Replace the Sprout Barley Instead of the Concentrated Fodder Including Anaerobic Probiotic ZAD® for Growing Rabbits

Samir A. Nagadi
Department of Arid Land Agriculture, Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University Jeddah, Saudi Arabia

Abstract:- **A study was carried to examine the effects of feeding Sprout barley (SB) as a partial replacement for concentrate feed (Con.) without or with anaerobic probiotics (ZAD®) on productive performance, carcass characteristics, blood constituents and economic efficiency of rabbits.**

Seventy five 8-weeks old New Zealand White rabbits divided equally into five groups to study one of the five experimental feeds; T1, T2, T3, T4 and T5 based on the amount and percentage of Con., SB and ZAD® for 56 days in a complete randomized design.

Live body weight (LBW), body weight gain (BWG) and feed intake (FI) were higher ($p<0.05$) in rabbits fed (T3 and T5) diets than those of rabbits in T2 and T4 or T1 (control group), although feed conversion ratio (FCR) showed better value ($p<0.05$) when rabbits fed in (T3 and T5). Digestible coefficients of CP, CF and NFE were higher ($p<0.05$) for rabbits in T3 and T4 than rabbits fed other treatments diets, conversely, DM was highest for rabbits fed on all treatments diets except control. Nutritive value (TDN and DCP) was favorable value in T2, T3 and T5. The same trend was observed in nitrogen balance %. Empty carcass (g) and Dressing% ($p<0.05$) increased for rabbits in T5, while the rabbits in different treatments diets recorded the highest liver kidney and edible giblets (%) compared with T1. Cecum activity as total volatile fatty acid revealed that rabbits in T3 and T5 were ($P <0.05$) higher than those of rabbits in T2 and T4 or control group (T1). The opposite trend was observed in ammonia concentration. Rabbits fed diet in (T2-T5) had the highest serum TP and Alb. Total lipid and total cholesterol was higher in serum blood of rabbits (T5) than those treatments or control group. The higher value of Economic Efficiency (EE) was obtained by rabbit fed on (T5) diets. Offered fifty % of SB instead of concentrated diet in rabbits feeds deleteriously affect productive performance, FI, FCR and blood lipids.

It was concluded that the best substitution of SB for concentrate feed containing 0.1% anaerobic probiotics (ZAD®) had no adverse effects on productive performance, carcass characters, blood lipids or economic efficiency of rabbits.

Keywords: Sprout barley; anaerobic probiotics; Growing rabbits; Growth performance; Economic efficiency.

I. INTRODUCTION

No doubt that fodder production (hydroponically sprouted grains) has been particularly important in regions around the world where other forage options like pasture, hay, silage, etc. is extremely limited. Worldwide, regions like the Middle East and other areas that have faced and/or are facing determinedly dry and droughty conditions are increasingly relying on these systems to be able to meet animal intake needs. Therefore, Sprouting has been used to improve the nutritive value of the grains because of the conversion of complex compounds into quite simpler compounds that are nutritionally more appreciated. Sprouting of grains produced an increased protein quantity and quality (Gebremedhin, 2015); increase the concentration of certain nutrients such as sugars, minerals and vitamin contents Cuddeford (1989). Moreover, sprouted grains are considered rich in enzymes, enzyme-rich feeds are generally alkaline in nature, so, feeding of the hydroponics fodder improves the animals' productivity by evolving a stronger immune system due to removal the acidic conditions. As well as, serving in the removal the anti-nutritional factors such as phytic acid of the grains, hydroponics fodders has a source of chlorophyll and contain a grass juice factor that able to improve the performance of the animals (Finney, 1982). Many studies on the use of sprouted grains were done as (Abouelezz and Hussein, 2017) who reported that barley fodder consider a good for rabbit performance; but others revealed that there were no significant benefits (Abbas and Musharaf, 2008).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

Anaerobic probiotics (ZAD®) is a biotechnical product completed from anaerobic bacteria converts the polysaccharide to monomers through the enzyme catalytic process. Gado, et al. (2011) revealed that ZAD® enhanced nutrients digestibility feed conversion of wheat straw in small ruminants. ZAD® is a mix of enzymes attained from anaerobic bacteria that had a useful impact on the digestibility of low quality roughages. According to Kingsly, et al. (2010) a variety of enzymes have been used as potent additives in the feeding diets of non-ruminants, and they are well-known to improve the level of absorption of nutrients in the intestines (Bedford and Morgan (1996) and Abdel-Aziz et al. (2014 and 2015)) and). The beneficial impacts of the addition of enzymes attribute to a significant decrease in the viscosity of digesta in the small intestine and the non-starch polysaccharides (NSP) extant in the endosperm cell walls, (Zijstra et al (1999). Additionally, the supplementation of cellulolytic enzymes to the diet of rabbits has a definite positive influence on the body weight gain Chandra et al. (2014). Previously, researchers had demonstrated the action of exogenous enzymes on various segments of the rabbit gut. Sequeira, et al. (2000) showed a significant reduction in the gastric pH due to the addition of enzymes, while enzymes showed non-significant affect on the gastric, intestinal, and caecal contents, uniform in the period next early weaning, (Falcão-e-Cunha, (2007).

Therefore, the effect of replacement quarter or half sprout barley for concentrate diet having different levels of anaerobic probiotics (ZAD®) on productive performance, digestible coefficient and economic efficiency of rabbits is of interest in this study.

II. MATERIALS AND METHODS

Sprouting process of hydroponic barley:

Green fodder barley was formed in a hydroponic sprouting component (10.0 x 6.0 x 3.5 meters as length x width x height, respectively), which had an adequate slope to remove the excessive water. The sprouting unit had four metal stands (4.0 x 0.5 x 2.3 m) of five shelves each (40 cm height each), with a size of up to 40 hydroponic plastic trays (30 x 70 cm). Equipped with half-automated spray irrigation were used. Barley grains were adequately washed, saturated for 24 h using tap water, range in plastic trays at 750 g/ tray, and irrigated with tap water, free of whichever additives, four times daily for seven days. During the sprouting age, the hydroponic fodder component was held at 22–27 °C and 70–80% relative humidity. The biomass manufacture of hydroponic barley fodder was documented daily; this sprouting method was reformed after Gebremedhin (2015), who saturated barley seeds for 12 h in tap water and contract the seeds germinate for 24–36 h in burlap bags before spreading 350 g of barley grains per platter.

Experimental extinction, Housing and Feeding Management

Seventy five male New Zealand white rabbits at the age of 8 weeks were randomly separated into 5 group each consisting of 15 rabbits. All rabbits were kept under the same management, hygienic and environmental conditions. Rabbits were separately housed in galvanized wire pens (Dimensions of 60×40×35 cm) until marketing at 16 weeks of age under a 12:12 h light–dark cycle. The rabbits were raised in a well-ventilated building; fresh water was mechanically available all the time by stainless steel nipples fixed in each pen. The basal trial diet was framed and pelleted to cover the nutrient requirements of rabbits according to N.R.C (1977) as shown in (Table 1).

TABLE 1. INGREDIENTS OF THE EXPERIMENTAL DIETS.

Components	T1	T2	T3	T4	T5
Clover hay	32	32	32	32	32
Barely	16.7	16.7	16.7	16.7	16.7
Wheat bran	10.25	10.2	10.2	10.2	10.4
Yellow corn	15	15	14.9	15	14.4
Anaerobic probiotic ZAD®	0	0	0.1	0	0.1
Soybean meal (44%CP)	20	20	20	20	20
Lime stone	0.7	0.75	0.75	0.75	0.85
Di calcium phosphate	1.4	1.4	1.4	1.4	1.6
Na Cl	0.3	0.3	0.3	0.3	0.3
Vitamin and mineral premix#	0.3	0.3	0.3	0.3	0.3
DL-Methionine	0.3	0.3	0.3	0.3	0.3
Anticoccidia (Diclazuril)	0.05	0.05	0.05	0.05	0.05
Molasses	3	3	3	3	3
Total (Kg)	100	100	100	100	100
****Price LE**	500	500	515	500	515

** LE=Egyptian pounds.

The experiment consists of five treatment groups as follow:
T1= 100% Concentrate mixture diets (Con100).
T2= 75% concentrate (Con75 + 0 ZAD®) / 25% sprout barley (SB25).
T3= 75% concentrate (Con75 + 0.1 %ZAD®) /25 % sprout barley (SB25).
T4= 50% concentrate (Con50 + 0 ZAD®) / 50 % sprout barley (SB50).
T5= 50% concentrate (Con50 + 0.1 %ZAD®) / 50 % sprout barley (SB50).

The experimental period lasted for 8 weeks. ZAD® powder of exogenous enzymes mixture produced from anaerobic bacteria was used as a feed additives, it includes 2.32 U/g Xylanase, 61.5 U/g α- Amylase, 7.05 U/g cellulase and 29.2 U/g protease. Fresh hydroponic sprouted barley snips (500 g, 0.2 to 0.5 cm in length) were presented in a separate feeder from 9:00 to 17:00 h daily, and the refusals were weighed. Samples of fresh and refused sprout barley were composed three times weekly and dry matter (DM) was determined in each, and the DM intake from forage was calculated as the difference between the added and rejected DM weights (Abouelezz et al., 2017).
Live body weight was calculated weekly throughout the experimental period, and body weight gain was calculated. Feed intake from concentrate and fresh sprout barley in DM basis was determined exactly and calculated as grams per rabbit per day, during the all treatment period.
Twenty five males (5 males in each treatment) were used in carrying out the digestibility trial for determining nutrient digestibility coefficient of the tested diets. Animals were kept individually in pens that allowable the separation of feces and urine. The experimental diets from concentrate feed and sprout barley were presented twice daily at 9 a.m. and 15 p.m. and fresh water was provided ad libitum. Study of daily feed consumption on DM basis was recorded. Any possible feed corruption was removed from the feces. Samples of daily feces of each rabbit were reserved and dried in oven at 60º C for 48h, then was crushed and stored for proximate chemical analysis. Samples of feed and feces were examined for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), and ash according to the classical A.O.A.C (2000) The nutritive value of the experimental diets as DCP and TDN value were designed according to Cheeke, et al. (2013). NDF, ADF and ADL were examined according to Van Soest et al., (1991). Hemicellulose was considered as the difference between NDF and ADF, while cellulose was calculated as the adjustment between ADF and ADL. Gross energy (kilo calories per kilogram DM) was considered according to Blaxter (1968), anywhere, each g of crude protein (CP) = 5.65 kcal, each g of ether extract (EE) = 9.40 kcal and each g crude fiber (CF) and nitrogen- free extract (NFE) = 4.15 kcal. Digestible energy (DE) was designed according to Fekete and Gippert (1986) by the following equation: DE (kcal/ kg DM) = 4253-32.6 (CF %) - 144.4 (total ash). Non fibrous carbohydrates (NFC) were calculated according to Calsamiglia et al. (1995) by the following equation: NFC = 100 - {CP + EE + Ash + NDF}.

Urine was collected into stacks containing 100 ml of H2SO4 (10%) to inhibit N losses. The volume of urine at each sampling was recorded and subsample (10%) was taken for each rabbit and kept at -20 o C for analysis of total N.
At 16 weeks of age, five rabbits were randomly taken from each treat and fasted for 12 hours before slaughtering to perform the carcass characteristics according to Steven et al. (1981). Also, rabbits assigned to slaughter test were used to study cecum characteristics Total volatile fatty acids (Eadie et al., 1967) and ammonia concentration was determined according to (Conway, 1958). Blood serum samples were taken from the same rabbits of each treatment after slaughter and collected in 5 ml. heparinized test tubes and centrifuged at 3000 r.p.m for 20 minutes then plasma were transmitted and stored in deep freezer at approximately -20ºC until the stage to determine total lipids (Zollner and Kirsch, 1962), cholesterol (Trinder, 1969) creatinine (Schirmeister, 1964), urea (Fawcett and Scott, 1960), protein (Gornal et al., 1949), albumin (Doumas and Waston 1971), aspartate aminotransferase (AST) and alanine aminotransferase (ALT), Reitman and Frankel (1957) were measured.

The economic efficiency (EEF) was calculated allowing to the following equation: EEF = Net revenue / total costs where the total cost calculated by Egyptian pound (L.E) in the local market at the time of the experiment. All records were subjected to analysis of Variance Using the General Linear Models (GLM) Procedure of SAS (2004). $Y_{ij} = \mu + T_i + e_{ij}$,
Where: μ= Overall mean of Yij, T = Effect of treatment) and eij= Experimental error.

The significant differences between treatment means were separated using Duncan's multiple range test (Duncan, 1955).

III. RESULTS AND DISCUSSION

Later 8 days of sprouting, the one kg of barley seeds produced 6.5 kg of green barley fodder, which enclosed 113.8 g DM/kg of the DM (g/kg), chemical analysis and cell wall constituents of the sprout barley (SB) and the experimental diets are offered in Table 2. The chemical structure of fresh sprout barley as crude protein, ether extract, ash, gross energy, hemicelluloses, cellulose, dry matter, organic matter, crude fiber, nitrogen-free extract, digestible energy (Kcal/kg DM), nitrogen free extract, acid detergent lignin, acid detergent fiber and neutral detergent fiber contents were suitable to replacement the concentrate feed. Sprout barley contained suitable amount of DM, OM, CP, NDF, ADF and DE, which support moderate growth of rabbits (Shanti et al. 2017). Abouelezz et al. (2019) reported that sprout barley contain 230.3 crude proteins, 41.7 ether extract, 267 nitrogen free extract and 39.7 ashes (all g/kg DM). The experimental diets were iso-caloric and iso nitrogenous. Protein contents for the four tested diets (T1–T5) ranged from 16.5 to 16.7%, the digestible energy values ranged from2543 to 2558 (kcal/ kg DM) for entirely diets. Totally parameters determined of chemical analysis were similar for the different experimental diets.

TABLE 2. QUALITATIVE ANALYSIS AND CELL WALL CONSTITUENTS (%) OF THE FRESH SPROUTED BARLEY (SB) AND THE EXPERIMENTAL DIETS.

Items	Fresh SB	Concentrated diets				
		T1	T2	T3	T4	T5
Chemical analysis (%)						
Dry matter	17.5	91.5	91.5	91.4	91.5	91.2
Qualitative analysis on DM basis						
Organic matter (OM)	96.1	82.6	82.7	82.5	82.6	82.4
Crude protein (CP)	15.2	16.6	16.5	16.6	16.7	16.6
Crude fiber (CF)	15.9	13.0	13.0	12.9	13.1	13.3
Ether extract (EE)	4.0	2.6	2.6	2.7	2.7	2.6
Nitrogen-free extract (NFE)	61.0	59.0	59.1	58.9	58.7	58.7
Ash	3.9	8.9	8.8	8.9	8.8	8.8
Gross energy(Kcal/kg DM)1	4424.3	4163.8	4168.8	4171.8	4173.7	4170.3
Digestible energy (Kcal/kg DM)2	3171.2	2543.7	2558.5	2548.7	2550.9	2548.7
Non fibrous carbohydrates (NFC)3	37.6	34.5	34.6	34.4	34.3	34.3
Cell wall elements						
Neutral detergent fiber (NDF)	39.4	37.5	37.5	37.4	37.5	37.7
Acid detergent fiber (ADF)	28.0	22.4	22.3	22.2	22.3	22.6
Acid detergent lignin (ADL)	5.9	6.5	10.0	9.7	9.3	9.2
Hemicellulose	11.4	15.1	15.2	15.2	15.2	15.1
Cellulose	22.1	15.9	12.3	12.5	13	13.4

1 Gross energy (Kcal/ Kg DM) was calculated according to Blaxter (1968), where, each g of CP = 5.65 kcal, each g of EE = 9.40 kcal and each g CF and NFE = 4.15 kcal.
2 Digestible energy was calculated according to Fekete and Gippert (1986) using the following equation: DE (kcal/ kg DM) = 4253-32.6 (CF %) -144.4 (total ash).
3 Non fibrous carbohydrates, calculated according to Calsamiglia et al. (1995) using the following equation: NFC = 100-{CP + EE + Ash + NDF}. Hemicellulose = NDF-ADF. Cellulose = ADF-ADL.

Productive performance:

Results of growth performance are illustrated in Table 3. It could be noticed that significant differences in final body weight, total body weight gain, daily body weight gain, total feed intake on DM basis, daily feed intake and feed conversion ratio between treatments. Group of rabbits in T3 and T5 had the highest final body weight, total body weight gain and daily body weight gain and feed conversion ratio compared to the further treatments. In accordance with Morales et al. (2009) who found that replacing the commercial feed of growing (NZW) rabbits by 10%, 20%, and 30% with green hydroponic barley fodder impaired feed intake and body weight. The same results was by Mohsen et al. (2015) who proved that the hydroponic barley fodder can replace up to 30% of the concentrated feed in rabbit diets without any adverse effect on growth enactment. Furthermore, the male rabbits which provided with fresh hydroponic barley fodder recorded the highest live body weight, weight gain and feed conversion ratio, (Abouelezz and Hussein 2017). Meanwhile, Carmona et al. (2011) revealed that the basal diet replacement up to 50% with sprout green oat had not affect the feed consumption and final body weight. Meanwhile, Shanti et al. (2017) said that feed intake on dry matter basis and growth rate was decreased statistically by 1.16 g/d (P<0.001) and 0.998 g/d (P<0.001) per part of hydroponic barley (HB) increase as in experimental used (replacing 20, 40 and 60% of pelleted feed by HB (HB20, HB40 and HB60, respectively). In conflict to our results, Ebenezer et al. (2018) found that 50% replacement of concentrate with hydroponic fodder (p<0.01) enhanced the final body weight, total body weight gain, daily body weight gain, total feed intake and significantly lowered the feed conversion ratio than other treatment groups without using anaerobic probiotic.

This study, showed that the DM intake of SB was 14.73, 15.53, 28.56 and 30.87 g/day, which represented (SB25) in T2 or T3 and (SB50) in T4 or T5 of the total DM intake in the experimental diets, respectively. The results here are similar to the sprouted yellow maize intake of rabbits reported by Ebenezer et al. (2018) where hydroponic yellow maize intake represented 25–50% of the total feed intake (DM basis). Abouelezz and Hussein (2017) found that the DM from sprouted barley and sprouted barley with bakers' yeast represented 24% and 22.45% of total feed intake on DM basis of feeding female growing rabbits.

TABLE 3. PRODUCTIVE PERFORMANCE OF GROWING RABBITS AS AFFECTED BY THE EXPERIMENTAL DIETS.

Items	Treatment					SEM
	T1	T2	T3	T4	T5	
Initial body weight (g)	901	868	858	870	883	37.59
Final body weight (g)	2034b	2069b	2195a	2031b	2301a	54.05
Total body weight gain (g)	1133b	1201b	1337a	1161b	1418a	24.52
Daily body weight gain (g)	20.23b	21.45b	23.88a	20.73b	25.32a	0.87
SB intake (DM g/day)1	-	14.73	15.53	28.56	30.87	0.55
Con intake (DM g/day)2	58.07a	44.18b	46.58b	28.55c	30.86c	0.31
Total feed intake (g)3	3252b	3299b	3478a	3198b	3457a	88.04
Daily feed intake (g)	58.07b	58.91b	62.11a	57.11b	61.73a	1.92
Feed conversion ratio (g)	2.87a	2.75a	2.6b	2.76a	2.44b	0.03

1SB=Sprouted barley intake on DM basis g/day; 2Con intake= concentrated diet intake on DM basis g/day; 3Total feed intake = (dry matter of concentrated diet + dry matter of sprout barley)
[a-b] Means within the same row with different superscripts are significantly different (P<0.05).

Improvement in growth performance of rabbits in T3 and T5 compared with rabbits in T2 and T4 may be qualified to a significant reduction in the viscosity of digestive in the intestine and the NSP existing in the endosperm cell walls, (Zijstra et al. 1999). Additionally, supplementation of cellulolytic enzymes to the rabbits diets has definite a positive influence on the weight gain, (Chandra et al. 2014). Since, the rate of digestion of fiber and starch in weaning rabbits is limited the supplementation of enzymes increased the dietary digestion as well as performance of weaning rabbits on starter diets, ((Marounek et al. (1995); Gutiérrez et al. (2002) and Abdel-Aziz et al. (2014 and 2015)) Previously, studies had demonstrated the mechanism of act exogenous enzymes on various sections of the rabbit gut. Sequeira, et al. (2000) showed a significant reduction in the gastric pH due to the addition of enzymes, while enzymes had no significant effect on the gastric, intestinal, and caecal contents, level in the period following early weaning, (Falcão-e-Cunha et al. 2007).

Carcass characteristics:

Results in Table (4) indicated that rabbits in T5 had (P<0.05) increase of empty carcass with head and dressing (%). In comparison with T1 rabbit group, the rabbits fed in T3 and T5 had been (P<0.05) effect on liver %, Kidney % and edible giblets percentage. However, there were insignificant differences in heart percentage between all experimental diets. In this connection, Morales et al. (2009) reported that dressing % of rabbits did not affect by replacement the commercial feed with sprout green barley. Besides that, the additional up to 50% of the commercial concentrate diet with sprout green oats had not (P<0.05) effect on slaughter weight and dressing % of Californian rabbits (Carmona et al. 2011). Adeyemi and Akanji (2012) Moussa et al. (2014) they reported that the using concentrate feed restriction in the presence of ad libitum forage had no significant influence on carcass characteristics of rabbits.

TABLE 4. CARCASS PERFORMANCE OF GROWING RABBITS AS AFFECTED BY THE EXPERIMENTAL DIETS.

Items	**Treatment**					
	T1	**T2**	**T3**	**T4**	**T5**	**SEM**
Pre-slaughter weight (g)	2005	2050	2035	2060	2100	54.05
Empty carcass with head(g)	1100b	1078b	1124b	1174b	1230a	21.16
Dressing%	54.86b	52.59c	55.23ab	56.99ab	58.57a	0.440
Liver %	2.09b	2.33a	2.35a	2.43a	2.36a	0.100
Heart%	0.24	0.23	0.25	0.25	0.22	0.010
Kidney%	0.51b	0.69a	0.68a	0.67a	0.64a	0.038
Edible Giblets%	2.84b	3.25a	3.28a	3.35a	3.22a	0.110

a-b Means within the same row with different superscripts are significantly different (P<0.05).

Digestible coefficients, nutritive value and nitrogen balance of nutrients:

Digestible coefficients, nutritive value and nitrogen balance of the trial diets are presented in Table 5. T3 and T5 in rabbit diets resulted (P<0.05) difference in digestion coefficients of DM, CP, CF and NFE. However, the differences were no (P>0.05) for the digestible coefficients of OM and EE compared to T2 and T4 and control group (T1).
Rabbits in group T3 and T5 has (p<0.05) improved digestible coefficient of DM when related to control group (T1). These results are in arrangement with those reported by Raeisi et al. (2018) who replaced of barley grains (0, 7, 14 or 21%) by hydroponic barley fodder in the rations of male Kermani sheep and showed that the digestibility coefficients of nutrients (P<0.05) increased by cumulative the amount of hydroponic barley fodder in experimental diets. Using hydroponics fodder could be increased the digestible of the nutrients which could be qualified to the tenderness of the fodder (Naik et al., 2014). This improvement might be due to high content of leafy and roots portions contents of sprouts which is easy to digest and hydrolysis by the enzymes of rumen microflora, as well as enzymatic digestion (proteases) present in the lytic vacuoles of plant cells. In this connect; Chung et al. (1989) said that high soluble protein and amino acids refer to the response in the early plant growth and enzymatic changes of sprouted grains are responsible for improving the digestibility in the animals.

TABLE 5. DIGESTION COEFFICIENTS, NUTRITIVE VALUES AND NITROGEN BALANCE% AS AFFECTED BY EXPERIMENTAL DIETS.

Items	**Treatments**					**SEM**
	T1	**T2**	**T3**	**T4**	**T5**	
DM	62.74b	65.03a	66.72a	66.82a	67.03a	1.85
OM	65.81	64.94	65.68	66.35	64.49	1.92
CP	74.63b	77.19b	78.35a	77.16b	79.81a	2.04
CF	34.91b	35.34b	41.76a	34.95b	42.57a	5.11
EE	56.03	55.81	55.98	54.98	56.58	2.56
NFE	67.96b	68.20b	74.94a	68.19b	76.85a	2.47
TDN	54.99b	56.98a	56.95a	55.01b	56.80a	3.45
DCP	12.73b	13.49a	13.50a	12.47b	13.48a	0.59
Nitrogen balance, %	47.174b	47.025b	49.305a	47.223b	49.097a	2.49

a-b Means within the same row with different superscripts are significantly different (P<0.05).

The most progress in digestion coefficients, nutritive values and nitrogen balance% occurred in T3 and T5 may be due to the enzymes content in it additives ZAD which contains about Xylanase, α-Amylase, cellulase and protease (2.32 U/g, 61.5 U/g, 7.05 U/g and29.2 U/g), respectively. The improvement varied between the treatments which fed on sprouted barley as well as more pronounced at higher addition of anaerobic probiotic (ZAD®). Apparently, this refers to the beneficial effect of ZAD® on fiber hydrolysis (Gado et al., 2007; Juskiewicz et al., 2007). Addition mixture exogenous fibrolytic enzyme as ZAD® tend to better in vitro rumen fermentation activity and cell wall digestibility of clover stems (Colombatto et al., 2007). However, the act of live microbials in the rumen or the caecum is not completely implicit.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

The incidence of lactate-producing bacteria is supposed to help the caecal and rumen microflora to acclimate with the presence of lactic acid (Beauchemin et al., 2003; Guerra et al., 2007; Marinho et al., 2007).

Cecum activity:

Results of the total volatile fatty acid (VFA) and ammonia concentration of caecal contents are shown in Table 6. Analysis of variance of total volatile fatty acid revealed that rabbits in T3 and T5 were (P <0.05) higher than those of T2 and T4 or control group (T1). Ammonia concentration was (P<0.05) different between treatments. The higher volume of ammonia concentration was recorded in group T2 and T4 (7.56 and 7.46) inversely T1, T3 and T5 which recorded (6.57, 6.67 and 6.78), respectively. The high concentration of total VFA generated from the caecum content of rabbit's T3 and T5 indicates high available energy that affected on growth performances. Dung et al. (2010) reported that the highest TVFA concentration and total ammonia concentration were obtained in sheep fed on diets containing sprout barley compared to diets without sprout barley. Mohsen et al. (2015) found that the pH rate and the concentrations of TVFA's and NH3- N of growing rabbits were insignificant affected by feeding sprout barley grains. While, Raeisi et al. (2018) reported that replacing part of the barley grain by hydroponic barley fodder (HBF) as 0, 7, 14 and 21 % caused (P<0.05) increased in ammonia-N production by increasing the dietary hydroponic barley fodder. This increasing in ammonia concentration back to the that the rate of NH3-N release from herbage NPN was faster than that of water soluble sugars in sprouted barley resulting in NH3-N accumulation, (Hafla et al. 2014).

TABLE 6: CECUM ACTIVITY AS AFFECTED BY DIETARY TREATMENTS.

Items	Treatment groups					
	T1	T2	T3	T4	T5	SEM
Total volatile fatty acids (mg/100ml)	3.56b	3.68b	4.40a	3.70b	4.42a	0.09
Ammonia(mg/100ml)	6.57b	7.56a	6.67b	7.46a	6.78b	0.22

a- b Means within the same row with different superscripts are significantly different (P<0.05).

Garcia et al. (2002) reported that the caecal contents are considered slightly acidic at (pH 5.4–6.8) Fermentation procedures is the main source of production (VFA) production which include (acetic, propionic and butyric acid), NH3 resulting from proteolysis, while, the VFA and NH3 are absorbed in the walls of the caecum and colon and are a basis of energy for the host. Our results, showed that ceacal ammonia concentrations in T3 and T5 were reduced (P<0.05) and closed to T1 (control group) when compared with T2 and T4. This agreed with previous findings Gado et al. (2017) who showed that inclusion of the ZADO® treatment has been (P<0.05) increased the rumen TVFA's concentrations before and post-feeding.

Blood plasma constituents:

Effects of dietary treatments on blood plasma parameters are set in Table 7. Data for creatnine, ALT and AST showed that there were no significant differences between the trials. However, there were significantly increased in total protein, albumin in T2, T3, T4 and T5 treatment groups compared with T1 control groups. Globulin of the rabbits in T5 was (P<0.05) higher than those of control group. This may be attributed to the improvements occurred in metabolism as a response to increase apparent nutrients digestibility particularly, CP and OM digestibility (Table 5). Serum total proteins refer to the dietary status of the animal and it has up connection with dietary protein (Kumar et al., 1980). Also, Bush (1991) found a positive correlation between nutritional protein and plasma blood protein concentration, and definite that the low level of plasma blood proteins back to the decrease in the protein absorbed and created and an increase in protein losses.

Urea nitrogen concentration was (P<0.05) decreased for rabbits fed diets in T3 and T5 followed by T2 and T4 as compared with that T1 (control group). Lower urea-N concentration in this study may be due to high protein utilization by rabbits fed diet supplemented with 0.1 ZAD.

Plasma cholesterol and total lipids were significantly higher with T5 compared to the control rabbits.

These results point to the total protein slightly reduced with T5 may be back to the lower digestibility of crude protein in the diet. In this respect, Shanti et al. (2017) observed that replacing a commercial feed with hydroponic barley (HB) caused a decrease in levels of

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 8 Issue 10, October-2019

blood urea and total protein in growing rabbits. The same results were observed by Raeisi et al. (2018) in sheep.

TABLE 7. BLOOD CONSTITUENTS AS AFFECTED BY TREATMENTS.

Items	Treatment					SEM
	T1	T2	T3	T4	T5	
Total protein (mg/dl)	6.19b	6.89a	7.11a	6.94a	7.13a	0.11
Albumin (mg/dl)	3.75b	4.38a	4.46a	4.39a	4.23a	0.07
globulin (mg/dl)	2.44b	2.51b	2.65b	2.55b	2.90a	0.10
Creatnine	1.08	1.25	1.28	1.40	1.34	0.06
ALT(U/L)	63.66	46.33	46.66	54.66	60.66	0.024
AST(U/L)	67.33	50.00	48.33	61.33	66.00	0.029
Urea N, mg/dl	42.91a	39.58ab	36.27b	40.31ab	36.66b	0.90
Total cholesterol (mg/dl)	215b	250ab	245ab	224b	266a	5.49
Total Lipid (mg/dl)	353b	390ab	379ab	368b	442a	9.34

A-c Means within the same row with different superscripts are significantly different ($P<0.05$).

Economic evaluation:

The most important factors involved in achievement of maximum efficiency values of meat production depend on the final body weight, length of the growing period and feeding cost. The relative economic efficiency (REE) was affected by different treatments as shown in Table 8. Results referring to that the Relative economic efficiency values were estimated according to the dominant market selling price of 1 kg LBW.

Results indicated that using sprout barley as a substitution concentrate feed in growing rabbit diets enhanced a little the net revenue and reduced the total feed cost. The lowest total feed cost / rabbit (15.76 LE) was observed with rabbits fed the diets T4 (Con50/SB50). Data showed that T5 (Con50+0.1ZAD/SB50) to growing rabbit gave the best economic efficiency (2.28) followed by T3, T4 and T2 (2.03, 1.95 and 1.93), when compared to the control group (1.79), respectively. The same trend was observed in the REE of diets by 127%, 113%, 109% and 108%, .respectively. These results are in agreement with those of Abouelezz and Hussein (2017) found that substitution hydroponic sprout barley of commercial concentrate feed of growing rabbits was a cheaper feed cost per gain than those of the control group. While economic the efficiency values were raised with Con75/SB25and Con50/SB50) without or with 0.1%ZAD by 7.82, 13.41, 8.94 and 27.37% respectively, compared with rabbits fed the concentrate diets only. The similar trend was seen by AL-Saadi, (2016) who discussed that the feed price per kg gain were relatively lower than the control in lambs were fed rations contained 10 and 30% sprout barley.

TABLE 8. ECONOMICAL EFFICIENCY AS AFFECTED BY DIETARY TREATMENTS.

Items	Treatment groups				
	T1	T2	T3	T4	T5
Total average weight gain (g)/head	1133	1201	1337	1161	1418
Price of 1kg body weight	40.00	40.00	40.00	40.00	40.00
Selling price/rabbit (LE) (A)	45.32	48.04	53.48	46.44	56.72
Total fresh (SB) intake/Kg/head	-	4.71	4.97	9.14	9.88
Price /Kg intake of (SB) (LE)**	0.00	4.01	4.22	7.77	8.40
Total Con Intake	3.25	2.47	2.61	1.60	1.73
Price /Kg intake of Con	16.26	12.37	13.43	7.99	8.90
Total feed cost/ rabbit (LE) (B)	16.26	16.38	17.66	15.76	17.30
Net revenue(LE)1	29.06	31.66	35.82	30.68	39.42
Economic efficiency2	1.79	1.93	2.03	1.95	2.28
Relative Econ. Eff.3	100	108	113	109	127

(1) Net revenue = A – B.; SB= Fresh sprout barley (price = 0.85/Kg); Con= concentrate diet
(2) Economic efficiency = (A-B/B).
(3) Relative Economic Efficiency= Economic efficiency of treatments other than the control/ Economic efficiency of the control group.

IV. CONCLUSION

The substitution of sprout barley as a partial replacement for concentrate feed contains anaerobic probiotics in rabbit diets are beneficial economic policy for reducing feed costs. The results suggested that sprout barley could be fed on rabbits at 50% replacement with the concentrate diet including 0.1%

anaerobic probiotics without adverse effects on productive performance, economic efficiency, carcass characteristics and blood parameters.

REFERENCES

[1] A. G. Gornal, C. J. Bardawill and M. M. Divid. "Determination of plasma protein by means of the biurent reaction". J. Biol.Chem., 177: 751. 1949.

[2] A. N. Hafla, K. J. Soder, A. F. Brito, M. D. Rubano and C. J. Dell, C.J. "Effect of sprouted barley grain supplementation of an herbage-based or haylage-based diet on ruminal fermentation and methane output in continuous culture". Journal of dairy science 97(12): 7856-7869. 2014.

[3] A. R. P. Kingsly, K. E. Ileleji, C. L. Clementson, A. Garcia, D. E. Maier, R. L. Stroshine and S. Radcliff. "The effect of process variables during drying on the physical and chemical characteristics of corn dried distillers grains with solubles (DDGS) - plant scale experiments," Bioresource Technology, vol. 101, pp. 193-199. 2010.

[4] A. O. A. C. "Official Methods of Analysis".17th ed., Published by the A.O.A.C., Washington, D.C., USA. 2000.

[5] Abbas, T.E.E., N. A. Musharaf. "The effects of germination of low – tannin sorghum grains on its nutrient contents and broiler chicks performance". Pak. J. Nutr. 7, 470–474. 2008.

[6] B. M. Bush. "Interpretation of laboratory results for small animal clinicians". Oxford Blackwell scientific publications, London. 1991.

[7] B. T. Doumas and W. Waston. "Albumin standards and measurement of plasma albumin with bromocresol green". Clin. Chem. Acta., 31: 87. 1971.

[8] D. B. Duncan. "Multiple Range and Multiple F-Test". Biometrics, 11: 1-42. 1955.

[9] D. Colombatto, F. L. Moulda, M. K. Bhat, and E. Owen. "Influence of exogenous fibrolytic enzyme level and incubation pH on the in vitro ruminal fermentation of alfalfa stems". Anim. Feed Sci. Technol., 137, 150-162. 2007.

[10] D. Cuddeford. "Hydroponic grass". In Pract. 11, 211–214. 1989.

[11] D. D. Dung, I. R. Godwin and J. V. Nolan. "Nutrient content and in sacco degradation of hydroponic barley sprouts grown using nutrient solution or tap water". – Journal of Animal and Veterinary Advances 9: 2432-2436. 2010.

[12] E. J. Conway. "Micro Diffusion Analysis and Volumetric Error". 4thed. The McMillan Co., New York, USA, 687p. 1958.

[13] F. F. F. Carmona, C. E. P. Perez, and M. A. H. Pizarro. "Productive response of rabbits fed with green hydroponic oats forage as partial replacement of commercial concentrate". Acta Agronmica, 60(2): 183-189. 2011.

[14] F. M. K. Abouelezz, and A. M. A. Hussein. "Evaluation of baker's yeast (saccharomyces cerevisiae) supplementation on the feeding value of hydroponic barley sprouts for growing rabbits". Egypt. Poult. Sci. Vol (37)(III): (833-854). 2017.

[15] F. M. K. Abouelezz, M. A. M. Sayed, and M. A. Abdelnabi. "Evaluation of hydroponic barley sprouts as a feed supplement for laying Japanese quail: Effects on egg production, egg quality, fertility, blood constituents, and internal organs". Animal Feed Science and Technology, vol 252: pp126-135. 2019.

[16] Falcão-e-Cunha, L. Castro-Solla, L. Maertens, L. Marounek, M. Pinheiro, V. Freire and J. L. Mourao. "Alternatives to antibiotics growth promoters in rabbit feeding: A review," World Rabbit Science, vol. 15, pp. 127-140. 2007.

[17] H. M Gado, H. M. Metwally, H. Soliman, A. Z. L. Basiony and E. R. El Galil, E.R. "Enzymatic treatments of bagasse by different sources of cellulase enzymes". In: The 11th Conf. Animal Nutr., Al-Aqsor-Aswan, Egypt on 2 November, 13–18, vol. 10, p. 607. 2007

[18] H. M. Gado, A. Z. M. Salem, N. E. Odongo and B. E. Borhami, B. E. "Influence of exogenous enzymes ensiled with orange pulp on digestion and growth performance in lambs". Animal Feed Science and Technology, vol. 165, pp. 131-136, 2011.

[19] H. Shanti, J. Omar, I. Alwaheidi, J. Abdallah and E. Dbadran. "Effect of substituting hydroponic barley for a commercial feed on performance and blood metabolites of growing Baladi rabbits". Journal of new sciences, Agriculture and Biotechnology, 39 (5), 2131-2135. 2017.

[20] I. Gutiérrez, A. Espinosa, J. García, R. Carabaño and C. De Blas. "Effect of levels of starch, fiber and lactose on digestion and growth performance of early-weaned rabbits". Journal of Animal Science, vol. 80, pp. 1029-1037. 2002.

[21] J. Garcia, T. Gidenne, L. Falcao e Cunha, and C. de Blas. "Identification of the main factors that influence caecal fermentation traits in growing rabbits". Animal Research, 51, 165–173. 2002.

[22] J. Juskiewicza, A. Semaskaiteb, Z. Zdunczyka, M. Wroblewskaa, R. Gruzauskasb, M. Juskiewicz. "Minor effect of the dietary combination of probiotic Pediococcus acidilactici with fructooligosaccharides or polysaccharidases on beneficial changes in the cecum of rats". Nutr. Res., 27, 133–139. 2007.

[23] J. K. Fawcett and J.E. Scott. "Determination of urea". Journal of Clic. Path., 13:156-159. 1960.

[24] J. M. Eadie, P.N. Hobson and S.O. Mann. "A note on some comparisons between the rumen content of barley fed steers and that of young calves also fed on high concentrate rations". J. Animal Production, 9:247-250. 1967.

[25] J. Schirmeister. "Determination Of Creatinine". Dtsch. Med Wschr., 89:1940. 1964.

[26] J. Sequeira, N. Nicodemus, R. Carabaño and M. J. Villamide. "Effect of type of wheat and addition of enzymes on some digestive parameters at different sampling time," in Proc.: 7th World Rabbit Congress. 4-7 July, 2000, Valencia, Spain, pp. 437-444. 2000.

[27] K. A. Beauchemin, D. Colombatto, D. P. Morgavi, W. Z. Yang. "Use of exogenous fibrolytic enzymes to improve feed utilization by ruminants". J. Anim. Sci., 81 (E. Suppl. 2), E37–E47. 2003.

[28] K. L. Blaxter. "The Energy Metabolism of Ruminants". 2 Ed. Charles Thomas Publisher, Spring Field. Illinois, U.S.A. 1968.

[29] K. Moussa, G. B. Isidore, B. G. A. Maxwell, B. N. Clément and F. Agathe. "Effect of associated using of commercial feed supplementation and green forage on rabbit (Oryctolagus cuniculus) growth and health". Scientia Agriculturae, 6 (3): 114-119. 2014.

[30] M. C. Marinho, M. M. Lordelo, L. F. Cunha, J. P. B. Freire. "Microbial activity in the gut of piglets: II. Effect of probiotic and probiotic supplementation". Livestock Sci., 108, 236-239. 2007.

[31] M. J. AL-Saadi. "Productive Effects and Economical Feasibility of Substitution Barley by 10 and 30% of Sprouted Barley in Diet of Awassi Male Lambs". Asian J. Anim. Vet. Adv., 11: 563-569. 2016.

[32] M. K. Mohsen, E. M. Abdel-Raouf, H. M. A. Gaafar and A. M. Yousif. "Nutritional Evaluation of Sprouted Barley Grains on Agricultural By-Products on Performance of Growing New Zealand White Rabbits". Nature and Science 13 (10) pp 35-45. 2015.

[33] M. Marounek, S. J. Vovk and V. Skřivanová. Distribution of activity of hydrolytic enzymes in the digestive tract of rabbits, British Journal of Nutrition, vol. 73, pp. 463-469. 1995.

[34] M. R. Bedford, and A. J. Morgan. "The use of enzymes in poultry diets," World's Poultry Science Journal, vol. 52, pp. 61-68. 1996.

[35] M. A. Morales, B. Fuente, M. Juarez and E. Avila. "Short communication: effect of substituting hydroponic green barley forage for a commercial feed on performance of growing rabbits". World Rabbit Sci., 17: 35-38. 2009.

[36] N. Abdel-Aziz, M. El-Adawy, A. Z. M. Salem, M. A. Cerrillo-Soto, L. M. Camacho, and B. E. Borhami. "Effects of exogenous enzymes, lactobacillus acidophilus or their combination on feed intake, digestibility and performance of rabbits fed sugarcane bagasse". Animal Feed Science and Technology, vol. 14, pp. 137-145. 2014.

[37] N. Abdel-Aziz, M. El-Adawy, M. A. Mariezcurrena-Berasain, A. Z. M. Salem, J. Olivares-Pérez, A. E. Kholif, and B. E. Borhami. "Effects of exogenous enzymes, lactobacillus acidophilus or their combination on feed performance response and carcass characteristics of rabbits fed sugarcane bagasse". Journal of Integrative Agriculture, vol. 14, pp. 544-549. 2015.

[38] N. Kumar, U. B. Singh and D. N. Verma. "Effect of different levels of dietry protein and energy on growth of male buffalocalves". Ind. J. Anim Sci, 15: 513. 1980.

[39] N. P. Guerra, P. F. Bernardez, J. Mendez, P. Cachaldora, L. P. Castro L.P. "Production of four potentially probiotic lactic acid bacteria and their evaluation as feed additives for weaned piglets". Anim. Feed Sci. Technol., 134, 89–107. 2007.

[40] N. Zollner and K. Kirsch. "Determination of total lipids in blood by colorimetric method". Z. Ges. Exp. Med., 135:454-454. 1962.

[41] N. R. C. National Research Council. "Nutrient Requirements of Rabbits". National Academy of Science, Washington, D.C, USA. 1977.

[42] O. A. Adeyemi, and A. O. Akanji. "Restricted concentrate with ad libitum forage feeding: effects on performance and carcass yield of growing rabbits". Revista Científica UDO Agrícola, 12(3): 668-674. 2012.

[43] P. J. Van Soest, J. B. Robertson and B. A. Lewis. "Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition". J. Dairy Sci., 74: 3583–3597. 1991.

[44] P. K. Naik, R. B. Dhuri, M. Karunakaran, B. K. Swain and N. P. Singh. "Effect of feeding hydroponics maize fodder on digestibility of nutrients and milk production in lactating cows". – Indian Journal of Animal Science 84: 880-883. 2014.

[45] P. L. Finney. "Effect of germination on cereal and legume nutrient changes and food or feed value": A comprehensive review .Recent Advances In Phytochemistry. Volume 17. | Finney, P.L. 1982. Effect of germination on cereal and legume nutrient changes and food or feed value: A comprehensive review. Recent Advanc. in Phytochem. 17: 229-305. 1982.

[46] P. R. Cheeke, N. M. Patton and G. S. Tempelton. "Rabbit production". 9th Edition, Interstate, Danville IL., USA. 2013.

[47] P. Trinder. "Determination of blood glucose uses an oxidation peroxides system with a non-carcinogenic chromogene". J. Clin. Path., 22:158-161. 1969.

[48] R. J. Ebenezer, P. P. Tensingh Gnanaraj, T. Muthuramalingam, T. Devi, A. Bharathidasan and A. S. Sundaram. "Growth Performance and Economics of Feeding Hydroponic Maize Fodder with Replacement of Concentrate Mixture in New Zealand White Rabbit Kits". Journal of Animal Health and Production, Volume 6,| Issue 2, Page 73. 2018.

[49] R. T. Zijstra, C. F. M. de Lange and J. F. Patience, J. F. "Nutritional value of wheat for growing pigs: Chemical composition and digestible energy content," Canadian Journal of Animal Science, vol. 79, pp. 187-194. 1999.

[50] S. Calsamiglia, M. D. Stem, and J. L. Frinkins. "Effects of protein source on nitrogen metabolism in continuous culture and intestinal digestion in vitro". J. Anim. Sci., 73: 1819. 1995.

[51] S. Chandra, M. Mahender, M. G. Prakash, T. Raghunandan and K. K. Reddy. "Productive performance of broiler rabbits fed diets supplemented with probiotic and enzymes under two systems of housing". Indian Journal of Animal Research, vol. 48, pp. 355-361. 2014.

[52] S. Fekete and T. Gippert. "Digestibility and nutritive value of nineteen important feedstuffs for rabbits". J. Appl. Rabbit Res., 9(3): 103-108. 1986.

[53] S. Reitman and S. Frankel. "Determination of GOT and GPT". Amr. J. Clin. Path., 28:56-63. 1957.

[54] SAS. User's guide. Statistic. SAS Inst. Cary, N.C. Releigh. 2004.

[55] T. Y. Chung, E. N. Nwokolo, J. S. Sim. "Compositional and digestibility changes in sprouted barley and canola seeds". – Plant Foods for Human Nutrition 39: 267-278. 1989.

[56] W. D. Steven Lukefapor, W. D. Hohenboken, P. R. Cheeke, N. M. Patton and W. H. Kennick. "Carcass and meat characteristics of Flemish giant and New Zealand white purebred and terminal cross rabbits". Journal of Applied Rabbit Research, 4 (3): 66-72. 1981.

[57] W. K. Gebremedhin. "Nutritional benefit and economic value of feeding hydroponically grown maize and barley fodder for Konkan Kanyal goats". IOSR J. Agric.Vet.Sci., 8:24-30. 2015.

[58] Z. Raeisi, R. Tahmasbi, O. Dayani, A. Ayatollahi Mehrgardi and I. Tavassolian. "Digestibility, microbial protein synthesis, rumen and blood parameters in sheep fed diets containing hydroponic barley fodder". Journal of Livestock Science and Technologies, 6 (1): 09-17. 2018.