Total	100		

§: Each 3 kg of the product contains:Vit. A, 12,000,000 IU; Vit. D_3, 2,500,000 IU; Vit. E, 10 g; Vit. K, 2.5 g; Vit. B_6 1.5 g; Vit. B_{12}, 10 mg; Biotin, 50 mg; Folic acid, 1.0 g; Nicotinic acid, 30 mg; Pantothenic acid, 10 g; Antioxidant, 19 g; Mn, 60 g; Cu, 10 g; Zn, 55 g; Fe, 35 g; I, 1.0 g; Co, 250 mg and Se, 150 mg

RESULTS AND DISCUSSION

Chemical composition of barley grains (BG) and hydroponic barley fodder during the last three days (6, 7 and 8 of age) of growing period by hydroponic system:

As shown in Table (2), OM content was practically similar for the three days, while the CP contents in HB at 6, 7 and 8 of age were higher by about 2.5, 3.3 and 3 % compared with BG. Likewise, EE, CF, ADF and NDF in HB during the last three days were higher than those of BG. In contrary, NFE and hemicellulose contents tended to be higher in BG than the corresponding values of HB during the three days of growing. As for DE concentration, it was considerably higher in BG (3609 Kcal/ Kg) than those recorded for HB at 6, 7 and 8 days of age, being 3192, 3212 and 3221 Kcal/ Kg, respectively. Regarding the effect of growing period on changes in chemical composition of HB, the results generally showed that there was a tendency for gradual decreases in DM and NFE, but increases in ash, EE, CP and CF contents by advancing age of plants. However, the OM content was practically similar for the samples taken during the three days of growing. Likewise, there were small differences in ADF, NDF and hemicellulose contents among different samples for HB during three days. Generally, it is worth noting that the chemical composition values of HB at 7 days was practically similar with those recorded with HB at 8 days since small differences were observed among them in most chemical nutrients. So, HB at 7days have been chosen to be fed in the applied feeding trials with growing rabbits. The lower DM % of HB may be due to that the large uptake of water initiates increases metabolic activity of resting seeds leading to loss of dry weight (starch) during germinating cycles of hydroponic fodder (Morsy *et al.,* 2013). The increase in EE content could be due to the production of chlorophyll associated with plant growth that are recovered in ether extract measurement (Mayer and Poljakoff-Mayber, 1975). Such changes in nutrients profile and recovery are misleading, since they only described the alterations in the proportion of nutrients during growth and sprouting of seeds (Morgan *et al.* 1992). A change in weight of any one of the nutrient led to proportional changes in other compositions. During the germination and early stage of plant growing, starch was catabolized to soluble sugars for use in respiration and cell-wall synthesis (Hillier and Perry, 1969). In addition, the CP content could be affected by the cultivation conditions in hydroponic systems.

Hydroponic system alters the amino acid profile of BG and increases the crude protein content of hydroponic barley (Morsy *et al.,* 2013). The increase in CF content during hydroponic system of barley may be due to the synthesis of structural carbohydrates such as cellulose, hemicelluloses and lignin (Cuddeford, 1989).

Table 2. Chemical composition of the barley grain (BG) and hydroponic barley (HB) during the last three days (6, 7 and 8 of age) of growing by hydroponic system (% DM).

Items	Barley grains	Hydroponic barley 6th d	7th d	8th d
DM	93.1	17.39	15.0	12.59
% of DM basis				
OM	97.6	96.9	96.3	96.1
EE	1.8	2.13	3.1	4.8
CP	12.7	15.2	16.0	15. 7
CF	6.3	14.1	14.5	16.0
NFE	76.8	65. 5	62.7	59.6
Ash	2.4	3.1	3.7	3.9
*Fiber fractions				
NDF	33.1	38.2	38. 5	39.4
ADF	15.2	22.3	22.7	24.0
Hemi-cellulose	17.9	15. 9	15.8	15.4
**DE (Kcal/ kg)	3609	3192	3212	3221

*** Fiber fraction (NDF and ADF %) calculated according to Pagano Toscano *et al.* (1986) using the following equation:**
% ADF= 9.432 + 0.912 (% CF)
% NDF =28.924 + 0.657 (% CF)
% Hemi-cellulose = % NDF - % ADF
*** *Digestible energy (DE) calculated according to Fekete (1987) using the following equation:**
DE (Kcal/ kg) = (7.1 (CP, g/kg)) + (12 (EE, g/kg)) + (5.59 (NFE,g/kg))

Chemical analysis of ingredients and calculated composition of the tested diets:

Data in Table (3) showed that the chemical composition of concentrate feed mixture (CFM) and hydroponic barley (HB) was within the normal published ranges in Egypt given by Abouelezz and Hussein (2017) and Raeisi *et al.* (2018). Regarding the calculated chemical composition of tested diets, it is showed that tested diets are nearly similar in EE, CP, CF, NDF and hemi-cellulose contents. It is evidence that DM and Ash content of tested diets tended to decreased gradually with increasing the level of HB. On the other hand, OM, NFE and ADF content of tested diets tended to increased gradually by increasing the level of HB being the highest in D4 (88.6, 56.7 and 21.4 %, respectively) and the lowest in D1 (85.2, 54.0 and 20.7 %, respectively).

The DE concentration of tested diets was gradually increased by increasing the level of HB level, being 2690, 2762, 2790 and 2841 Kcl/ kg for D1, D2, D3 and D4 diets, respectively.

Effect of feeding HB on nutrients digestibility and feeding values:

Data in Table (4) cleared that DM, OM, EE and NFE digestibilities were significantly (P < 0.05) highest in rabbits fed D1 (without HB) compared with those fed different levels of HB diets (D2, D3 and D4). The obtained values of CP digestibility showed that group fed D2 was significantly (P < 0.05) the highest value (78.62 %) compared with those fed D3 and D1 (76.06 and 75.16 %, respectively) without significant difference between the latter diets. While, the lowest CP value was observed with group fed D4 (59.42 %). Digestibility coefficient of CF was significantly (P < 0.05) the highest with rabbits fed D2 (42.53 %), while, the lowest value was recorded with group fed D4 (25.74 %).

Table 3. Proximate chemical analysis (%), calculated gross energy (GE) (Mj/kg DM), digestible energy (DE) (Kcal/Kg) of tested feed ingredients and the calculated composition of the tested diets (on DM % basis).

Item	Feed ingredients HB	CFM
DM	15.0	91.3
OM	96.3	85.1
EE	3.04	2.77
CP	16.0	16.0
CF	14.5	12.4
NFE	62.8	53.9
Ash	3.7	14.9

Experimental diets				
Item	D1	D2	D3	D4
DM	91.3	82.0	75.4	67.3
OM	85.2	86.5	87.4	88.6
EE	2.8	2.8	2.8	2.8
CP	16.0	16.0	16.0	16.0
CF	12.4	12.4	12. 8	13.1
NFE	53.9	55.3	55.8	56.7
Ash	14.9	13.5	12.6	11.4
*Fiber fraction				
NDF	37.1	37.1	37.2	37.5
ADF	20.7	20.7	20.9	21.4
Hemi-celulose	16.4	16.4	16.3	16.1
**DE(Kcal/ kg)	2690	2762	2790	2841
***GE (Mj/kg DM)	16.8	17.5	17.3	17.5

D1 (control), D2: C + 20% HB, D3: C + 40% HB and D4: C + 60% HB
***Fiber fraction (NDF and ADF %) calculated according to Pagano Toscano *et al*. (1986) using the following equation:**
% ADF= 9.432 + 0.912 (% CF) % NDF =28.924 + 0.657 (% CF)
% Hemi-cellulose = % NDF - % ADF
****Digestable energy (DE) calculated according to Fekete (1987) using the following equation:**
DE (Kcal/ kg) = (7.1 (CP, g/kg)) + (12 (EE, g/kg)) + (5.59 (NFE,g/kg))
***** Gross energy (GE) calculated according to MAFF (1975) using the following equation:**
GE (Mj/kg DM) = 0.0266 CP% + 0.0407 EE% + 0.0192 CF% + 0.0177 NFE%

Similar results were reported by AL-Saadi and Al-Zubiadi (2015) who found that digestibility coefficient of CP and EE were significantly (P <0.05) higher in 30% sprouts supplementation group than 10% sprouts supplementation group and control group, respectively by Awassi male lambs. In this respect, Reddy *et al.* (1988) with cattle observed significant increase in the digestibility (%) of all nutrients of diets containing hydroponic maize fodder (HMF) compared with the control diet. The latter authors explained such improvement in digestibility may be attributed to the tenderness of the fodder due to its lower age.

Shipard (2005) showed that sprouts are the most enzyme rich food on the plant and the period of greatest enzyme activity in sprouts is generally between germination and 7 days of age (Chavan *et al*., 1989).

As for the nutritive value of tested diets, it was clear that group fed control (D1) and (D2) diets had the highest significant (P < 0.05) TDN values (64.91 and 63.30 %, respectively) without significant difference between them, then D3 (55. 22 %). The lowest significant (P < 0.05) value (45.11 %) was recorded with D4, which could be associated with lowest nutrients digestibility coefficients (Table 4). In the same trend, DE (Kcal / Kg) values were gradually decreased (P < 0.05) with the increasing HB level where the best value was recorded for group of rabbits fed control diet (without HB, D1) (2864.7 Kcal / Kg), followed by group fed D2 (2763.1 Kcal / Kg) without significant difference between them, while the lowest value was recorded with rabbits fed 60 % HB (D4) (1998.4 Kcal / Kg), while group fed D3 showed intermediated value (2451.8 Kcal / Kg). As for DCP %, rabbits received D2 and D3 diets recorded the highest significant (P < 0.05) values of DCP (12.44 and 12.17 %,) than the control and those fed on D4 diet. While, the lowest significant (P < 0.05) value (9.51 %) of DCP % was recorded with D4. These results are in good agreement with those obtained by Fayed (2011) with lambs in Sinai, who found that DCP values were significantly (P < 0.05) higher with sprouted barley on Tamarix than untreated rice straw and tamarix. Similar trend was obtained by Ibrahim *et al.* (2001). There is a contradiction for the real effect of HB on nutrients digestibility that may be related to the composition of the tested diets, the percentage and variety of HB added to the diet, method of germination (hydroponic *vs* sprouted), the type of the animal used (monogastric *vs* ruminants), plan of nutrition and other environmental factors.

Table 4. Effect of feeding HB on digestion coefficients and feeding values of the tested diets with APRI rabbits.

Item	Experimental diets				±SEM
	D1	D2	D3	D4	
Digestibility coefficients%					
DM	70.31[a]	64.98[b]	55.28[c]	43.50[d]	1.27
OM	73.26[a]	69.92[b]	59.73[c]	47.26[d]	1.24
EE	83.53[a]	80.28[b]	78.19[c]	69.28[d]	0.22
CP	75.16[b]	78.62[a]	76.06[b]	59.42[c]	0.50
CF	40.34[b]	42.53[a]	35.67[c]	25.74[d]	0.31
NFE	78.95[a]	71.77[b]	60.11[c]	49.03[d]	1.50
Nutritive values (on DM basis)%					
*TDN%	64.91[a]	63.30[a]	55.22[b]	45.11[c]	0.93
DCP%	12.08[b]	12.44[a]	12.17[ab]	9.51[c]	0.08
DE (Kcal/ Kg)	2864.7[a]	2763.1[a]	2451.8[b]	1998.4[c]	33.70

D1 (control), D2: C + 20% HB, D3: C + 40% HB and D4: C + 60% HB
***TDN% was calculated according to classic formula (Cheeke *et al.*, 1982) as follows:**
% TDN = DCP + DCF + DNF + (DEE*2.25)
DE was calculated according to Schiemane *et al.* (1972) as follows:
DE, Kcal/Kg DM = 5.28 (DCP, g/Kg + 9.51 (DEE g/Kg) + 4.2 (DCF g/Kg) + 4.2 (DNFE g/Kg).

Blood plasma constituents:

The results in Table (5) revealed significant (P<0.05) effect of feeding HB at levels of 20 and 40 % on concentrations of total protein, albumin and glucose. While, there were no significant differences among groups on concentration of globulin, cholesterol, triglycerides, urea and creatine concentrations. AST activity in blood plasma was significantly (P<0.05) decreased by using 20% and 40% of HB compared with rabbits fed diet D1 (without HB) and D4 (60 % HB). Rabbits fed D4 showed lowest values of TP, Al and glucose, as well as the highest value of cholesterol, triglycerides, urea and creatine concentrations and AST activity. The increase of total protein and albumin concentration as affected by feeding HB may be associated with the high DCP content in D2 and D3 diets (Table 4), compared with the control (D1) diet. This is in accordance with those reported by Kumar *et al.* (1980) who found a positive correlation between dietary protein and plasma protein concentration by buffaloes. Also, Chavan *et al.* (1989) stated that the complex qualitative changes via soaking and sprouting of seeds which convert stored proteins of cereal grains into albumins and globulins caused the improvement of the quality of cereal proteins and increased the plant enzymes contents (Shipard, 2005). Through germination, protease enzymes are activated and convert the protein polymers into amino acids and small peptides (Shewry, 2007). These enzymes convert the complex compounds of protein into albumin and globulin which improve protein quality and elevate lysine content of grains (Chavan *et al.* 1989). Usually, biochemical blood parameters are reflected on health status and are good indicators of animal physiological, pathological, and nutritional status. In general, the obtained values of most plasma parameters were within the normal ranges given by Heinze (2002), being the normal ranges for total protein (5.4 – 7.3 g/dl), albumin (2.4 - 4.5 g/dl), globulin (2.9 – 4.9 g/dl), glucose (80 – 150 mg/dl), cholesterol (10 – 80 mg/dl), ALT (10 – 45 IU/l) and AST (10 – 120 IU/l) for rabbits.

Table 5. Effect of feeding HB on some blood constituents of growing APRI rabbits fed experimental diets.

Item	Experimental diets				±SEM
	D1	D2	D3	D4	
Total protein (g/dl)	6.10[ab]	6.87[a]	6.40[ab]	5.67[b]	0.28
Albumin (g/dl)	3.07[b]	3.53[a]	3.36[ab]	2.97[c]	0.11
Globulin (g/dl)	3.03	3.33	3.04	2.70	0.28
Glucose (mg/dl)	108.7	111.7	111.3	107.7	4.04
Cholesterol (mg/dl)	56.3[a]	46.3[b]	49.7[ab]	57.0[a]	2.36
Triglycerides (mg/dl)	108.7[a]	81.3[c]	98.3[b]	112.3[a]	2.86
LDL (mg/dl)	44.3[a]	33.7[b]	40.7[a]	42.3[a]	1.85
HDL(mg/dl)	52.7[b]	63.7[a]	57.7[b]	54.7[b]	1.69
Kidney function					
Urea-N (mg/dl)	39.7[a]	27.7[b]	34.7[a]	40.0[a]	1.80
Creatine (mg/dl)	1.41[a]	1.06[b]	1.36[a]	1.43[a]	0.05
Liver function					
ALT (IU/l)	31.0[a]	21.0[b]	26.0[ab]	31.3[a]	1.92
AST(IU/l)	43.3[a]	30.7[b]	35.3[b]	40.3[a]	1.51

D1 (control), D2: 20% HB, D3: 40% HB and D4: 60% HB
a& b and c.: means in the same row with different superscripts differ significantly (P<0.05)

Effect of dietary treatments on caecum total microbial counts (TMC):

Results in Table (6) showed that rabbits fed HB diets (D2, D3 and D4) had significantly (P<0.05) increased the average total viable count of bacteria compared with those fed the control diet without HB (D1). Similar trend was obtained by El-Gogary *et al.* (2018) on rabbits. It is of great importance to note that replacing concentrate feed mixture (CFM) protein by HB significantly increase the total viable bacterial count, since HB has shown much improving positive effects on growth performance and controlling of pathogenic bacteria. In addition, one rabbit of group 4 fed 60% HB diet died, while no cases of death have been recorded with other treatments during the experimental period. In addition, about 55% and 20 % of animals number in group D4 and D3 have suffered diarrhoeal illnesses at the age of 8 week and facultative among animals up to the end of experimental period. This could be associated with the high level of moisture in diets containing HB as well as could be a result of increasing pathogenic bacteria such as coliforms and especially *E. coli* which are important opportunist pathogens and can be a major cause of enteritis and losses in rabbits farm. Under some circumstances, pathogenic and toxigenic strains of the organism proliferate and cause diarrhea (Harcourt-Brown, 2002).

High percentage of diarrhoeal cases (55%) as well as the death of one rabbit in group D4 could support this idea. However, more knowledge and information are needed to clarify the fractions of population of bacteria (beneficial or pathogenic bacteria) in cecum of rabbits fed HB diets to implement the intestinal health of rabbits (Bivolarski *et al.* 2011).

The length of cecum significantly (P<0.05) differed among tested groups. The significantly (P<0.05) highest cecum length was recorded with rabbits fed D3 and D4 (12.67 and 12.00 cm, respectively), while the significantly (P<0.05) lowest value was observed with group fed D2 (10.00 cm).

Similarly, Abou Sekken *et al.* (2012) reveled that caecum length of rabbits was significantly (P<0.05) higher in all diets treated with sprouted grains than control.

Table 6. Effect of feeding HB diets on viable total bacterial count (cfu /g) in cecum of rabbits.

Treatments	Cecum Length (cm)	Total count (cfu /g)
D1	11.50^{ab}	$159 * 10^{3d}$
D2	10.00^{b}	$219 * 10^{3c}$
D3	12.67^{a}	$266 * 10^{3b}$
D4	12.00^{a}	$323 * 10^{3a}$
SEM	0.546	18.33

D1 (control), D2: C + 20% HB, D3: C + 40% HB and D4: C + 60% HB
a& b and c: means in the same column with different superscripts differ significantly (P<0.05)

CONCLUSION

It may be concluded that replacing of HB at the rate of 20 or 40 % of CFM protein in growing rabbit diets had beneficial effect of most criteria studied. Higher level 60% replacing of CFM protein of HB used herein is not recommended since it negatively affected nutrients digestibility and feeding values of tested diets.

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تأثير الإحلال الجزئي لبروتين العلف التجارى بالشعير المستنبت النامى بنظام الهيدروبونيك في علائق الأرانب الأبرى على 1- معاملات الهضم – القيمة الغذائية – بعض مقاييس الدم والعد الميكروبي في الأعور

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أجريت هذه التجربة على 40 أرنبا ناميا من ذكور أرانب الأبرى النامية عند عمر 5 أسابيع بهدف دراسة تاثير إحلال البروتين الخام لخليط العلف المركز بمستويات مختلفة من الشعير المستنبت على الأداء الإنتاجى للأرانب، معاملات الهضم، القيمة الغذائية، وبعض مكونات الدم والعد الميكروبي للأعور، بالإضافة إلى دراسة التغير في التركيب الكيميائي للشعير المستنبت خلال اليوم 6، 7 و 8 من النمو. وزعت الأرانب عشوائيا إلى أربعة مجموعات تجريبية متماثلة بكل منها 10 أرانب. تم تسكين الأرانب في أقفاص فردية مزودة بغذايات ومساقي آلية خلال مدة التجربة (عمر 5 – 12 أسبوع). غذيت أرانب المجموعه الأولى على عليقة الكنترول (مخلوط العلف المركز) المحتوى على 16 % بروتين خام، بينما تم الإحلال بنسب 20، 40 و60 % من بروتين العلف المركز بالشعير المستنبت في المجموعات التجريبية الثانية والثالثة والرابعة على التوالي وذلك خلال مدة تجربة التغذية (7 أسابيع). في نهاية التجربة تم إجراء 4 تجارب هضم (3 أرانب بكل معاملة) لتقييم العلائق المختبرة. وتم تغذية الأرانب على نفس العليقة التي تم إختبارها في تجربة التغذية. وفى نهاية تجربة الهضم تم ذبح 3 أرانب لكل معاملة. أوضحت نتائج الدراسة أن هناك اتجاهاً عاما بالإنخفاض التدريجي في كل من المادة الجافة والكربوهيدرات الذائبة، مع زيادة تدريجية لمحتوى الرماد، الدهون، البروتين والألياف كلما تقدم عمر النبات في النمو (6، 7 و8 أيام). وقد سجلت الأرانب التي تم تغذيتها على العليقة الثانية أعلى معاملات الهضم (P <0.05) لكلاً من البروتين والألياف، بينما سجلت أقل قيمة (P <0.05) مع الأرانب التي تم تغذيتها على العليقة الرابعة والتي احتوت علي نسبة 60% احلال من بروتين العليقة بالشعير المستنبت. كان هناك تأثير معنوي (P <0.05) موجب عند تغذية الأرانب على الشعير المستنبت بمستويات 20 و40٪ على كلاً من تركيزات البروتين الكلي والألبومين والجلوكوز في الدم. ولقد لوحظ زيادة في متوسط إجمالي العدد البكتيرى في الأعور في الأرانب المغذاه على العلائق التجريبية على الشعير المستنبت بمختلف التركيزات مقارنة مع تلك التي تم تغذيتها على عليقة الكنترول. يمكن استنتاج أن إحلال الشعير المستنبت بنسب 20 أو 40 % من البروتين الخام لمخلوط العلف المركز له تأثير إيجابى على معظم القياسات التي تم دراساتها. إلا أن المستوي الأعلى من الشعير المستنبت للعليقة الرابعة بنسبة 60% من بروتين العلف المركز لا يوصى بإستخدامه لأنها تؤدى إلى انخفاض معظم قيم معاملات الهضم وكذلك القيم الغذائية.