Utilization Effect of Distillers Dried Grains with Solubles and Mycofix® Select in Growing Rabbit Diets

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ABSTRACT

An experiment was conducted to investigate the effect of adding different levels of distillers dried grains with solubles (DDGS) alone or in combination with Mycofix® Select (Mycotoxin Deactivating Agent) to growing rabbit diets on growth performance, carcass traits, bood parameters, some behavioral and physiological changes, and economic efficiency. A total of 112 New Zealand white male rabbits of 5 weeks of age with an average initial weight of 690 g, were allotted into eight equal groups of 14 rabbits each. The 1st group was fed the basal diet as a control while three other groups (2nd to 4th) were fed diets with 10, 20, and 30 of DDGS respectively as a percent of the control diet. The 5th group was the first group in which Mycofix® Select was added to the diet at a level of 0.05%. The addition of DDGS in the last three groups (6th to 8th) was the same as for the 2nd to 4th group, but in these groups Mycofix® Select was added at levels of 0.1, 0.15, and 0.20% respectively. The experiment was extended for 7 weeks. At end of the experiment, five rabbits from each group were slaughtered, blood samples were collected and carcass traits were estimated. Results obtained showed that feeding weaned rabbits diets with levels higher than 10% of DDGS (20 or 30%) significantly decreased ($p<0.01$) the overall performance parameters (body weight and daily weight gain were decreased while feed consumption and feed conversion rate were increased) when compared to the control or with the group which fed 10% DDGS. Furthermore, supplementation of the diets with Mycofix® Select led to significant improvement in the overall performance parameters ($P<0.01$) in comparison to non-supplemented diets. The healthy status of rabbits was adversely affected by high levels of DDGS (over 10%) as observed by the significant increase in the levels of ALT ($p<0.05$), AST, glucose, globulin, total lipid, total cholesterol, VLDL and LDL ($P<0.01$) in the blood serum of rabbits with increasing the inclusion level of DDGS. Furthermore, the levels of HDL, red blood cells, white blood cells and lymphocytes were significantly decreased ($p<0.01$). The dressing percentage and liver, kidney, intestine, stomach and heart weight expressed as a percentage of carcass weight were significantly increased with DDGS inclusion. Additionally, higher levels of DDGS inclusion led to some behavioral and physiological changes such as dermatological necrotic lesions, fur loss, diarrhea, and feed refusal. Economically, feeding growing rabbits on diet contained 10% DDGS and 0.1% Mycofix® were increased the economic efficiency and performance index by 5.72 and 10.0 % respectively in comparison to the control diet. It was concluded that DDGS could be successfully used as a partial substitute for corn/barley soybean meal in growing rabbit diets at inclusion level of 10%. However higher levels of DDGS (20 or 30%) adversely affected the growth performance and healthy status of the rabbits. Most of these adverse effects tended to be improved by supplementation of the diet with an antimycotoxin agent (Mycofix® Select)

INTRODUCTION

Rabbits meat is one of the healthy protein sources due to its high nutritional value, low cholestrol content and good taste. However, it is relatively expensive and may not be available to all consumers. Feed costs in rabbit production represent about 60% of the total costs. The prices of the traditional feed ingredients mainly corn and soybean meal have increased much in the last few years, therefore, incorporation of the alternative feed ingredients may participate in solving the problem. Distillers dried grains with solubles (DDGS) is considered one of the important alternative feed ingredients. It is a co-product of the dry milling of corn used for ethanol production (Biofuel). After the high quality kernels of corn are ground, starch molecules are converted into sugars and fermented into ethanol. The co-product resulted is called DDGS. Each bushel (25 kg) of corn yields 10.2 liter ethanol, 8.2 kg DDGS and 8.2 kg CO2 *(1)*. DDGS is considered a package of nutrients. Except for starch, the nutrient content in DDGS is approximately three times higher than corn. It contains 28% crude protein, 9% fat, elevated level of phosphorous (0.84%) and is of competitive price. Although DDGS may be seen as a practical solution for animal producers, enabling them to counteract the rising prices of feed stuffs, the wide spread care free use of this product is still far from reality because DDGS is considered a concentrated source of mycotoxin which has hazardous effects to animal health and productivity *(2)*. Mycotoxins in corn are concentrated about three fold in DDGS during ethanol production process *(3)*. As reported by many researchers, mycotoxins may cause various problems such as gastrointestinal problems *(4)*; kidney and liver damage *(5)*; immune suppression *(6)*; skin problems *(7)* and blood abnormalities such as abnormal liver enzymes (AST and ALT), low hematocrit and red blood cells levels *(8)*. So, monitoring the mycotoxins content of DDGS prior to its inclusion in animals' diets is crucial to avoid exposure of the animals to the negative effects of mycotoxins. Furthermore, addition of feed additives that have antimycotoxins activity to the problematic feed could counteract this adverse effect.

Very little research was conducted on feeding DDGS to rabbits. One study had been conducted in Spain *(9)*, where researchers compared the nutrient digestibility of wheat bran, corn gluten feed, and DDGS in New Zealand White x Californian crossbred rabbits. They found DDGS to be a suitable ingredient for rabbit diets as it provided more digestible energy, acid detergent fiber, and protein than wheat bran and corn gluten feed.

The present study was aimed to investigate the effect of adding different levels of distillers dried grains with solubles (DDGS) alone or in combination with Mycofix® Select (mycotoxin deactivating product) to growing rabbit diets on the growth performance (body weight, daily weight gain, feed intake, and feed conversion ratio), carcass traits, blood parameters, some behavioral and physiological changes (such as fur loss, dermal lesions, feed refusal and decreased activity), and economic efficiency.

MATERIALS AND METHODS

The present study was conducted at the Animal Research Unit of Nutrition and Clinical Nutrition Dept., Faculty of Veterinary Medicine, Zagazig University, Egypt. It started in May 2008 and extended for 7 weeks. One hundred and twelve male weaned New Zealand white rabbits (NZW) with an average initial body weight of 690 gm, were distributed into 8 equal groups of 14 rabbit each and housed in (50x50x50 cm) cages of two rabbits each. All rabbits were kept under the same managerial, hygienic and environmental conditions. Trial design is schematized in Table 1.

Corn DDGS was obtained at the beginning of the trial from Cairo3A Company and stored in a clean, dry and well ventilated place. Samples of DDGS and feed were chemically analyzed for moisture, dry matter, crude protein, ether extract, and ash according to the standard procedures cited by A.O.A.C *(10)*. The DDGS and feed samples from each treatment were collected prior to the beginning of the experiment and sent for mycotoxin analysis to Quantas Analytics, Tulln, Austria *(11, 12)*, so, the inclusion of Mycofix® Select could be recommended according to results. Ingredients of the experimental diets are presented in Table 2. Proximate analysis of DDGS and diets are presented in Table 3.

Mycotoxicological analysis of DDGS is presented in Table 4.

The experimental diets were isocaloric isonitrogenous and formulated to meet the nutrient requirements set by the National Research Council *(13)*. The diets were offered in pelleted form. Feed and water were provided *ad-libitum* throughout the experiment. Each group was fed one of the experimental diets for 7 weeks. Live body weight and feed intake were recorded every 2 weeks. The economic efficiency(Y) and performance index (PI) were calculated according to the following equations: Y= (A-B)/B x 100 where A is the selling cost of the obtained gain and B is the feeding cost of this gain. The PI = (LBW/FC) X100 where, LBW is the live body weight expressed in kilograms and FC is the feed conversion efficiency (kg feed/kg gain) *(14)*.

Table 1. Experimental design

Groups	Treatments
1	0% DDGS
2	10% DDGS
3	20% DDGS
4	30% DDGS
5	0% DDGS + 0.05 % Mycofix® Select
6	10% DDGS + 0.1 % Mycofix® Select
7	20% DDGS + 0.15 % Mycofix® Select
8	30% DDGS + 0. 2 % Mycofix® Select

DDGS: Distillers Dried Grains with Solubles

At the termination of the experimental period, five rabbits from each group were slaughtered and carcass traits were estimated and recorded. Blood samples were collected at slaughtering into two parts. The first parts were collected in clean centrifuge tubes without anticoagulant for separation of serum with the objective of measuring the following serum parameters: alanine aminotransferase (ALT), aspartate aminotransferase (AST), total lipids, total cholesterol, high density lipoprotein (HDL), low density lipoprotein (LDL), very low density lipoprotein (VLDL), glucose, total protein, and albumin. Measurements were performed using commercial kits and colorimetrical methods. The second parts were collected in clean centrifuge tubes containing anticoagulant (EDTA) and used for complete blood pictures. All data were subjected to ANOVA using SPSS 6.0 software *(15)*.

RESULTS

Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on growth performance

Body weight development: The effect of DDGS and Mycofix® inclusion on body weight development of growing rabbits was presented in Table 5. The analysis of variance of the data revealed no significant difference between rabbits in group 1 (0% DDGS) and group 2 (10% DDGS), but there was a significant decrease ($P<0.01$) in the body weight of animals in group 3 (20%DDGS) and group 4 (30%DDGS) by 6.8 and 8.1 % respectively when compared to the control (0% DDGS). Furthermore, addition of Mycofix® to the diets of animals in groups 5 to 8 led to an increase of body weight in comparison with the corresponding non-supplemented groups 1 to 4. Body weight of rabbits in groups 7 (20% DDGS+Mycofix®) and 8 (30% DDGS+Mycofix®) were significantly higher ($P<0.01$) than that of animals in groups 3 and 4, by 7 and 6.6%, respectively. Nonetheless, the difference was not significant between group 5 (0%DDGS+Mycofix®) and group 1 (0%DDGS) and between group 6 (10%DDGS+Mycofix®) and group 2 (10% DDGS). The highest observed body weight was in group 6 (1890.3 g) followed by group 5 (1810 g) while the lowest body weights were found in group 3 (1654.2 g) and in group 4 (1630.3 g).

Table 2. Physical composition of ingredient diets for growing rabbits

Ingredients	G1 0%DDGS	G2 10%DDGS	G3 20%DDGS	G4 30%DDGS	G5 0%DDGS +Mycofix®	G6 10%DDGS +Mycofix®	G7 0%DDGS +Mycofix®	G8 0%DDGS +Mycofix®
Corn	18.3	15.3	12.3	9.3	18.25	15.2	12.15	9.1
Barley	10	8	6	4	10	8	6	4
Soybean meal	16	11	6	1	16	11	6	1
Wheat bran	16.5	16.5	16.5	16.5	16.5	16.5	16.5	16.5
Clover hay	30	30	30	30	30	30	30	30
DDGS	0	10	20	30	0	10	20	30
Molasses	3	3	3	3	3	3	3	3
Wheat straw	3	3	3	3	3	3	3	3
Calcium Carbonate	0.8	0.9	1.00	1.1	0.8	0.9	1.00	1.1
Dicalcium Phosphate	1.4	1.3	1.2	1.1	1.4	1.3	1.2	1.1
Common salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
[1] Muvco Permix	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
D. L. Methionine	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
[2]Mycofix® Select	-	-	-	-	0.05	0.1	0.15	0.2
[3]Coxistac	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100	100	100	100

[1]Muvco premix: Each 2.5kg contain Vit. A (10000000 IU), Vit. D3 (2000000 IU), Vit. E (10000 mg), Vit. K3 (1000 mg), Vit. B1 (1000mg), Vit. B2 (5000 mg), Vit.B6 (1500 mg), Pantothenic acid (10000 mg), Vit. B12 (10 mg), Niacin(30000 mg), Folic acid (1000 mg), Biotin(50 mg), Fe (30000 mg), Mn(60000 mg), Cu (4000 mg), I (300 mg), Co(100 mg), Se (100 mg) and Zn (50000 mg). (Muvco Company for Pharmaceutical Preparation, Egypt).

[2]Mycofix®, Select is a product of Biomin GmbH, Herzogenburg, Austria.

[3]Coxistac is an anticoccidial drug produced by Delta Vet. Center Company, Egypt.

Table 3. Proximate analysis of the DDGS and experimental diets

Groups Chemical analysis	DDGS sample	G1 0%DDGS	G2 10%DDGS	G3 20%DDGS	G4 30%DDGS	G5 0%DDGS +Mycofix®	G6 10%DDGS +Mycofix®	G7 0%DDGS +Mycofix®	G8 0%DDGS +Mycofix®
DM %	87.55	87.0	87.2	87.5	87.3	87.6	86.9	87.5	87.5
CP%	27.3	16.4	16.5	16.7	16.7	16.35	16.55	16.8	16.85
EE%	11.63	2.2	2.8	3.61	4.3	2.2	2.8	3.59	4.35
*CF%	7.85	12.03	12.12	12.21	12.30	12.03	12.12	12.21	12.30
Ash%	5.07	9.25	9.68	10.11	10.44	9.35	9.65	10.2	10.45
*DE(Kcal/kg)	4011	2502	2502	2502	2502	2502	2502	2502	2502

*Calculated according to feed composition tables of NRC (**11**)

Table 4. Mycotoxin analysis for DDGS and feed samples

Samples **Type of mycotoxin (PPM)**	**DDGS sample**	**G1(0%DDGS) feed sample**	**G2 (10%DDGS) feed sample**	**G3 (20%DDGS) feed sample**	**G4(30%DDGS) feed sample**
Deoxynivalenol	2000**	<150**	1000**	600**	700**
Zeralenone	64	<25*	<25*	<25*	<25*
Alpha-Zearalenol	448	<15*	88	<15*	<15*
Beta- Zearalenol	100	111	89	42	163
Aflatoxin B1	<0.5*	1.1	<0.5*	<0.5*	0.9
Aflatoxin B2	<0.1*	0.1	<0.1*	<0.1*	<0.1*
Aflatoxin G1	<0.5*	<0.5*	<0.5*	<0.5*	<0.5*
Aflatoxin G2	<0.1*	<0.1*	<0.1*	<0.1*	<0.1*
Fumonisin B1	380	29	<25*	28	26
Fumonisin B2	102	<25*	<25*	<25*	<25*
Ochratoxin A	3	<1*	<1*	<1*	<1*
T-2 toxin	<30*	<30*	<30*	<30*	<30*
HT-2 toxin	<30*	<30*	<30*	<30*	<30*
Diacetoxiscirpenol	<30*	<30*	<30*	<30*	<30*

Non-marked results were obtained by HPLC (high pressure chromatography)

*This value is the analytical detection limit

** This result was obtained by TLC (thin layer chromatograp)

Daily weight gain: Results observed revealed that the highest average daily weight gain was 24.4 g in group 6 (10%DDGS+Mycofix®), while the lowest values were 19.7 and 19.1 g in groups 3 (20%DDGS) and 4 (30%DDGS), respectively. Compared to the control (0%DDGS), DDGS incorporation in the diet at 10% (group 2) did not significantly change the daily weight gain, while its incorporation at 20% (group 3) and 30% (group 4) decreased the daily weight gain significantly by 11.3 and 14.0% respectively. Similarly, addition of Mycofix® to the diets led to an improvement in daily weight gain in comparison to non-supplemented groups. Groups 5 (0%DDGS+Mycofix®) and 6 (10%DDGS+Mycofix®) had 2.7 and 10.8 % higher daily weight gain than groups 1 (0%DDGS) and 2 (10%DDGS) respectively.

Feed intake: Total feed consumption was significantly differed among groups (P<0.01). Inclusion of DDGS at levels above 10% led to significant decrease in feed consumption. The highest feed consumption was registered in group 6 (10%DDGS+Mycofix®) (4140 g) while the lowest feed consumption were 3587 and 3147 g in groups 3 (20%DDGS) and 4 (30% DDGS), respectively. Feed intake of group 2 (10%DDGS) was not significantly higher than that of group 1 (0%DDGS). However, group 3 (20%DDGS) and group 4 (30%DDGS) had significantly lower (P<0.01) feed intake than group 1 (0%DDGS) (8.2 and 11.8% lower, respectively). Furthermore, groups 5 (0%DDGS+Mycofix®) and 6 (10%DDGS+Mycofix®) were not significantly higher than groups 1 (0%DDGS) and 2 (10%DDGS) respectively. On the contrary, group 8 (30%DDGS+Mycofix®) was significantly 6.9% higher than Group 4(30%DDGS).

Feed conversion rate: Statistical analysis of the results revealed that the FCR was significantly (P>0.05) differed among treatments. The lowest FCR was 3.56 in group 6 (10% DDGS+Mycofix®) while the highest FCR was 3.88 and 3.79 in groups 3 (20%DDGS) and 4 (30%DDGS), respectively. FCR in groups 2 (10%DDGS), 3 (20%DDGS) and 4 (30%DDGS) were 1.08, 5.43 and 2.98 % higher than group 1(0%DDGS), respectively. Addition of Mycofix® to the diets of groups 5 to 8 tended to decrease the FCR in comparison to non-supplemented groups.

Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on carcass traits

The dressing percentage tended to be adversely affected (P>0.05) by addition of DDGS at levels higher than 10% (Table 6). The highest dressing percentage was 48.26% in both group 1 (0%DDGS) and 2 (10%DDGS) while the lowest percentages were 42.46 and 41.80% in group 3 and 4 respectively. Incorporation of DDGS in rabbit diets led to significant (P<0.01) increase in liver, kidney and intestine relative weights and increased the relative weights of the stomach. Compared to non-supplemented groups, supplementation of the diets with the mycotoxin deactivator led to a significant decrease (P<0.01) in the relative weights of liver and kidney. Intestine relative weights of groups 7 (20%DDGS+Mycofix®) and 8 (30%DDGS+Mycofix®) were significantly decreased (P<0.01) than those of groups 3 (20% DDGS) and 4 (30% DDGS). A possible explanation for the significant increase of the liver, kidney and intestinal relative weights with increasing amounts of DDGS in the diet may be due to the harmful effect of mycotoxins, which was counteracted in the supplemented groups by the action of Mycofix® Select. The heart percentage was significantly differed among groups (p<0.05), the highest percentage was (0.4) in group 1 while the lowest value was (0.3) in group 5 and 7. In contrast, there was no significant influence in the lung percentage from the addition of DDGS or Mycofix®.

Table 5. Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on growth performance and economic efficiency

Groups	G1	G2	G3	G4	G5	G6	G7	G8	P value
Body Weight (g)									
Initial	684 ±13.4	693 ± 9.9	687±11.7	695 ±8.4	691 ± 9.3	682 ± 10.8	704 ± 10.6	687 ±9.4	0.88
7th week	1774±43.5^{b}	1787±39.2^{ab}	1654±36.3^{c}	1630±35.5^{c}	1810±33.5^{ab}	1890±37.3^{a}	1770±36.0^{b}	1737±35.7^{bc}	0.001
Daily weight gain (g)									
Overall	22.2 ± 0.7^{b}	22.3 ± 0.8^{b}	19.7 ± 0.6^{cd}	19.1 ± 0.6^{d}	22.8 ± 0.6^{b}	24.7 ± 0.7^{a}	21.7 ± 0.6^{b}	21.4± 0.7^{bc}	0.001
Feed intake (g)									
Overall	3907± 100^{abc}	3950 ± 66^{ab}	3587 ± 92de	3447± 66^{e}	3981 ± 36^{ab}	4140 ± 81^{a}	3791± 81^{bcd}	3685 ± 98^{cd}	0.001
Feed conversion rate									
Overall	3.68 ± 5.4^{ab}	3.72 ± 7.34^{ab}	3.88± 7.15^{b}	3.79± 8.45^{ab}	3.63± 7.85^{b}	3.56 ± 7.39^{b}	3.66 ± 8.31^{ab}	3.60± 6.23^{b}	0.065
Economic efficiency									
Diet cost (L.E*/kg diet)	1.584	1.578	1.573	1.567	1.596	1.602	1.609	1.615	
Rabbit selling cost (L.E*/kg live weight)	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	
Economic efficiency %	128.99	127.98	122.6	125.1	128.2	136.37	127.0	129.41	
Performance index %	48.22	46.07	42.63	43.01	49.86	53.09	48.36	48.25	
**Livability %	100	100	85.71	71.42	92.85	100	100	92.85	

* L.E (Egyptian pound)

** % of live rabbits in each group

Table 6. Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on carcass traits

Groups	G1	G2	G3	G4	G5	G6	G7	G8	P Value
Carcass Weight (g)	1732 ±35.1^{ab}	1762 ±60.1^{a}	1670±41.1^{ab}	1602 ±39.7^{b}	1708 ±35. 2^{ab}	1756 ± 67.4^{ab}	1705±44.5^{ab}	1639 ± 24.1^{ab}	0.20
Dressing %	48.26 ±0.6^{a}	48.26 ±0.9^{a}	42.46 ±1.6^{ab}	41.8 ±1.8^{b}	48.0 ±1.4^{a}	47.61±1.2^{ab}	43.12 ±1.2^{ab}	47.36 ±1.4^{ab}	0.06
Liver %	4.16 ±0.17^{bc}	4.8 ±0.23^{ab}	4.76 ±0.19^{ab}	5.21 ±0.13^{a}	4.08 ±0.27^{c}	3.95 ±0.11^{c}	4.11 ±0.21^{c}	4.34 ±0.25^{bc}	0.001
Lung %	0.72 ±0.01	0.77 ±0.06	0.71 ±0.03	0.73 ±0.04	0.71 ±0.05	0.68 ±0.03	0.68 ±0.03	0.74 ±0.06	0.77
Kidney %	0.69 ± 0.02^{c}	0.80 ±0.02^{b}	0.81 ±0.02^{ab}	0.87 ±0.04^{b}	0.68 ±0.03^{c}	0.69 ±0.03^{c}	0.68 ±0.03^{c}	0.71 ±0.03^{c}	0.001
Stomach %	1.48 ±0.09^{ab}	1.44 ±0.07^{ab}	1.68 ±0.07^{a}	1.54 ±0.05^{a}	1.25 ±0.1^{b}	1.52 ±0.1^{a}	1.61 ±0.05^{a}	1.6 ±0.08^{a}	0.02
Intestine %	6.38 ±0.31^{b}	6.70 ±0.41^{b}	8.65 ±0.75^{a}	7.98 ±0.13^{a}	6.08 ±0.17^{bc}	6.73 ±0.28^{b}	6.12 ±0.37^{bc}	5.12 ±0.36^{c}	0.001
Heart %	0.4 ±0.04^{a}	0.36 ±0.02^{ab}	0.37 ±0.02^{ab}	0.32 ±0.01^{b}	0.3 ±0.08^{b}	0.36±0.02^{ab}	0.3 ±0.01^{b}	0.31 ±0.01^{b}	0.054

Means within the same row carrying different superscript are significant at ($P \leq 0.05$)
(±) standard error (SE)

Table 7. Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on blood biochemistry

Group Parameters	G1	G2	G3	G4	G5	G6	G7	G8	P Value
Glucose (mg/dl)	73.0±3.9^{a}	81.0±4.96^{a}	74.3±4.15^{a}	54.1±4.27^{b}	83.6±3.60^{a}	79.2±7.63^{a}	73.8±5.6^{a}	83.5±3.62^{a}	0.004
AST(U/L)	13.6±0.92^{c}	16.8±0.86^{bc}	21.2±2.28^{ab}	27.2±4.16^{a}	15.6±2.61^{bc}	11.4±0.67^{c}	15.6±1.46^{bc}	16.4±1.46^{bc}	0.001
ALT (U/L)	32±2.30^{ab}	25.2±2.55^{bc}	28.2±3.02^{ab}	36.0±4.47^{a}	26.8±2.85^{abc}	24.4±2.42^{bc}	24.2±3.91^{bc}	16.8±4.30^{c}	0.017
Total Protein (g/dl)	4.99±0.45^{a}	4.76±0.24^{a}	4.87±0.54^{a}	5.13±0.23^{a}	4.68±0.51^{a}	4.58±0.23^{a}	5.65±0.35^{a}	5.13±0.27^{a}	0.58
Albumin (g/dl)	3.91±0.43^{a}	3.28±0.14^{ab}	3.43±0.2^{ab}	3.37±0.18^{ab}	3.1±0.24^{b}	2.80±0.20^{b}	3.27±0.17^{ab}	3.24±0.23^{ab}	0.16
Globulin (g/dl)	1.08±0.16^{c}	1.47±0.12^{bc}	1.71±0.18^{b}	1.75±0.16^{b}	1.58±0.27^{bc}	1.78±0. 06^{b}	2.38±0. 2^{a}	1.89±0.14^{ab}	0.001
Total Lipid(mg/dl)	251.8 ±13.1^{d}	499.9 ±66.5^{bc}	486.8±25.8^{bc}	1195 ± 126.7^{a}	470 ± 30.0^{bc}	512 ±70.8^{bc}	707 ± 16.6^{b}	504 ± 98.5^{bc}	0.001
Total Cholesterol (mg/dl)	57.9 ± 8.59^{e}	94.40 ± 2.82^{de}	119.7±10.2^{d}	299.31 ± 34.2^{a}	137.8±6.59^{cd}	193 ±14.8^{bc}	223 ± 23.14^{b}	139.8 ±21.7^{cd}	0.001
HDL (mg/dl)	17.4 ± 0.2^{a}	15.75 ± 1.18^{ab}	8.96 ± 0.12^{c}	9.73 ± 0.23^{c}	9.26 ± 0.52^{c}	10.51 ±0.32^{c}	14 ± 0.32^{b}	16.73 ± 1.49^{a}	0.001
VLDL (mg/dl)	22.2 ± 4.46^{d}	44.7 ± 3.33^{c}	44.42 ±3.91^{c}	85.85 ± 6.31^{a}	45.05 ±2.64^{c}	43.71 ± 8.3^{c}	64.71 ±1.89^{b}	63.62 ± 8.9^{b}	0.001
LDL (mg/dl)	18.3 ± 6.23^{d}	34.0 ± 1.67^{cd}	66.4±13.19^{cd}	203.7± 31.38^{a}	83.5 ± 9.39^{c}	138.9±6.30^{b}	144.9±21.57^{b}	59.1 ±22.18^{cd}	0.001

Means within the same row carrying different superscript are significant at ($P \leq 0.05$)

(±) standard error (SE)

Table 8. Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on blood hematology.

Group / Parameters	G1	G2	G3	G4	G5	G6	G7	G8	P Value
Red Blood Cells cell x 10^6/ul	5.05 ± 0.31^{a}	4.64 ± 0.23^{ab}	4.56 ± 0.22^{ab}	4.63 ± 0.22^{ab}	4.45 ± 0.15^{ab}	5.12 ± 0.24^{a}	4.10 ± 0.21^{bc}	3.64 ± 0.16^{c}	0.001
Haemoglobin (g/dl)	9.92 ± 0.71^{a}	9.22 ± 0.45^{a}	8.94 ± 0.44^{a}	9.68 ± 0.7^{a}	9.57 ± 0.45^{a}	9.56 ± 0.57^{a}	9.88 ± 0.43^{a}	9.7 ± 0.38^{a}	0.685
PCV	29.76 ± 2.14^{a}	27.66 ± 1.36^{a}	26.82 ± 1.36^{a}	29.05 ± 2.1^{a}	28.71 ± 1.36^{a}	28.69 ± 1.71^{a}	29.64 ± 1.29^{a}	26.1 ± 1.15^{a}	0.685
MCV	5.90 ± 0.28^{bc}	6.05 ± 0.53^{abc}	5.96 ± 0.50^{abc}	6.32 ± 0.49^{abc}	6.44 ± 0.11^{abc}	5.67 ± 0.49^{c}	7.31 ± 0.51^{a}	7.18 ± 0.28^{ab}	0.09
White Blood Cells cell x 10^3/ul	6.72 ± 0.14^{b}	6.81 ± 0.23^{b}	3.87 ± 0.19^{d}	4.41 ± 0.29^{d}	6.97 ± 0.44^{b}	8.44 ± 0.63^{a}	4.80 ± 0.20^{cd}	5.76 ± 0.64^{bc}	0.001
Neutrophil%	34.2 ± 5.17^{abc}	40.2 ± 4.21^{ab}	36.8 ± 2.01^{ab}	48.8 ± 8.09^{a}	20.6 ± 2.69^{c}	21.8 ± 4.04^{c}	29.6 ± 2.15^{bc}	29.8 ± 2.67^{bc}	0.002
Lymphocte %	58.40 ± 4.52^{bc}	49.2 ± 3.56^{cd}	52.2 ± 3.52^{bcd}	45.00 ± 7.9^{d}	73.00 ± 2.75^{a}	64.00 ± 3.4^{ab}	63.8 ± 2.61^{ab}	54.00 ± 2.09^{bcd}	0.001
Esinophil%	3.4 ± 0.51^{abc}	3.00 ± 0.54^{bcd}	2.4 ± 0.24^{cd}	1.8 ± 0.2^{d}	2.00 ± 0.54^{d}	4.00 ± 0.31^{ab}	3.4 ± 0.5^{abc}	4.6 ± 0.54^{a}	0.001
Monocyte %	1.8 ± 0.21^{de}	4.2 ± 0.58^{ab}	3.4 ± 0.51^{bc}	2.6 ± 0.24^{cd}	0.8 ± 0.2^{e}	5.00 ± 0.31^{a}	1.8 ± 0.37^{de}	5.2 ± 0.37^{a}	0.001
Basophil%	2.2 ± 0.48^{de}	3.4 ± 0.4^{cd}	5.2 ± 0.86^{ab}	3.8 ± 0.37^{bc}	3.6 ± 0.4^{cd}	5.2 ± 0.48^{ab}	1.4 ± 0.24^{e}	6.4 ± 0.4^{a}	0.001

Means within the same row carrying different superscript are significant at ($P \leq 0.05$)

(±) standard error (SE)

Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on blood parameters

Compared to the control (0%DDGS), inclusion of 30%DDGS in rabbits diets led to significant decrease (P<0.01) in the blood glucose level. However, at lower DDGS levels (10% and 20%) no significant differences were observed. Additionally, blood glucose level in Mycofix® supplemented groups was not significantly different than non-supplemented groups. AST level was significantly increased (P<0.01) by the addition of DDGS in comparison with the control. Addition of Mycofix® decreased the level of AST in comparison with the corresponding non supplemented groups, in a significant (P<0.01) manner in the case of group 4 (30%DDGS) and group 8 (30% DDGS+Mycofix®). The highest value was 27.2 (U/L) in group 4 (30% DDGS), while the lowest values was 11.4 (U/L) in group 6 (10% DDGS+Mycofix®). The value of ALT was variable among groups (P<0.05), the highest level was 36.0 (U/L) in group 4 (30% DDGS) while the lowest value was 16.8 (U/L) in group 8 (30% DDGS+Mycofix®). No significant difference (P<0.05) was observed among different groups in total protein level. The albumin level in control group (0%DDGS) was higher than in DDGS containing groups. The serum globulin value was significantly increased by DDGS inclusion to the diets. Globulin values for group 7 (20% DDGS+Mycofix®) were significantly higher (P<0.01) than those found for group 3, the corresponding non-supplemented group. The highest values found for this parameter was 2.38 (g/dl) in group 7 (20% DDGS+ Mycofix®), while the lowest value was 1.08 (g/dl) in group 1 (0% DDGS).

Statistical analysis of data revealed a direct proportional increase in the serum total cholesterol level, LDL (low density lipoprotein) and VLDL (very low density lipoprotein) with increasing inclusion levels of DDGS, moreover addition of Mycofix® (group 5 to 7) led to further increase in the total cholesterol level (P<0.01) compared to (groups 1 to 3), but total cholesterol value of group 8 (30% DDGS+Mycofix®) was significantly lower than that of group 4 (30%DDGS). In contrast, HDL (high density lipoprotein) was significantly decreased (P<0.01) with increasing the level of DDGS incorporation (groups 1 to 4); however addition of Mycofix® (group 5 to 8) showed some variation. Groups 5 (0% DDGS+Mycofix®) and 6 (10% DDGS+Mycofix®) were significantly lower (P<0.01) than groups 1 (0% DDGS) and 2 (10% DDGS), but groups 7 (20% DDGS+Mycofix®) and 8 (30% DDGS+Mycofix®) were significantly higher (P<0.01) than groups 3 (20% DDGS) and 4 (30% DDGS), respectively.

Inclusion of DDGS alone or in combination with Mycofix® into the diet led to variation in the red blood cell count among different groups. The highest value was 5.05 x 10^6/ul in group 1 (0% DDGS) while the lowest value was 3.64 x 10^6/ul in group 8 (30% DDGS+Mycofix®). Red blood cell count of group 8 (30% DDGS+Mycofix®) was significantly lower (P<0.01) than the corresponding non-supplemented group. Dietary incorporation of DDGS at levels higher than 10% led to significant decrease in the total leukocytic count. Groups 6 (10% DDGS+Mycofix®) and group 8 (30% DDGS+Mycofix®) had significantly higher (P<0.01) white blood cell values than corresponding non-supplemented groups. The highest value found for this parameter was 8.44 x 10^3/ul in group 6 (10% DDGS+Mycofix®) while the lowest value was 3876 in group 3 (20% DDGS).

Utilization effect of distillers dried grains with solubles and mycofix® select in growing rabbit diets on some behavioural and physiological changes

During the experiment, behavioural and physiological changes were observed in some rabbits particularly in those fed diets containing higher level of DDGS (20 and 30% DDGS) such as feed refusal, diarrhoea, fur loss, and skin necrosis (as shown in fig 1. and fig. 2).

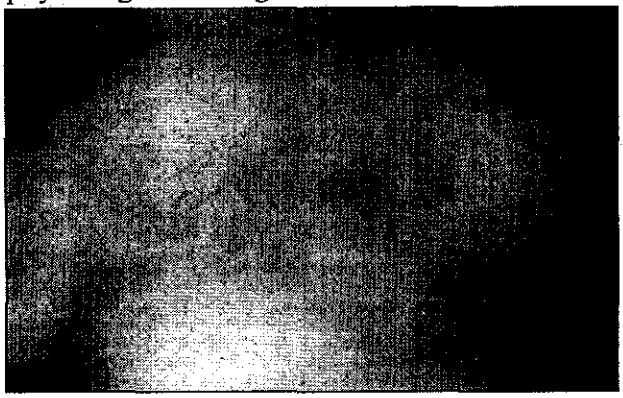

Fig 1. Fur loss

Fig 2. Skin necrosis

DISCUSSION

In the present study, data revealed that DDGS could be incorporated at a level of 10% in the diets of growing rabbits. Higher level of DDGS (20 or 30%) adversely affected the performance and healthy status of the rabbits. Additionally, supplementation of the DDGS containing diets with mycotoxin deactivator (Mycofix® Select) improved the growth performance and healthy status of the rabbits fed on these diets. The observed adverse effects on growth performance at higher levels of DDGS (20 and 30%) could be probably caused by reduced feed intake. There are two possible explanations for the observed reduction in feed intake at higher DDGS inclusion levels. One explanation could be due to higher levels of mycotoxin, particularly deoxynivalenol, which was the most prevalent type of mycotoxin in the DDGS and feed samples used in this experiment as shown in table 4. Deoxynivalenol (DON or vomitoxin) was the most commonly found trichothecene mycotoxin on a global basis ***(16, 17)***. It is produced by *Fusarium graminearum* fungi. Toxic effects of DON on animals have been well documented and mainly concern the immune system and gastrointestinal tract ***(18)***. In particular, DON caused vomiting, feed refusal, dermatological lesions, necrosis, diarrhea, and malabsorption of nutrients ***(2, 19, 20)***. Additionally, it has been reported ***(21)*** that DON caused abnormal incidence of diarrhea and mortalities, delayed gastric emptying and intestinal propulsion by inducing intestinal migrating motor complexes through a peripheral action at the serotinine 3 receptors. Due to the high presence of mycotoxin in DDGS (Table 4), by increasing DDGS inclusion level in the diet it would be expected that the level of mycotoxin contamination would be increased accordingly. However, mycotoxicological analysis revealed the highest level of deoxynivalenol in feed samples was observed in group 2 (10%DDGS) and not, as expected, in group 4 (30% DDGS). This overestimated value in group 2 might have been caused by lack of uniformity during sampling or mixing of feed sample before analysis. The 1st explanation was supported by the obtained results which revealed that addition of the mycotoxin deactivating product led to significant improvement in the growth performance of DDGS containing diets. Another possible explanation for the lowered feed intake may have been the decreased pellet quality in diets with higher DDGS incorporation. Although no pellet quality tests such as pellet durability index (PDI) were performed in this experiment, pelleted feed in groups containing 20 or 30 %DDGS appeared to be more fragile and easily damageable than the diets of groups containing 0 or 10% DDGS. Also, one of the major problems that limit the use of high levels of DDGS in broiler diets is the reduction in pellet quality *(22)*. Pellet quality is a concern at higher levels of DDGS because there is little starch left in DDGS to contribute to particle bonding after fermentation to produce biofuel. In addition, the high oil content of DDGS also affects adhesion between particles because of its hydrophobic nature *(23)*. Many authors reported the positive relation between pellet quality and performance of broilers *(24, 25)*. From the economic point of view, it was found that feeding growing rabbits on diet contained 10%DDGS and 0.1%Mycofix® Select increased the economic efficiency and productivity index by 5.7 and 10.0% respectively in comparison to control diet.

CONCLUSION

The obtained results revealed that DDGS could be successfully used at inclusion levels up to 10% as a partial substitute for corn/barley soybean meal in growing rabbit diets. Higher levels of DDGS in the diets (20 or 30%) adversely affected growth performance and healthy status of the rabbits. Additionally, supplementation of the diets with a mycotoxin deactivator agent (Mycofix® Select) led to significant improvement in growth performance and healthy status of the rabbits. The best results were obtained by incorporation in the diet of 10% DDGS and 0.1% Mycofix® Select.

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REFERENCES

1. ***Stock, R. A., Lewis, J. M., Klopfenstein, T. J., and C.T. Milton. (1999):*** Review of New Information on The Use of Wet and Dry Milling Feed Byproducts in Feedlot Diets. Proc. Am. Soc. Anim. Sci. Available at:http://www.asas.org/jas/symposia/proceedings/0924.pdf. Accessed 10/10/2007.
2. ***Rodrigues, I. (2007):*** What You Cannot See in DDGS (Biomin Analyses DDGS Samples for Mycotoxin Contamination).www.efeedlink.com/pdfiles/BiominDDGSArtigo.pdf. Accessed 3/1/2009.
3. ***Honeyman, M., Lammers B. and Hoyer, S. (2007):*** Feeding Bioenergy Co-products to Swine. Available at http://www.ipic.iastate.edu/publications/IPIC11a.pdf. Accessed 11/12/2007
4. ***Aziz N.H., El-Aziz A.M.A., Omran R.M.A. (1995):*** Effects of T-2 Mycotoxin on Histopathological Changes in Rabbits. Biomed.Lett., 51, 271-281.
5. ***Szilágyi M., Fekete S., Huszenicza Gy., Albert M. (1994):*** Biochemical and Physiological Effects of Long-Term Sublethal T-2 Toxin Feeding in Rabbits. Acta Biol. Hung., 45, 69-76.
6. ***Richard, J.L., Bray G.A., Ryan D.H. (1991):*** Mycotoxins as Immunomodulators in Animal Systems. Mycotoxins, Cancer and Health. Pennington Centre Nutrition Series, Vol. 1, 196-220.
7. ***Fairhurst S., Maxwell S.A., Seawin J.W., Swanston D.W. (1987):*** Skin Effects of Trichothecenes and Their Amelioration by Decontamination. Toxicology, 46, 307-319.
8. ***Mizutani Y., Ito Y., Ohtsubo K. (1997):*** Inhibition of Platelet Aggregation *Invitro* by Trichothecene Mycotoxins (In Japanese quails). Mycotoxins, 44, 41-44.
9. ***Villamide, M.J., De blas, J.C., and Carabano. R. (1989):*** Nutritive Value of Cereal by-products for Rabbits. 2. Wheat Bran, Corn Gluten Feed and Dried Distillers Grains and Solubles. Journal of Applied Rabbit Research 12:152-155.
10. ***A.O.A.C. (1984):*** Association of Official's Analytical Chemists: Official Method of Analysis .13th .Ed.Washington .D.C. USA.

11. ***Chang, H. L., DeVries, J. W., Larson, P. A. and Patel, H. H. (1984):*** Rapid Determination of Deoxynivalenol (Vomitoxin) by Liquid Chromatography Using Modified Romer Column Cleanup. J. Assoc. Off. Anal. Chem. 67:52.

12. ***Trucksess, M. W., Nesheim, S. and Eppley, R. M. (1984):*** Thin Layer Chromatographic Determination of Deoxynivalenol in Wheat and Corn. J. Assoc. Off. Anal. Chem. 67:40.

13. ***National Research Council (NRC) (1977):*** Nutrient Requirements of Rabbits. Second Revised Edition. National Academy Press. Washington. D.C. USA.

14. ***El-Kerdawy, D. M. A. (1997):*** Olive Pulp as a New Energy Source for Growing Rabbits. Egyptian Journal of Rabbit Science. 7(1):1-12.

15. ***SPSS (1993):*** SPSSx for Windows. Release, 6.0, Copyright SPSS inc., 1989-1993, New York, USA.

16. ***Wood, G. E. (1992):*** Mycotoxins in Foods and Feeds in the United States. J. Anim. Sci. 70:3941–3949.

17. ***World Health Organization (1993):*** Some Naturally Occuring Substances: Food Items and Constituents, Heterocyclic Aromatic Amines and Mycotoxins. IARC Monogr. Eval. Carcinog. Risks Hum. 56:397–444.

18. ***Rotter B., Prelusky, D. B., and Pestka, J. J. (1996):*** Toxicology of Deoxynivalenol (Vomitoxin). J. Toxicol. Environ. Health 48:1–34.

19. ***Ueno, Y. (1983):*** General toxicity. Pages 135–146 in Developments in Food Science IV, Trichothecenes, Chemical, Biological and Toxicological Aspects. Y. Ueno, ed. Elsevier, Amsterdam, the Netherlands.

20. ***Pestka, J. J., Lin, W. S., and Miller. E. R. (1987):*** Emetic Activity of The Trichothecene 15 Acetyldeoxynivalenol in Swine. Food Chem. Toxicol. 25:855–858.

21. ***Mézes, M. (2008):*** Mycotoxins and Other Contaminants in Rabbit Feeds. 9th World Rabbit Congress – June 10-13, 2008 – Verona – Italy.

22. ***Waldroup, P. W., Min, Y. N., Liu, F. Z., Wang, Z., Coto, C., Cerrate, S., Costa, F. P., and Yan, F. (2008):*** Evaluation of Distillers Dried Grains with Solubles in Combination with Glycerin in Broiler Diets. Int. J. Poult. Sci., 7(7): 646-654.

23. ***Behnke, K. C. (2007):*** Feed Manufacturing Considerations for Using DDGS in Poultry and Livestock Diets. In: Proc. 5th Mid-Atlantic Nutrition Conference, Timonium, MD, pp: 77-81.

24. ***Kilburn, J. and Edwards, H. M. (2001):*** The Response of Broilers to the Feeding of Mash or Pelleted Diets Containing Maize of Varying Particle Size. Br. Poult. Sci., 83: 1891-1896.

25. ***McKinney, L. J. and Teeter, R. G. (2004):*** Predicting Effective Caloric Value of Non Nutritive Factors. I. Pellet Quality and II. Prediction of Consequential Formulation Dead Zones. Poult. Sci., 63: 1165-1174.

الملخص العربى

تأثير إستخدام النواتج العرضية لتقطير الحبوب و الميكوفيكس سيليكت فى علائق الأرانب النامية

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أجريت هذة التجربة من أجل إستكشاف تأثير إضافة مستويات مختلفة من النواتج العرضية لتقطير الحبوب (الدى دى جى إس) بمفردها أو مع إضافة مضاد السموم البيولوجى (ميكوفيكس سيليكت) فى علائق الأرانب على معدلات الأداء, بعض القياسات فى الدم , صفات الذبيحة, بعض التغييرات السلوكية والفسيولوجية و الكفاءة الإقتصادية. تمت هذة الدراسة على ١١٢ أرنب نيوزيلندى أبيض عمر ٥ أسابيع وإستمرت التجربة لمدة ٧ أسابيع . قسمت الأرانب إلى ٨ مجموعات متساوية بكل مجموعة ١٤ أرنب. تم تغذية المجموعة الأولى على العليقة الأساسية (بدون إضافة الدى دى جى إس أو الميكوفيكس) و أعتبرت كمجموعة ضابطة, بينما تم تغذية المجموعات الثلاث الاخرى (الثانية إلى الرابعة) على علائق تحتوى على ١٠ و ٢٠ و ٣٠ % من الدى دى جى إس على التوالى . المجموعة الخامسة غذيت على عليقة المجموعة الأولى ولكن تم إضافة مستوى ٠,٠٥ % من الميكوفيكس إليها. المجموعات الثلاث الأخيرة (السادسة إلى الثامنة) غذيت على نفس علائق المجموعات الثانية إلى الرابعة مع إضافة مستويات ٠,١ و ٠,١٥ و ٠,٢٠ % من الميكوفيكس إليها على التوالي. تم قياس وزن الجسم وكمية العلف المستهلكة كل إسبوعين. في نهاية هذه التجربة ، تم ذبح خمسة أرانب من كل مجموعة ثم جمعت عينات الدم منها. أظهرت النتائج التي تم الحصول عليها أن تغذية الأرانب على علائق تحتوى على النواتج العرضية لتقطير الحبوب بمستويات أعلى من ١٠% أدت إلى أنخفاض معنوى فى معدلات الأداء الإجمالية (انخفض وزن الجسم وكمية العلف المستهلكة بينما إزداد معدل التحويل الغذائى) بالمقارنة بالمجموعة الضابطة أو المجموعة التي تم تغذيتها على ١٠% من الدى دى جى إس .علاوة على ذلك، أدت إضافة مضاد السموم إلى تحسن ملموس في معدلات الأداء بالمقارنة بالمجموعات التى لم يضاف إليها. تأثرت الحالة الصحية الأرانب تأثرا سلبيا عند إضافة مستويات عالية من الدى د ى جى إس (أكثر من ١٠ %)حيث إزدادت مستويات الألانين أمينو ترانسفيريز, الأسبرتيت أمينو ترانسفيريز, الجلوكوز, الكوليسترول الكلى والكوليسترول منخفض الكثافة و منخفض جدا الكثافة في مصل دم الأرانب مع زيادة مستوى إدراج الدى دى جى إس. وبالمقابل, انخفضت مستويات الكوليسترول عالى الكثافة والعدد الكلى لخلايا الدم الحمراء وخلايا الدم البيضاء. لوحظ حدوث نقص فى نسبة التصافى و حدوث زيادة فى وزن الكبد والأمعاء و المعدة مع إزدياد نسبة إدراج الدى دى جى إس بالمقارنة بالمجموعة التى غذيت على العليقة الضابطة. بالإضافة إلى ذلك، أدت إضافة مستويات من الدى دى جى إس أعلى من ١٠% إلى بعض التغييرات السلوكية و الفسيولوجية مثل بعض الأعراض الجلدية, فقد الفراء و الاسهال. وقد تحسنت معظم هذة الأثار السلبية فى المجموعات التى أضيف لها ميكوفيكس سيليكت. وجد ان الكفاءة الإقتصادية فى المجموعة السادسة هى الأفضل بالمقارنة بباقى المجموعات. أستنتج من ذلك أنه يمكن استخدام الدى دى جى إس بنجاح بديلا جزئيا للذرة/الشعير و كسب فول الصويا عند مستوى إدراج ١٠ %. و أن إدراجة عند مستويات ٢٠ أو ٣٠ % يؤثر سلبيا على معدلات الأداء والحالة الصحية للأرانب. وجدت أفضل النتائج فى المجموعة السادسة التى تحتوى على ١٠% دى دى جى إس و ٠,١ % ميكوفيكس سيليكت.