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EFFECT OF DISTILLERS DRIED GRAINS WITH SOLUBLES (DDGS) SUPPLEMENTED WITH OR WITHOUT ENZYME ON THE PERFORMANCE OF GROWING RABBITS

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A factorial experiment (4×2) was carried out including four levels of corn distiller dried grain with solubles (DDGS) (0,16,22 and 28%) and two levels of supplemental enzyme (0.0 and 0.5 gm/ Zylam kg diet). A total number of 96 New Zealand(NZW) rabbits at 5 wks old were weighed and randomly distributed into the 8 treatment groups (12 rabbits, each) in three replicates (4rabbits, each).Growth performance, economic efficiency, apparent digestibility and carcass traits as well as blood plasma constituents were studied during the growing period (5-14 weeks).

Results show that no significant differences in live body weight (LBW) , body weight gain (BWG) and feed intake (FI) were observed by different levels of inclusion DDGS, enzyme supplementation or the interaction between their in rabbit diets except BWG during 12-14 weeks of age, which it was significantly (P<0.05) improved by feeding different levels of DDGS . Inclusion of 22 and 28 % DDGS in growing rabbit diets had significantly improved feed conversion ratio(FCR), protein efficiency ratio(PER) and performance index(PI) as compared with the control during the whole experimental period. However, increasing DDGS to 22 or 28% in growing rabbit diets significantly decreased energy efficiency utilization (EEU) as compared with the control during overall experimental period. Economic efficiency (EEF) % were affected by DDGS inclusion during the whole experiment period , group of rabbits fed diets containing 28% DDGS exhibited the best EEF value as compared to control diets. All digestibility coefficient of nutrients and nutritive value were insignificantly improved by DDGS , enzyme supplementation and their interaction . Eviscerated carcass, total edible parts and abdominal fat percentages were insignificantly higher by increasing DDGS and enzyme addition levels as compared to control diets during the growth period. The DDGS had no significant effect on plasma total protein, total cholesterol, aspartate aminotransferase (AST),alanine aminotransferase (ALT) and creatinine, while, it is had significantly (p<0.01) decreasing total lipids as compared to the control.

However, enzyme addition had not significant effects on all plasma constituents except of total lipids which significantly increased by enzyme addition only as compared to the control .

***In conclusion**, the present results show that DDGS can be used successfully in growing rabbit feeding effectively and economically up to 28 % without adverse effect on growth performance. Carcass traits, blood constituents and animal health in general.*

Keywords :DDGS, rabbit, growth performance, digestibility coefficients, carcass traits, blood parameters.

In recent years, the ethanol production as a partial substitute of petrol has rapidly increased and further increases are expected in the future (Windhorst, 2007). Ethanol is currently produced at a commercial scale via enzymatic breakdown of starch and yeast controlled fermentation of glucose into ethanol. This production is mainly based on corn, whereas, wheat or barley are used in ethanol plants. Distillers dried grains with solubles (DDGS) is the primary resulting by-product of this production. Mainly of these by-products were used in ruminant feeds (Shurson, 2008), and were become available for non ruminants according to the increased availabilities (Batal and Dale, 2003 and Noll *et al*., 2007).

Recently many investigators used DDGS in feeding some of the farm animals, like horse (Hill,2002), beef (Martin *et al*.,2007 and MacDonald *et al*.,2007), dairy cattle (Kleinschmit *et al*.,2006), small ruminant (Archibeque *et al*.,*2008*), broilers (Wang *et al*.,2007) and Shalash *et al*., 2009), laying hens (Lumpkins *et al*.,2004; Thacker ,2007 and Shalash *et al*., 2010), turkey hens (Robertson , 2003), laying duck (Awad *et al*.,2011a) and growing duckling (Awad *et al*., 2011b).

In Egypt, there is need to seek for more untraditional animal feed resources to compensate the shortage of animal feeds. Rabbits have a substantial role in making use of a large amount of agricultural manufacture by-products and indeed the economics of the production systems depend mainly up on the efficient use of all the component resources. One of these by-products is dried distillers grains with solubles, which still not used at large scale in Egypt as a feed ingredient in farm animals rations.

Zylam 500 is a mixture enzymes processed from *Baciluss subtilis* , and produced by a micro filtration advanced fermentation technique . Zylam 500 is a highly efficacious Zylanase in degrading both soluble and insoluble arabino-Zylans, the most important anti-nutritional factor in cereals and ceaeal by products used in animal feed so as to improve the utilization of nutrients, animal uniformity and animal performance, increase proportional usage of cereal by-products in formulating animal feed to reduce feed cost.

Therefore, the current study aimed to investigate the effects of DDGS inclusion in growing rabbit diets with or without enzyme supplementation on the growth performance, digestibility coefficients, carcass traits and some blood constituents, as well as, the economic efficiency during the growing period.

MATERIALS AND METHODS

This study was carried out in a private rabbit farm at Dekkrns, Dakahlia Governorate, Egypt. It was started in September 2010 and terminated at November of the same year.

A factorial design experiment (4×2) was performed including four levels of DDGS (0, 16, 22 and 28%) and two levels of Zylam supplementation (0.0 or 0.5 gm/ kg diet) as recommended Khyrat El- Nile Company, Naser City, Egypt. Ninety six growing NZW rabbits 5 weeks of age were nearly equal in average live weight distributed into eight experimental groups (12 rabbits each group). Each treatment was consisted of 3 replicates of 4 rabbits each.. Each group of rabbits was fed on one of the eight diets which contained corn DDGS (0, 16, 22 or 28 %) with or without (0.0 or 0.50 g Zylam / kg diet) enzyme addition (Table 1). All experimental diets were nearly isocaloric and isonutrogenous and cover the requirements of growing rabbits as recommended by NRC (1977). Rabbits were housed in galvanized cages in well-ventilated pens. Each cage have a stainless steel nipple for drinking. Fresh water and pelleted diets were offered *ad libitum* throughout the experimental period from 5 to 14 wks of age. Rabbits were reared under similar hygienic, environmental and managerial conditions

Live body weight and feed intake of rabbits were recorded at 5, 8 , 11 and 14 weeks of age. While, body weight gain and feed conversion ratio were calculated at 5-8, 9-11, 12-14 and 5-14 wks of age. Protein efficiency ratio,energy efficiency utilization and performance index were also calculated for the whole experimental period. The PER was calculated as weight gain (g) / crude protein consumed (g), EEU was calculated as digestible energy consumed (Kcal) / weight gain (g), whereas, PI was calculated as live weight (Kg)/ feed conversion x 100 according to North (1981) for the certain periods . The economic efficiency was calculated at the periods of 5-14 weeks of age as follows: Economical efficiency = (price of one kg live weight –feed cost/kg gain / feed cost/kg gain) x 100. The selling price of one kg weight was considered to be 18.0 L.E.

At the end of experiment , eight digestibility trails were conducted according to Fekete and Gippert (1982) by using three rabbits from each experimental group (one from each replicate) were housed individually in metabolic cages that permit to collect faces and urine separately . The trial lasted for 7 days as a preliminary period followed by 5 days as a collection period to

Table 1. Composition and calculated analysis of the experimental diets .

Ingredients	Treatment groups							
	1	2	3	4	5	6	7	8
Yellow corn	15.00	11.00	7.00	6.00	15.00	11.00	7.00	6.00
DDGS[1]	0.00	16.00	22.00	28.00	0.00	16.00	22.00	28.00
Barley	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Soybean meal(44%)	15.00	8.00	5.00	3.00	15.00	8.00	5.00	3.00
Wheat bran	17.00	12.00	13.00	10.00	17.00	12.00	13.00	10.00
Egyptian clover hay	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Di-calcium P.	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Lime stone	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Premix[2]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Total	**1000**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Zylam (500gm/ ton) [3]					××	××	××	××
Calculated analysis (air dry basis) [4]***:***								
DE,kcal/kg	2550	2560	2550	2560	2550	2560	2550	2560
Crude protein%	17.12	17.16	17.23	17.12	17.12	17.16	17.23	17.12
Crude fiber%	12.48	12.64	12.93	12.92	12.48	12.64	12.93	12.92
Ether extract%	2.56	3.52	3.93	4.28	2.56	3.52	3.93	4.28
Calcium%	1.02	1.08	1.00	1.00	1.02	1.08	1.00	1.00
Total P%	0.74	0.74	0.76	0.75	0.74	0.74	0.76	0.75
Lysine%	0.86	0.72	0.67	0.63	0.86	0.72	0.67	0.63
Methionine%	0.25	0.27	0.28	0.29	0.25	0.27	0.28	0.29
Meth+ cys%	0.52	0.53	0.54	0.55	0.52	0.53	0.54	0.55
Determined analysis (dry matter basis) :								
OM%	88.80	88.82	88.76	88.78	88.80	88.82	88.76	88.78
CP%	19.26	19.23	19.20	19.22	19.26	19.23	19.20	19.22
CF%	14.08	14.19	14.24	14.14	14.08	14.19	14.24	14.14
EE%	3.60	3.62	3.64	3.62	3.60	3.62	3.64	3.62
NFE%	45.04	45.26	45.33	45.30	45.04	45.26	45.33	45.30
Ash%	18.02	17.70	17.59	17.72	18.02	17.70	17.59	17.72
DE kcal/kg	2601	2612	2623	2612	2602	2612	2627	2614
Price (L.E/kg)[5]	200.0	190.8	185.5	183.3	204.0	194.8	189.5	187.5

1- DDGS = Corn distillers dried grains with solubles (3035,DE. 26.3% ,CP. 9.0% ,EE . 8.1 %, CF . 0.14%,Ca . 0.73 %, Total P .)

2- Each 1 kg of the Vit and Min. contains: Vitamin A 2 MIU, Vit. D_3 150000 IU, Vit E 8.33 g, Vit. K 0.33 g, Vit B_1 1 g, Vit.B_2 1.09 g, Vit. B_6 0.33 g, Vit. B_5 8.33 g, Vit. B_{12} 1.7 mg, Pantothenic acid 3.33 g, Folic acid 0.83 g, Biotin 33 mg, Choline chloride 20 g, Mg. 66.79 g, Zn. 11.79 g, Fe. 12.5 g, Cu. 0.5 g, I. 0.3 g, Se. 16.6 mg, Co. 1.33 mg. and carrier $CaCO_3$ to 1000 g..

3- Each 1 g of Zylam (500) contains: β .Xylanase (1,260U/g), α–amylase 8,000 U/g carrier wheat flour.

4- According to NRC (1977)

5-Price of one kg (LE) at time of experiment for different ingredients : Yellow corn ,1.90; Soybeen meal, 3. 00 ; DDGS, 1. 60 ; Barley, 1.80 ; Wheat bran, 1.60 ; Egyptian clover hay, 1.25 ; Di – calcium, 4.00 ; limestone, 0.10 ; Salt , 0.25 ; Vit & Min , 9.00 ; Meth , 24,00 ; Lys, 13, 00 and Zylam (500) , 90.00 .

quantify the consumed feed and faeces output .Routine chemical analysis of samples of feed and faeces was performed according to A.O.A.C (1995). Apparent digestibility coefficients and nutritive value (TDN) were calculated according to the formula described by Cheeke *et al.* (1982).

At the end of experimental period (14 wks of age), three rabbits from each treatment group (one from each replicate) were randomly selected and slaughtered. Rabbits were fasted for 18 hours before slaughtering, then were weighed individually as a pre-slaughter weight. Data of carcass traits (including eviscerated carcass, head, liver, heart and edible parts as well as abdominal fat) were calculated as % of pre-slaughter weight. At slaughtering time , blood samples from each rabbit were collected in heparinized test tubes and centrifuged at 3500 rpm for 15 minutes to obtain blood plasma .Plasma were assigned for determination of total protein (Peters, 1968) , total cholesterol (Ellefson and Caraway, 1976), total lipids (Bucolo and David, 1973), transaminase enzymes activities ALT and AST (Reitman and Frankel,1957) and createnine by using commercial kits.

Data of the experiment were statistically analyzed using the General linear model of SAS (2004). In this study, the model used was 4 x 2 factorial design. Considering the DDGS and enzyme addition level as the main effects, as follows: $Yijk = \mu + Ti + Rj + (TR)ij + eijk$

Where : Yijk = An observation ; μ = Overall mean ; T = Effect of DDGS levels ; i= (1, 2, 3 and 4) ; R = Effect of enzyme addition levels ; j = (1 and 2) ; TR=Effect of interaction between DDGS and enzyme addition levels ; and eijk = Experimental random error.

Differences among treatment means were estimated by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance

Results in Table (2) showed that no significant effect was detected among NZW rabbits fed on diets contained different levels of both DDGS levels or enzyme supplementation and their interaction on their live body weight (LBW) and Body weight gain (BWG) during all experimental periods, except body weight gain during 12-14 wks, which it was significantly ($P<0.05$) improved by feeding different levels of DDGS only as compared to the control (Table 2).

These results were confirmed with Gaber *et al.* (2008) who found that feeding NZW rabbits diets contained DDGS up to 20 % DDGS with or without enzyme addition had no significant effects on live body weight and body weight gain from 8-14 wks of age. Also, Lumpkins *et al.* (2004) reported that feeding broiler diets contained 0-18% DDGS had no

Table 2. Effect of dietary DDGS and enzyme supplementation levels and their interaction on live body weight and body weight gain at different ages of NZW rabbits.

Treatment groups		LBW (g)				BWG (g)			
		5 wk	8 wk	11 wk	14 wk	5-8 wks	9-11 wks	12-14 wks	5-14 wks
DDGS level %									
0.0		615.0	1157.0	1780.8	2244.9	25.80	29.70	22.08[b]	25.88
16.0		605.8	1119.8	1682.5	2308.8	24.48	26.80	29.82 [a]	27.07
22.0		625.0	1113.2	1762.8	2402.0	23.25	30.93	30.45 [a]	28.20
28.0		613.7	1145.8	1743.9	2338.9	25.35	28.48	28.33 [a]	27.37
SEM		10.31	25.37	53.61	55.95	1.19	1.89	2.08	0.84
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	*	**NS**
Enzyme level (g / kg)									
0.0		615.6	1133.6	1740.7	2319.2	24.67	28.92	27.54	27.05
0.5		614.2	1134.8	1744.3	2328.1	24.78	29.04	27.80	27.21
SEM		7.29	17.94	37.91	39.56	0.84	1.34	1.47	0.59
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interactions									
DDGS	**EN**								
0.0	**0.0**	610.0	1185.0	1850.0	2335.8	27.37	31.67	23.13	27.40
	0.5	620.0	1129.2	1711.7	2153.9	24.23	27.73	21.03	24.37
16.0	**0.0**	610.0	1129.2	1706.1	2266.4	24.73	27.47	26.67	26.33
	0.5	601.7	1110.5	1658.9	2351.1	24.23	26.13	32.97	27.80
22.0	**0.0**	625.0	1098.6	1764.5	2365.6	22.53	31.73	28.63	27.63
	0.5	625.0	1127.8	1761.1	2438.3	23.97	30.13	32.27	28.77
28.0	**0.0**	617.5	1170.0	1642.2	2308.9	24.03	24.80	31.73	26.83
	0.5	610.0	1121.7	1845.5	2368.9	26.67	32.17	24.93	27.90
SEM		14.58	35.87	75.82	79.13	1.68	2.68	2.95	1.18
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

DDGS = Distillers dried grains with solubles, SEM = Stander error mean, Wks= Weeks
a,b :Means in the same column bearing different superscript are significantly different ($P \leq 0.05$).
NS = Not significant * = Significant at ($P<0.05$)

significant differences in their performance. Recently, *Noll and Brannon* (2006) with turkeys fed 20% DDGS and Awad *et al.* (2011 b**)** with Domyati ducklings came to the same conclusions.

Data of Table (3) showed that feed intake was not significantly affected by DDGS levels and enzyme supplementation and their interaction during all experimental periods. It could be noticed that FI of rabbits fed diet contained

Table 3 : Effect of dietary DDGS and enzyme supplementation levels and their interaction on daily feed intake and feed conversion ratio of NZW rabbits during the experimental periods (5-14 weeks of age)

Treatment groups		FI(g /d)				FCR			
		5-8 wks	9-11 wks	12-14 wks	5-14 wks	5-8 wks	9-11 wks	12-14 wks	5-14 wks
DDGS level %									
0.0		81.73	128.45	153.62	121.28	3.18 ^{a}	4.35 ^{b}	7.06 ^{a}	4.71 ^{a}
16.0		77.38	129.57	165.15	124.03	3.16 ^{a}	4.86 ^{a}	5.65 ^{b}	4.59 ^{ab}
22.0		73.00	133.72	167.95	124.90	3.15^{a}	4.33^{b}	5.57 ^{b}	4.43 ^{b}
28.0		69.78	133.18	162.97	121.95	2.75 ^{b}	4.76 ^{ab}	5.87 ^{b}	4.45 ^{b}
SEM		3.20	7.39	8.76	3.44	0.02	0.16	0.19	0.06
Sig.		**NS**	**NS**	**NS**	**NS**	*	*	**	**
Enzyme level (g / kg)									
0.0		74.17	125.56	157.46	119.07	3.02 ^{b}	4.41 ^{b}	5.84 ^{b}	4.41 ^{b}
0.5		76.78	136.90	167.38	127.02	3.11 ^{a}	4.74 ^{a}	6.24 ^{a}	4.69 ^{a}
SEM		2.27	5.23	6.19	2.43	0.02	0.11	0.14	0.04
Sig.		**NS**	**NS**	**NS**	**NS**	*	*	**	**
Interactions									
DDGS	**EN**								
0.0	**0.0**	80.13	127.77	146.63	118.20	2.93	4.03	6.49	4.31
	0.5	83.33	129.13	160.60	124.37	3.44	4.66	7.63	5.11
16.0	**0.0**	78.57	121.27	157.80	119.23	3.18	4.44	5.99	4.53
	0.5	76.20	137.87	172.50	128.83	3.15	5.28	5.31	4.66
22.0	**0.0**	71.90	132.27	166.67	123.63	3.20	4.18	5.88	4.49
	0.5	74.10	135.17	169.23	126.17	3.10	4.48	5.27	4.38
28.0	**0.0**	66.07	120.93	15873	115.20	2.75	5.00	5.00	4.29
	0.5	73.50	145.43	167.20	128.70	2.76	4.52	6.74	4.61
SEM		4.53	10.46	12.39	4.87	0.03	0.22	0.27	0.08
Sig.		**NS**	**NS**	**NS**	**NS**	**	*	**	**

DDGS = distillers dried grains with solubles, SEM = Stander error mean, Wks= Weeks
a,b :Means in the same column bearing different superscript are significantly different ($P \leq 0.05$).
* = Significant at (0.05). ** = Significant at (0.01). NS = Not significant

DDGS with or without enzyme supplementation was nearly similar values during the whole experimental period (5-14wks). These results are in agreement with those reported by Gaber *et al*. (2008) who found that daily feed intake had no significant effects by feeding diets contained DDGS up to 20 % with or without enzyme addition for growing NZW rabbits. Wang *et al.* (2007) who found that feed intake did not differ significantly for birds fed diet contained 15% DDGS as compared with those fed diet without DDGS . Similarly, Lumpkins *et al.* (2004) reported that no significant differences in feed intake were observed by feeding 6 – 18 % DDGS in broiler diets. Also,

Awad *et al*. (2011b) found that no significant effects on feed consumption of Domyati ducklings by feeding 18% DDGS diet during the growing period.

Values of feed conversion ratio (FCR) of rabbits were significantly affected (P<0.05or P<0.01) due to DDGS, enzyme addition and their interaction during all the experimental periods (Table 3). FCR values were significantly (P<0.05 or P<0.01) improved by feeding diets contained 22 and 28 % DDGS as compared with those fed control diet during the whole experimental period, whereas, it were significantly decreased by enzyme supplementation. The best value of FCR was occurred by feeding diet contained 28% DDGS without enzyme addition during the whole experimental period (5-14 wks). In this respect, Gaber *et al.* (2008) who found that feed conversion ratio had no significant effects by feeding diets contained DDGS up to 20% with or without enzyme addition of NZW rabbits at 6-14 wks of age. Wang *et al.* (2007) reported that feed conversion ratio did not differ significantly for broiler fed diets contained 15 or 30% DDGS than those fed diets without DDGS during 0-49 d of age. Also, Awad *et al*. (2011 b) reported that no significant differences in feed conversion were observed for ducklings by feeding DDGS up to 18 % at growing period.

Protein efficiency ratio (PER):

Results of Table (4) show that the PER values were significantly (P<0.05 or P<0.01) affected by different levels of DDGS, enzyme addition and their interaction. PER values were significantly(P<0.05) improved by feeding 22 and 28 % DDGS diet by about 6.40 and 5.60 % , respectively as compared with the control diet during the whole experimental period (5-14 wks). PER value was significantly (P<0.01) decreased by enzyme addition by about 6.01 % as compared to the control during the whole experimental period (5-14 wks). The interaction between DDGS level and enzyme addition resulted in higher value of PER by feeding 28 % DDGS diet without enzyme addition during the whole experimental period. These results are in contrast with those obtained by Gaber *et al.* (2008) who reported that varying DDGS diets with or without enzyme addition did not affect protein efficiency ratio (PER) of the NZW rabbits.

Efficiency of energy utilization (EEU):

The efficiency of energy utilization (EEU) values were significantly (P<0.05 or P<0.01) affected by feeding different levels of DDGS, enzyme addition and their interaction (Table 4) during all the experimental periods. EEU values were significantly(P<0.05) decreased by feeding 22 % DDGS only, whereas, it were no significantly affected by feeding diet contained 16 and 28 % DDGS diet as compared to those fed the control diet during the whole experimental period (5-14wks). EEU values were significantly

increased by enzyme addition by about 6.40 % as compared to the control at the whole experimental period. The interaction between DDGS level and enzyme supplementation had a higher value of EEU by feeding the control diet with enzyme supplementation during the whole experimental period. These results are in contrast with those obtained by Gaber *et al.* (2008) who reported that varying DDGS diets (10 ,15 and 20 %) with or without enzyme addition did not affect energy efficiency utilization (EEU) of the NZW rabbits at 8- 14 wks of age.

Performance index (PI):

The performance index (PI) values were significantly($P<0.05$ or $P<0.01$) affected by feeding different DDGS levels and the interaction between DDGS and enzyme addition while PI values were not significantly affected by enzyme supplementation during experimental periods (Table 4). PI value was significantly ($P<0.05$) increased by feeding 22 % DDGS by about 12.71(%) as compared to the control. On the other hand, PI values were significantly($P<0.05$) increased by 4.61 and 9.28 % by feeding diet contained 16 and 28 % DDGS, respectively as compared to those fed the control diet during the whole experimental period (5-14wks). PI values were insignificantly decreased by feeding enzyme addition as compared to the control during the whole experimental period. These results are in agreement with those obtained by Gaber *et al.* (2008) who reported that rabbits fed diet contained 0.5 g /kg enzyme addition had no significant effects on performance index (PI) at the growing period. On the other hand , these results are in contrast with those obtained by Gaber *et al.* (2008) who reported that rabbits fed diet contained 10 , 15 and 20 % DDGS had no significant effects on performance index (PI) at the growing period.

Economic efficiency(%):

Results of Table (4) showed that the differences in the economical efficiency values due to the DDGS Level in the diet were significant ($P\leq0.05$) Throughout the whole experimental period (5 –14 weeks) where the groups fed diet containing 28 %, 16 % and 22 % had better values of economical efficiency by about 14.7, 12.3 and 3.5 (%) than the control group, respectively.

The enzyme supplementation to the experimental diets was insignificantly decreased the economic efficiency by 4.2 % than the control group (unsupplemented). The effect of interaction between DDGS levels and enzyme supplementation was significant at the whole experiment (5–14 weeks of age). It is clear that rabbits fed diet containing 16% DDGS without enzyme supplementation recorded the highest economical efficiency (114 %).

Apparent digestibility and nutritive values

Percentages of digestion coefficients of DM, OM, CP, EE, CF , NFE and nutritive value as total digestible nutrients (TDN) are illustrated in Table 5. It is clear that no significant effects were found in all digestibility coefficients and nutritive value due to feeding diets contained different levels of DDGS ,enzyme supplementation and their interaction. All digestibility coefficient of nutrients were insignificantly improved by feeding diet contained different DDGS levels as compared to control. These results may be due to DDGS from the alcohol beverage industry is a valuable source of water-soluble vitamins and minerals (Couch *et al*., 1970; Jensen, 1981 and Waldroup *et al.*, 1981), which affect feed metabolism . Also , DDGS is high in available nutrients, particularly phosphorus

In this respect, Gaber *et al.* (2008) found that feeding diet contained DDGS from 0 - 20 % had no significant effects on all digestibility coefficient of nutrients except of OM which decreased by 20 % DDGS of growing rabbits at 14 wks of age Our results agree with Shalash *et al.* (2010) who reported that digestibility coefficient values of crude protein , crude fiber , ether extract and nitrogen free extract were not significantly affected by DDGS levels (0-20%)in laying hen diets. Also, Awad *et al.* (2011b) reported that feeding diet contained 0 - 18 % DDGS had no significant effect on all digestibility coefficient of nutrients of Domyati duckling at 10 wks of age.

Carcass traits :

Results of Table (6) show the effect of different levels of DDGS, enzyme supplementation and their interaction in the diets on some carcass traits (expressed as percentages of fasted LBW) of NZW rabbits at 14 wks of age . Eviscerated carcass, total edible parts and abdominal fat percentages were insignificantly higher by feeding 22 and 28 % DDGS diets as compared to the control diet. Enzyme addition resulted in high relative weights of eviscerated carcass and total edible parts as compared to the control without significant differences among them. The interaction between DDGS level and enzyme addition resulted in heavy eviscerated carcass and total edible parts by feeding 22 and 28 % DDGS diets with enzyme addition (0.5 g/kg).

Similar results were found by Gaber *et al.* (2008) they reported that all relative weights of dressing carcass and total edible parts were not differed significantly by feeding 0-20% DDGS diets of NZW rabbits during growing period. Wang *et al.* (2007) reported that birds fed diets contained 15 or 20% DDGS on a constant basis did not differ significantly in dressing percentage and carcass composition as compared to those fed the no DDGS diet . Lumpkins *et al.* (2004) reported that carcass yield was not significantly affected by feeding diets contained 6, 12, or 18% DDGS to broiler chicks through 42 days of age . Also, Awad *et al.* (2011b) reported that feeding diet contained 18 % DDGS had no significant effect on carcass characteristics.

Table 5. Effect of dietary DDGS and enzyme supplementation levels and their interaction on nutrient digestibility coefficients of NZW rabbits at 14 weeks of ages.

Treatment groups		Digestibility coefficient						Feeding value
		DM	OM	CP	EE	CF	NFE	TDN
DDGS level %								
0.0		65.42	67.54	75.46	74.47	57.46	66.77	58.72
16.0		65.44	67.55	75.50	74.52	57.52	66.76	58.96
22.0		66.05	67.78	76.07	74.60	57.58	66.92	59.25
28.0		65.47	67.59	75.54	74.53	57.56	66.80	58.98
SEM		0.48	0.47	0.47	0.52	0.51	0.48	0.41
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Enzyme level (g / kg)								
0.0		65.58	67.59	75.63	74.51	57.51	66.78	58.95
0.5		65.60	67.64	75.66	74.55	57.55	66.84	59.00
SEM		0.34	0.33	0.33	0.37	0.36	0.34	0.29
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interactions								
DDGS	**EN**							
0.0	**0.0**	65.41	67.53	75.45	74.45	57.45	66.77	58.71
	0.5	65.42	67.55	75.46	74.48	57.47	66.76	58.73
16.0	**0.0**	65.44	67.54	75.49	74.49	57.50	66.75	58.95
	0.5	65.45	67.56	75.50	74.54	57.53	66.77	58.97
22.0	**0.0**	66.03	67.72	76.05	74.59	57.54	66.84	59.20
	0.5	66.06	67.83	76.10	74.61	57.61	66.99	59.30
28.0	**0.0**	65.45	67.57	75.51	74.51	57.53	66.77	58.95
	0.5	65.48	67.61	75.56	74.55	57.59	66.82	59.01
SEM		0.68	0.66	0.66	0.66	0.72	0.68	0.58
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

DDGS =Distillers dried grains with solubles, SEM = Stander error mean
NS = Not significant.

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Table 6. Effect of dietary DDGS and enzyme levels and their interaction on carcass traits of NZW rabbits at 14 weeks of ages.

Treatment groups		Fasted LBW (g)	Evs. Carcass %	Head %	Liver %	Heart %	T. edi. parts %	Abd. Fat %
DDGS level %								
0.0		2153.3	50.76	5.48	3.81	0.33	60.38	0.67
16.0		2004.2	49.42	5.50	3.53	0.30	60.75	0.65
22.0		2246.7	51.84	5.22	3.46	0.30	60.82	0.72
28.0		2286.7	52.68	5.32	3.43	0.32	61.75	0.75
SEM		88.0	0.83	0.15	0.18	0.02	0.98	0.07
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Enzyme level (g / kg)								
0.0		2163.3	51.04	5.43	3.60	0.31	60.38	0.68
0.5		2182.1	52.32	5.33	3.52	0.31	61.48	0.72
SEM		62.0	0.71	0.10	0.12	0.01	0.69	0.05
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Interactions								
DDGS	**EN**							
0.0	**0.0**	2228.3	50.68	5.46	3.46	0.33	59.93	0.68
	0.5	2078.3	50.86	5.50	4.15	0.32	60.83	0.67
16.0	**0.0**	2005.0	50.99	5.57	3.60	0.30	60.17	0.63
	0.5	2003.3	52.15	5.43	3.45	0.30	61.33	0.66
22.0	**0.0**	2098.3	50.41	5.57	3.44	0.31	59.73	0.70
	0.5	2395.0	52.27	5.87	3.47	0.29	61.90	0.76
28.0	**0.0**	2321.7	52.42	5.10	3.88	0.30	61.70	0.72
	0.5	2251.7	52.98	5.53	2.99	0.33	61.83	0.78
SEM		124.4	0.85	0.21	0.25	0.02	1.39	0.09
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

DDGS = Distillers dried grains with solubles, SEM = Stander error mean
Treatment had no significant effect at ($P \leq 0.05$) on all parameters.
NS = Not significant

Plasma metabolites

Data of Table (7) indicated that All blood plasma constituents were not significantly affected by feeding DDGS diets except of total lipids which were significantly (P<0.01 decreased. However, enzyme addition by 0.5g/kg diet resulted in significant increase of total lipids by 5.40% as compared with the control.

The enzyme supplementation had no significant effect on plasma total protein, total cholesterol, AST, ALT and creatinine, while, enzyme supplementation (0.5 g /kg diet) resulted significant (P<0.01) increase of total lipids by 5.40 % as compared to the control. The interaction effect between DDGS and enzyme supplementation on all blood constituents studied were not significant Table 7.

Table 7. Effect of dietary DDGS and enzyme supplementation levels and their interaction on plasma constituents of NZW rabbits at 14 weeks of ages.

Treatment groups		Total protein (g/dl)	Total Lipids (g/dl)	Total cholesterol(mg/dl)	AST (U/dl)	ALT (U/dl)	Creatinin (mg/dl)
DDGS level %							
0.0		6.38	3.24 [a]	84.22	16.35	19.02	0.86
16.0		6.52	3.06 [b]	85.10	17.60	20.27	0.90
22.0		6.52	2.94 [b]	79.67	18.48	21.16	0.92
28.0		6.49	2.92 [b]	80.88	19.23	21.90	0.89
SEM		0.08	0.05	2.46	0.89	0.88	0.03
Significance		**NS**	**	**NS**	**NS**	**NS**	**NS**
Enzyme level (g / kg)							
0.0		6.46	2.96 [b]	84.03	18.07	20.65	0.89
0.5		6.48	3.12 [a]	81.40	17.77	20.52	0.89
SEM		0.06	0.03	1.74	0.63	0.62	0.02
Significance		**NS**	**	**NS**	**NS**	**NS**	**NS**
Interactions							
DDGS	**EN**						
0.0	**0.0**	6.38	3.14	88.10	16.40	18.73	0.88
	0.5	6.39	3.34	80.33	16.30	19.30	0.84
16.0	**0.0**	6.44	3.02	84.07	17.87	20.53	0.87
	0.5	6.61	3.09	86.13	17.33	20.00	0.92
22.0	**0.0**	6.45	2.87	82.20	18.57	21.23	0.90
	0.5	6.59	3.01	75.13	18.40	21.08	0.92
28.0	**0.0**	6.44	2.81	81.77	19.43	22.10	0.91
	0.5	6.54	3.03	84.00	19.03	21.70	0.87
SEM		0.11	0.06	3.47	1.27	1.25	0.05
Significance		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

SEM = Satander error mean

a,b :Means in the same column bearing different superscript are significantly different ($P \leq 0.05$).

NS = Not significant, ** = Significant at (0.01).

The present results are in agreement with those obtained by Gaber *et al.* (2008) who reported that rabbits fed diet contained different levels of DDGS and enzyme addition had no significant effects on plasma total protein , total cholesterol, AST and ALT, whereas total lipids were significantly decreased at 8-14 wks of age. Shalash *et al.* (2009) reported that plasma cholesterol and creatinine content of laying hens were not significantly affected by feeding diet contained 12 % DDGS as compared to the control. Also**,** Awad *et al.* (2011 b) found that total protein, triglycerides, total cholesterol, AST, ALT and

creatinine content were not significantly affected by feeding diets contained 6 , 12 and 18 % DDGS in ducklings diets as compared to the control.

In conclusion, from the economical points of view, it could be concluded that the DDGS could be used successfully up to 28% in feeding growing rabbits without any adverse effects on growth performance , carcass traits, blood constituents and animal health in general.

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تأثيـر استخدام النواتج المجففة لتقطير الحبوب بالسوائل مع أو بدون اضافة انزيم علـى أداء النمو فى الأرانب النامية

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أجريت تجربة بتصميم احصائى ٤×٢ تشمل أربع مستويات من النواتج المجففة لتقطير الحبوب بالسوائل (DDGS) (صفر، ١٦ ، ٢٢ ، ٢٨%) و مستويين من انزيم الزيلام (صفر ، ٠,٥٠ جرام / كجم) أستخدم فى الدراسة عدد ٩٦ أرنب نيوزيلاندى أبيض عمر ٥ أسابيع وزنت ووزعت عشوائيا إلى ثمانيةمجموعات تجريبية (١٢ أرنب لكل مجموعة تجريبية) فى ثلاث مكررات (٤ أرانب لكل مكررة) وذلك لدراسة تأثير إستخدام علائق تحتوى على مستويات مختلفة من النواتج المجففة لتقطير الحبوب بالسوائل (DDGS) مع أو بدون إضافة مخلوط انزيمى (٢x٤) فى تغذية الأرانب النيوزيلاندى خلال فترة النمو (من ٥ - ١٤ أسبوع) على أداء إنتاج النمو و صفات الذبيحة وبعض صفات الدم ومعاملات هضم المركبات الغذائية فضلا عن الكفاءة الاقتصادية.

وبتحليل النتائج اتضح الآتي:

١. لم يتأثر معنويا كل من وزن الجسم الحى و معدل الزيادة فى الوزن و كمية الغذاء المأكول للأرانب سواء بالمعاملات الغذائية المختلفة أو مستويات اضافة الانزيم أو مستوى التداخل باستثناء الزيادة فى وزن الجسم خلال الفترة من ١٢- ١٤ أسبوع حيث كانت الزيادة معنوية

٢. تأثر ت معنويا كل من الكفاءة الغذائية ومعدل استفادة البروتين ودليل النمو بالمعاملات الغذائية حيث كانت أفضل القيم لهذه الصفات للمجموعة التي تغذت على ٢٢ ، ٢٨ % DDGS بدون إضافات إنزيمية خلال الفترة الكلية للتجربة بينما انخفضت معنويا قيمة كفاءة تحويل الطاقة بزياد مستوى DDGS (٢٢ أو ٢٨ %) في العليقة.

٣. تأثرت الكفاءة الاقتصادية معنويا بالمعاملات الغذائية مقارنة بالكنترول حيث كانت أفضل قيمة للكفاءة الاقتصادية للمجموعة التى تغذت على ٢٨% DDGS بدون اضافات انزيمية خلال الفترة الكلية للتجربة.

٤. لم تتأثر معنويا كل معاملات الهضم للعناصر الغذائية بالمعاملات التجريبية مقارنة بالكنترول.

٥. لم تتأثر صفات الذبيحة المدروسة بالمعاملات الغذائية وان كان هناك تحسن غير معنوي في الوزن النسبي للذبيحة المفرغة ومجموع الأجزاء المأكولة للمجموعات التي تغذت على DDGS وإضافة الإنزيم لها بالمقارنة بالكنترول.

٦. لم تتأثر معنويا قيم كل من البروتينات الكلية والكولسترول وإنزيمات الكبد والكرياتنين في بلازما الدم بالمعاملات التجريبية بينما انخفضت معنويا قيم الليبيدات الكلية بالتغذية على DDGS بالمقارنة بالكنترول ..بينما لم تؤثر إضافة الإنزيم معنويا في جميع مكونات الدم فيما عدا الليبيدات الكلية والتي ازدادت قيمتها معنويا بالمقارنة بالكنترول (بدون إضافة الإنزيم).

التوصية: من النتائج السابقة ومن الناحية العملية والاقتصادية يمكن الاستنتاج بأنه يمكن إستخدام DDGS في علائق الأرانب خلال فترة النمو بمستوى يصل إلى ٢٨ % بدون إضافات إنزيمية و بدون أي تأثيرات سلبية على أداء النمو ومعاملات هضم العناصر الغذائية وصفات الذبيحة ومكونات الدم.