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EFFECT OF DIETARY CORN COBS AND ENZYMES SUPPLEMENTATION ON GROWING RABBITS PERFORMANCE

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ABSTRACT

A total number of sixty weanling New Zealand White (NZW) rabbits aged five weeks old was used in this study. Rabbits were randomly distributed into 6 treatments, each one contains 5 males and 5 females. Three levels of corn cobs and two levels of enzymes preparation were used in a 3 x 2 factorial arrangement. Corn cobs were used at levels of 0 (control), 10 and 20 % of the diets. Enzymes preparation containing cellulase, β-glucanase, α-amylase, protease and lipase was added at 0 and 500 g/ ton of diet. Water and feed in pelleted form were offered ad-libitum during the experimental period from 5 to 12 weeks of age.

The obtained results showed that rabbits fed the control and 10% corn cobs diets with enzymes recorded the significantly values of body weight, body weight gain and relative growth rate. The rabbits fed the control diet with enzymes consumed the highest amount of feed followed by those fed the control diet without enzymes then the 10% corn cobs with enzymes diet. The best feed conversion ratios were recorded for rabbits fed the diet containing 10% corn cobs with enzymes additions than those fed the control diet with enzymes addition compared with all other dietary treatments. Addition of enzymes in all experimental diets significantly improved digestibility coefficients of nutrients compared with those without enzymes addition.

The interaction between corn cobs levels and enzymes addition had no significant effect on carcass and dressing percentages. Dietary treatments significantly reduced total protein and globulin by increasing the level of corn cobs in the experimental diets. The addition of enzymes in diets containing corn cobs significantly improved the liver functions. Chemical composition of meat did not significantly differ due to the effect of dietary treatments. Rabbits fed 10% corn cobs diet with enzyme additive showed the highest economical efficiency values.

***Conclusively**, the present results showed that the use of corn cobs can be successfully fed at levels up to 10% of growing NZW rabbits diet supplemented with enzymes without adverse effect on growing rabbits performance.*

Keywords: Corn cobs; digestibility; enzymes; growing NZW rabbits.

INTRODUCTION

Energy resources such as corn, barley, oats and wheat are the major components of mono-gastric animal diets. Corn represents by far the major grain used in animal feeds. Yellow corn production in Egypt is not enough to supply animals feed, so we must depend on the use of imported yellow corn. Therefore, some alternatives are needed to overcome this problem. It is commonly known that there is a shortage in the traditional feedstuffs rather than the continuous increase in their prices from time to tome. Therefore, attempts have been carried out to search for alternative untraditional low price by-products which could be used in feeding mono-gastric animals. Corn cobs are a by-product obtained during the production of corn grains. It is contains high crude fiber fractionation 35.46% cellulose and 43.14% hemicellulose (Abo-Khashaba, 1999). There are accumulative evidences indicating that cell wall non-starch polysaccharides (NSP) have anti-nutritional activity in many mono-gastric animals (Choct, 2004). The most adverse effects of soluble NSPs on nutrient digestion and absorption in monogastric animals, are due to their ability to increase the viscosity of the digesta (Chcot, 2002), and excretions of sticky droppings (Iji, 1999). Also, NSP caused an increase in intestinal weight through rate of cell proliferation, leading to changes in mucosal structure and function. B-glucans and other NSPs may bind to dietary nutrients as well as reduce nutrients mobility, thereby impairing digestion and absorption (Read, 1987).

Dietary enzyme supplementation is used widely in mono-gastric diets in attempts to improve nutrient utilization and health. It is used also to improve product quality and to reduce pollution as well as to increase the choice and content of ingredients which are acceptable for inclusion in diets (Acamovic, 2001). Enzymes could be used to maximize the efficiency of feed utilization by reducing the effects of antinutritional factors, feed manufacturing costs and variability of nutrient bioavailability in feed. Enzyme cocktails containing more than one enzyme will often improve the response compared to pure, single enzymes, assuming that cost considerations are not ignored. Several studies have been attempted for incorporating exogenous enzymes into rabbit diets to improve nutrients availability, however in most trials, rabbits appeared lapsable responsive and variable effects were observed on their performances (Garcia *et al*., 2005; Falcao-e-Cunha *et al*., 2007). Eiben *et al*. (2004) testing cellulase, got improvements in FC and mortality of rabbits weaned at 23 days of age. It is interesting to note that in some trials enzymes improved fiber digestibility.

Therefore, the aim of the present study was to evaluate the corn cobs at levels of 0 (Control), 10 and 20 % of the diets with or without dietary enzymes preparation which contains cellulase, β-glucanase, α-amylase, protease and lipase on New Zealand White rabbits performance, digestibility of nutrients, carcass traits, some blood constituents, composition of meat and economic efficiency.

MATERIALS AND METHODS

The present study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agriculture Research Center, Egypt during 2010. Corn cobs used in this study were collected as they came from grain shops in

Kafr El Sheikh Government, sun dried, cleaned from foreign matter and ground in a hammer mill.

Rabbits:

A total number of sixty weanling New Zealand White (NZW) rabbits of five weeks age was individually housed in open house and assigned at random to six groups (5 males and 5 females) per each. Each individual rabbit was allocated in a cage with slatted floor of iron (45 × 45 × 38 cm) for length, width and height, respectively. Water and feed in pelleted form were given to the rabbits ad-libitum during the experimental period (5 to 12 weeks of age).

Diets:

Three levels of corn cobs and two levels of enzymes preparation Kemzyme (Enz) were used in a 3 x 2 factorial arrangement. Corn cobs were used at levels of 0 (control), 10 and 20 % of the diets. A commercial enzymes preparation "Kemzyme"[a] was added at 0 and 500g/ ton of the diet. Each gram of Kemzyme contains 5000 μ/g cellulase, 3000 μ / g β-glucanase, 450 μ/g α -amylase, 450 μ / g protease and lipase. Kemzyme is a product of Kemin Agrifoods Europe.

Experimental design:

A digestibility trail was carried out to determine the digestibility of corn cobs without or with enzyme supplementation. In the feeding trail, rabbits of the first and second groups were fed a commercial rabbit diet (diet 1) without enzymes additive served as control (G1) or with enzymes additive (G2). While, in the third and forth groups 10% of berseem hay in diet 1 was replaced by corn cobs (diet 2) without enzymes additive (G3) or with enzymes additive (G4) and in the fifth and six groups 20% of berseem hay in diet 1 was replaced by 20% corn cobs (diet 3) without enzymes additive (G5) or with enzymes additive (G6). The experimental pelleted diets were formulated to contain adequate levels of nutrients for growing NWZ rabbits as recommended by the National Research Council (NRC, 1994). The ingredients and chemical composition of the experimental diets are shown in Table 1.

At the end of experiment (12 weeks of age), four rabbits from each treatment were fasted for 12 hours, weighed and slaughtered to estimate some carcass traits. Blood samples were collected from the four rabbits of each treatment slaughtered for carcass traits and used to determine some blood constituents. At the termination of the experiment, four rabbits from each were housed individually and used in the digestibility trail to determine the digestion coefficients of the different nutrients of the experimental diets.

The collection period lasted for 5 days. Feed intake was measured and feces output was collected daily. Hair and scattered feed were separated or taken out of the feces. The collected feces for rabbits of each treatment was pooled together, and dried at 60^{o}C till constant weight, The dried feces for the successive five days was left few hours to get equilibrium with the atmosphere then ground, well mixed and stored in

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a Kemzyme product of Kemin Agrifoods Europe.

Table 1: Formulation and calculated analysis of experimental diets.

Ingredients %	Diet 1	Diet 2	Diet 3
Corn cobs	-	10.00	20.00
Yellow corn	23.00	20.85	18.80
Berseem hay	32.85	22.80	12.85
Barley	16.53	16.53	16.53
Wheat bran	03.50	03.50	03.50
Soybean meal 44 %	17.80	20.00	22.00
Molasses	02.70	02.70	02.70
Di calcium phosphate	02.40	02.40	02.40
Limestone	00.55	00.55	00.55
DL-Methionine	00.07	00.07	00.07
Vit. and Min. premix [1]	00.30	00.30	00.30
Salt (NaCl)	00.30	00.30	00.30
Total	**100**	**100**	**100**
Calculated analysis[2] %			
CP	15.99	15.99	15.87
CF	12.70	12.12	13.67
EE	2.58	2.39	2.18
Ca	1.36	1.22	1.08
Ph	0.69	0.50	0.51
Methionin	0.26	0.27	0.28
DE (Kcal/kg)[3]	2536	2535	2535
Price per 100 kg (L.E)[4]	187.65	178.41	168.09

1-Each 3 kg vitamin and mineral premix provides: Vit. A 12000000 IU, Vit. D3 750000 IU, Vit. E 10000 mg, Vit. K 2000 mg , Vit B1 1000 mg,vit B2 4000 mg, Vit. B6 1500 mg, Vit B12 10 mg, Pantothenic acid 10000 mg,Niacin 20000 mg, Biotine 50 mg, Folic acid 1000 mg, Choline chloride 500mg, selenium 100mg, Manganese 55 gm, Zinc 50 gm, Fe 60 gm, CU 2.5 gm, CO 6 mg and Iodine 1 gm.

2-According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001), except the values of corn cobs which were determined Table 2.

3-Calculated according to De Blas and Mateos, (1998).

4-According to prices of the used ingredients at the experimental time (2010).

screw-top glass jars for chemical analysis.

Measurements and determinations:

Live body weight (BW) and daily feed intake (DFI) were recorded for rabbits biweekly and daily body weight gain (DBG), relative growth rate (RGR), feed conversion (FC) (feed, g/gain, g) values and viability rate were calculated at the end of the feeding trial. Total protein and albumin of blood samples were determined, according to Gornal *et al.* (1949) and Doumas *et al.* (1971), respectively. The total globulin values were calculated by subtracting the values of total albumin from the values of total protein for each sample. Aspartate

aminotransferase (AST), alanine aminotransferase (ALT) and uric acid were determined by kits from Bio Merieux (France) according to the procedure outlined by the manufacturer. At the end of the experiment, four rabbits from each treatment were housed individually and used in the digestibility experiment. The collection period lasted for 5 days. Feed intake was measured and feces output was collected daily. Hair and scattered feed were separated or taken out of the feces. The collected feces of each treatment was pooled together, and then dried at 60 ºC till constant weight. The dried feces for the successive five days was left few hours to get equilibrium with it in the atmosphere then, ground, well mixed and stored in screw-top glass jars for analysis. The chemical composition of corn cobs, diets, feces and meat for percentages of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE), nitrogen free extract (NFE) and ash were conducted according to AOAC (2000). Cell wall constituents as neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid-detergent lignin (ADL) were determined according to (Gpering and Van Soest, 1970). Hemi cellulose and cellulose were determined according to (Fonnesbeck and Harris, 1971; Van Soest and Wine 1968). Digestible energy (DE) of corn cobs (2402 Kcal/Kg) was determined according to Abo-Khashaba (1999).

Economical efficiency:

Economical efficiency (EEF) for all experimental diets was calculated from the input/output analysis according to the price of the experimental diets and body weight gain. Values of EEF were calculated according to the following equation.

$$EEF = A / B \times 100, \qquad A = C - B$$

Where A is net revenue, B is the cost of feed intake during experimental period, C is body revenue.

Statistical analysis:

Data were subjected to two-way analysis of variance applying SAS program SAS (1996) using general linear model GLM. The statistical model was as follow:

$$Y_{ijk} = \mu + T_i + E_j + T_iE_j + e_{ijk}$$

Y_{ijk}: Observation measured, μ: Overall mean, T_i: Effect of corn cobs (i= 1,.. 3), E_j: Effect of Enzymes (j=1, 2), TE_{ij}: Effect of corn cobs x Enzyme interaction ($_{ij}$= 1,...6), e_{ijk}: Experimental error.

Significant differences among treatment means were separated using Duncan Multiple Range procedure (Duncan, 1955).

RESULTS AND DISCUSSION

Effect of enzyme supplementation on the apparent digestibility of corn cobs and cell wall constituents (as fibrous by-products):

The chemical composition and digestion coefficients of corn cobs and cell wall constituents (CWC) without/with enzyme supplementation are shown in Table 2. The apparent digestibility coefficient (%) without and with enzyme supplementation ranged from 69.16-80.15, 38.19-60.57, 76.77-80.11, 54.88-88.99 and 78.99-80.88 for OM, CP, EE, CF and NFE (on DM basis) respectively, being higher with enzymes supplementation. The percentage of improvement reached 15.89, 58.60, 4.35, 62.12 and 2.25 for the previous respective components, showing that addition of enzyme to the tested corn cobs improved the digestibility coefficients. It is worthy noting that CP and CF recorded the highest % improvement being 58.60 and 62.15, respectively, while that of NFE recorded the lowest one (2.25%).

On the other hand, the digestion coefficients of CWC of corn cobs (on DM basis) without enzyme supplementation were 40.46, 28.42, 0.085, 66.88 and 30.50 for NDF, ADF, ADL, hemicellulose and cellulose respectively. The corresponding values for CWC of corn cobs with enzyme supplementation were 61.58, 34.37, 0.090, 90.80 and 41.63, respectively recording 52.12, 20.95, 5.88, 35.75 and 36.46% improvement in digestion coefficients. This effect was more pronounced in hemicellulose and NDF and was similar ADF and cellulose while lingnin was lowest one affected by enzyme supplementation as shown in the previous table. These results indicated that using enzyme products improved its utilization in growing rabbits.

Growth performance:

It is worth to note that the initial BW of experimental rabbits at five weeks age was statistically insignificant and had averages ranged from 770.0 to 771.3 g. The effects of diets containing corn cobs with or without enzymes additions on growth performance are shown in Table 3. The data revealed that the final BW, DBG, RGR% and DFI were nearly similar for both the control and 10% corn cobs fed groups and were significantly ($P<0.05$) higher than those of 20% corn cobs fed group. These results may be due to the reduction in digestibility of nutrients for rabbits fed different levels of corn cobs as the most noticeable effect of NSP in the diets of mono-gastric. The lowest consumed DFI was recorded for rabbits fed diet containing 20% corn cobs compared with those of the control group and other treatments. For the whole experimental period, there were no significantly differences in FC between rabbits fed the diet containing 10% corn cobs and those fed the control one. Whereas, the poorest FC was recorded by rabbits fed diet containing 20% corn cobs.

The data indicated that enzymes addition in rabbits diets significantly (P<0.05) increased final BW, DBG and RGR compared with those of rabbits fed diets without enzymes addition. The improvement in live BW and DBG for rabbits fed the diet with enzyme addition may be due to the enhancing effect of enzymes on microflora growth in the gut and cecum as well as the increase in volatile fatty acids production and organic matter digestibility**.** These results agree with the finding of Abd El-Latif *et al.* (2008) found that adding enzymes supplementation improved BW and DBG for rabbits fed dietary 10% crude fiber. Ibrahim (2000) who cleared that rabbits fed diets with kemzyme or optizyme showed an improvement in BW and DBG as compared with those fed the control diet. Moreover, Sarhan (2001) found that adding 500 mg Kemzyme or Optizyme / kg to growing rabbits diet significantly improved BW at 9 and 13 weeks of age. Makled *et al.,* (2005) reported that rabbits fed diets supplemented with 500 and 750 mg kemzyme/kg feed improved significantly BW at 6 , 8 , 10 and 12 wks of age. Gutierrez *et al.* (2002) showed that DBG of rabbits from 25 to 39 days of age was increased by 3.1 % as a result of including Porzyme and NSP digesting enzyme (Xylanase, Pectinase) from 25 to 39 days of age in diets. The data of this study revealed that enzymes addition in rabbits diets increased DFI significantly (P<0.05) increased consumed DFI compared with those without enzymes addition. These results are similar to those of Makled *et al*. (2005) who found that average DFI of rabbits was increased due to adding optizyme which contains xylanase, protease, cellulase, hemocellulase and amylase at levels of 500 or 750 mg / kg feed. The data clear that enzymes addition in rabbit diets improved (P<0.05) FC compared with those without enzymes addition. The enhancement of FC as a result of adding enzymes may be due to the effect of enzymes in improving the digestibility of feed nutrients as reported by El-Mandy *et al.* (2002). The present results of FC are in disagreement with the finding of Sarhan (2001) who found that FC was significantly improved due to optizyme-enzymes supplementation for growing rabbits.

The interaction between corn cobs levels and enzymes addition had significant effect an improvement on BW, DBG and RGR, where the highest values were found for rabbits fed the control and 10% corn cobs diets with enzymes. While, rabbits fed diet containing 20% corn cobs without enzymes recorded the lowest significant (P<0.05) values of final BW, DBG and RGR compared with other rabbits fed enzymes and other treatments. The interaction between levels of corn cobs and enzymes addition on DFI was significant (P<0.05). Rabbits fed the control diet with enzymes consumed the highest amount of DFI followed by those fed diet containing 10% corn cobs with enzymes while, rabbits fed diet containing 20% corn cobs without enzyme

recorded the lowest significant amount. The best FC was recorded with rabbits fed 10% corn cobs diet without enzymes followed by the control diet with enzymes with significant differences compared with those fed diets containing 20% corn cobs without enzymes. In addition, adding enzymes preparation to mono-gastric animal diets suffer from under utilization of nutrients due to absence of enzymes necessary for hydrolyzing non-starch polysaccharides in the foregut, reduces the viscosity of intestinal content and improves nutrients absorption (Sullivan, 1987). Enzymes supplementation might improve rabbits performance by different mechanisms for increasing DFI and improving nutrient digestibility. Both mechanisms might be induced, at least partially, by a reduction of the viscosity within the intestinal tract. Enzymes supplementation reduces intestinal viscosity and decrease retention time of digesta in the gut allowing for greater consumption and therefore improving FC. Also, a viscosity reduction will improve contact between nutrients and digestive enzymes leading to improve digestibility.

Digestibility coefficients:

The effect of dietary treatments on digestibility coefficients of different nutrients are presented in Table 4. Significant reduction in all digestibility coefficients of different nutrients was observed by increasing the level of corn cobs in the experimental diets and that may be attributed to the slight higher crude fiber contents of the corn cobs containing diets. The data revealed that rabbits fed on diets supplemented with enzymes recorded significantly ($P<0.05$) higher digestibility values for DM, OM, CP, CF, EE and NFE compared with those of rabbits fed diets without enzymes. These results agree with the finding of Makled *et al.*, (2005) found that rabbits (10 months old) fed diet incorporate Optizyme (500 and 750 mg/kg diet) increased significantly the digestibility coefficients of DM, OM, CP, CF and EE compared with the control diet. Rabbits fed the control diet with enzymes and those fed the diets containing 10% corn cobs with enzymes had the highest significant ($P<0.05$) DM digestibility. In addition, rabbits fed the control diet with enzymes recorded significantly ($P<0.05$) the highest OM, CP, CF and EE digestibility values. Whereas rabbits fed the diet containing 10% corn cobs with enzymes showed the highest NFE digestibility. The addition of enzymes preparation activity undoubtedly enhanced the nutritive value of corn cobs based diets for rabbits. Moreover, the improvement in digestibility coefficients of nutrients especially CF fiber may be due to the presence of cellulase, betaglucanase and amylase enzymes which may improve the digestion. Similar to our results Makled *et al*. (2005) found some improvement in digestibility coefficients of most nutrients especially CP and CF with Optizyme supplementation. They also concluded that Optizyme supplementation may improve the release of cell bound

Table 4: Digestibility coefficients (%) of rabbits as affected by experimental treatments.

Items	Digestibility coefficients (%)					
	DM	**OM**	**CP**	**CF**	**EE**	**NFE**
Corn cobs (%) effects:						
Control (0%)	66.77^{a} ±0.33	68.94^{a} ±1.54	73.29^{a} ±0.87	33.92^{a} ±1.18	70.66^{a} ±3.02	69.35^{b} ±0.53
10%	66.77^{a} ±0.33	67.98^{b} ±0.66	67.32^{b} ±0.68	26.14^{c} ±1.04	66.09^{b} ±1.25	67.52^{c} ±0.40
20%	66.24^{b} ±1.92	65.31^{c} ±0.67	65.42^{c} ±0.52	28.32^{b} ±0.84	65.92^{b} ±1.46	69.98^{a} ±0.61
Sig.	*	*	*	*	*	*
Enzymes effects:						
Without enzyme	64.79^{b} ±0.16	65.86^{b} ±0.11	67.61^{b} ±0.16	26.42^{b} ±0.12	61.88^{b} ±0.16	67.48^{b} ±0.22
With enzyme	66.41^{a} ±0.17	68.95^{a} ±0.13	69.73^{a} ±0.17	32.49^{a} ±0.13	73.23^{a} ±0.17	70.41^{a} ±0.21
Sig.	*	*	*	*	*	*
Interaction effects:						
Control (0% corn cobs) x without Enz	65.83^{b} ±0.16	64.35^{e} ±0.16	70.69^{b} ±0.17	30.40^{b} ±0.12	61.62^{c} ±0.16	67.81^{d} ±0.23
Control (0% corn cobs) x with Enz.	67.71^{a} ±0.16	73.53^{a} ±0.23	75.89^{a} ±0.17	37.44^{a} ±0.12	79.70^{a} ±0.23	70.89^{b} ±0.17
10% corn cobs x without Enz.	65.83^{b} ±0.16	67.21^{c} ±0.16	66.83^{d} ±0.16	25.83^{d} ±012	61.61^{c} ±0.48	68.22^{cd} ±0.23
10% corn cobs x with Enz.	67.71^{a} ±0.16	63.40^{f} ±0.43	64.00^{f} ±0.43	30.81^{b} ±0.23	70.23^{b} ±0.23	71.73^{a} ±0.23
20% corn cobs x without Enz.	62.72^{c} ±0.29	66.03^{d} ±0.16	65.31^{e} ±0.16	23.05^{e} ±0.12	62.43^{c} ±0.48	66.42^{e} ±0.23
20% corn cobs x with Enz.	63.81^{c} ±0.16	69.93^{b} ±0.16	69.32^{c} ±0.16	29.23^{c} ±0.23	69.75^{b} ±0.24	68.62^{c} ±0.23
Sig.	*	*	*	*	*	*

$^{a-f}$ Means within a column not sharing similar superscripts in each are significantly ($P \leq 0.05$) different.
NS: Not significant, *$P \leq 0.05$,
Enz.=Enzymes (Cellulase, β -glucanase, α- amylase, Protease and Lipase)

nutrients, compensate for the decrease in the endogenous enzymes and improve the activity of gut ecology. Also, Abo-Khashaba (1999) indicated that added kemzyme to diet containing corn cobs improved the digestion coefficients of the different nutrients especially CF. The reduction in digestibility of nutrient for rabbits fed all levels of corn cobs may be due to the most noticeable effect of cellulose in the diets of mono-gastric animals is an increase in viscosity of digesta and the excretion of sticky dropping. This is considered to be the main

influence of NSPs on productivity (Salih *et al*., 1990 ; Classen & Bedford, 1991 and Smits & Annison, 1996).

Carcass traits:

Results of carcass traits are recorded in Table 5. There are no significant differences observed in carcass and dressing percentages by increasing the level of corn cobs in the experimental diets. The highest significant ($P<0.05$) values of giblets were observed with rabbits fed the control diet followed by those fed the diet containing 10% corn cobs and rabbits fed 20% corn cobs diet. The data revealed that rabbits fed diet provided with enzyme had no significant effect on carcass and dressing percentages compared with others fed diet without enzymes. Whereas, rabbits fed diet supplemented with enzymes recorded higher ($P<0.05$) giblets percentage. The interaction between corn cobs levels and enzymes addition had no significant effect on carcass and dressing percentage. The highest significant ($P<0.05$) values of giblets percentage was recorded by rabbits fed the control diet without or with enzymes followed by those fed diet containing 10% corn cobs without or with enzyme addition and 20% corn cobs with enzymes addition without significant differences. While, rabbits fed diet containing 20% corn cobs without enzymes recorded the lowest value of giblets percentage.

Blood constituents:

Results of total protein, albumin, globulin and uric acid are recorded in Table 6. Significant reductions were detected in total protein and globulin by increasing the level of corn cobs in the experimental diets. There is no significant effect on albumin and uric acid by increasing the level of corn cobs in the experimental diets. The data revealed that diets provided with enzymes had no significant effect on total protein, albumin, globulin and uric acid compared with diets without enzymes. The interaction between corn cobs levels and enzymes supplementation had a significant effect on total protein, globulin and uric acid. However, the differences between rabbits fed all levels of corn cobs with or without enzymes and the control diet in albumin were not significant. Results regarding albumin and globulin are in agreement with those reported by Veselin *et al*. (2003) who found no significant changes in the levels of the albumin and globulin in the blood of rabbits supplemented with Protozin multi-enzymes (19 mg/kg diet) in the concentrate mixture. The present results of blood parameters are within the physiological normal values for rabbits reported by Abd El-Khalek *et al.* (2000) and Ashour (2001).

Table 5: Carcass traits of rabbits as affected by experimental treatments.

Items	Carcass %	Dressing[1] %	Giblet[2] %
Corn cobs (%) effects:			
Control (0%)	56.79±1.22	62.49±0.79	5.76[a]±0.11
10%	57.40±1.10	61.85±0.64	4.32[b]±0.02
20%	56.61±1.07	61.84±0.62	4.00[c]±0.11
Sig.	**NS**	**NS**	*****
***Enzymes effects*:**			
Without enzyme	56.42±0.91	61.84±0.49	4.72[a]±0.27
With enzyme	57.44±0.88	62.28±0.60	4.66[b]±0.22
Sig.	**NS**	**NS**	*****
Interaction effects:			
0% corn cobs x without Enz	55.25±1.63	61.21±0.87	5.89[a]±0.16
0% corn cobsx with Enz	58.33±1.63	63.76±1.04	5.64[a]±0.16
10% corn cobs x without Enz	58.06±1.64	62.65±0.87	4.36[b]±0.03
10% corn cobs x with Enz	56.73±1.64	61.05±0.87	4.29[b]±0.03
20% corn cobs x without Enz.	55.96±1.54	61.65±0.93	3.93[b]±0.23
20% corn cobs x with Enz	57.26±1.64	62.02±0.93	4.07[b]±0.04
Sig.	**NS**	**NS**	*****

[a-c] Means within a column not sharing similar superscripts in each are significantly ($P \leq 0.05$) different. *$P \leq 0.05$.

NS: Not significant, Enz.=Enzymes (Cellulase, β -glucanase, α- amylase, Protease and Lipase)

1Dressing % = (carcass weight + Giblets / live body weight) × 100

2 Giblets = Heart + liver + kidneys,

Liver enzymes:

The effect of dietary treatments on some liver enzymes i.e. AST and ALT of NZW rabbits are shown in Table 6. Significant increase in AST and ALT values were observed by increasing the level of corn cobs in the experimental diets. The data revealed that diets provided with enzymes significantly decreased AST value for rabbits compared with those fed diets without enzymes, whereas ALT values were not significantly affected by enzymes. Supplementation of enzymes improved the liver functions AST and ALT values. The interaction between corn cobs levels and enzymes supplementation had a significant effect on AST and ALT. Rabbits fed diets containing different levels of corn cobs and provided with enzymes recorded the lowest significant ($P<0.05$) values of AST and ALT compared with those fed corn cobs without enzymes supplementation. Also, data in table 6 revealed that better values of both AST and ALT were recorded for rabbits fed the control diet with enzymes compared with those fed diets containing

corn cobs without or with enzymes. These results are in agreement with those of Abd El-Fattah *et al.* (2003) and Ibrahim and Saleh (2005). On the other hand El-Gendi *et al.* (2000) found that chicks fed Kemzyme had the highest average of ALT (7.51 u/l). However, these results are not consistent with the findings of Salem *et al*. (2008) who reported that Avizyme supplementation had no significant effect on plasma AST concentration. Kemzyme did not significantly affect plasma AST concentration. Also when Avizyme and Kemzyme were added together, plasma AST concentration was not significantly affected.

Chemical composition of rabbits meat:

Data in Table 7 represents the chemical composition of NZW rabbits meat, as affected by experimental treatment. The comparison among the experimental groups showed that meat of rabbits had nearly similar contents of

protein, ether extract and ash for all dietary treatments findings clearly showed the absence of any significant differences in the chemical composition of rabbit meat due to the effect of dietary treatments without significant differences. These results are in accordance with those reported by Ismail and Gippert (1999) and Abd El-Khalek *et al.* (2000) who reported insignificant differences in the chemical composition of NZW rabbit meat due to the effect of dietary treatments.

Economical efficiency:

The effect of dietary treatments on economical efficiency of NZW rabbits are presented in Table 8. During the whole experimental period, rabbits fed 10% corn cobs with enzymes supplementation showed the highest net revenue and economical efficiency followed by those fed the control diet with enzyme, while, rabbits fed 20% corn cobs diet without enzymes showed a reverse trend. The increase in body weight gain of rabbits of the control group reduced the total cost of body weight gain of these rabbits compared with those of other treatments.

Conclusively, the present results showed that the use of corn cobs in replacement of berseem hay can be successfully fed at 10% of growing rabbits diet supplemented with enzymes as cellulase, beta-glucanase, alfa-amylase, protease and lipase without adverse effect on growing rabbits performance.

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Table 7: Composition of meat analysis of rabbits as affected by experimental treatments.

Items	Crude protein (%)	Ether extract (%)	Ash (%)
Corn cobs (%) effects:			
Control (0%)	65.67±0.18	14.24±0.03	4.43±0.03
10%	66.32±0.35	14.41±0.48	4.57±0.10
20%	66.43±0.28	13.58±0.43	4.33±0.12
Sig.	**NS**	**NS**	**NS**
***Enzymes effects*:**			
Without enzyme	65.87±0.26	14.06±0.04	4.24±0.02
With enzyme	66.41±0.25	14.09±0.05	4.64±0.03
Sig.	**NS**	**NS**	**NS**
Interaction effects:			
0% corn cobs x without Enz	65.47±0.26	14.26±0.04	4.38±0.02
0% corn cobs x with Enz	65.87±0.26	14.22±0.04	4.48±0.03
10% corn cobs x without Enz	65.81±0.45	14.91±0.49	4.32±0.05
10% corn cobs x with Enz	66.83±0.43	13.90±0.80	4.82±0.05
20% corn cobs x without Enz.	66.33±0.42	13.03±0.48	4.03±0.05
20% corn cobs x with Enz	66.53±0.42	14.14±0.66	4.64±0.05
Sig.	**NS**	**NS**	**NS**

NS : Not significant,
Enz.=Enzymes (Cellulase, β -glucanase, α- amylase, Protease and Lipase)

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تأثير قوالح الذرة و إضافة الإنزيمات فى العليقة على أداء الأرانب النامية

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استخدم في هذة الدراسة عدد ٦٠ أرنب نيوزيلاندى عمر ٥ اسابيع ، قسمت عشوائيا إلى ٦ معاملات تجريبية و بكل معاملة (عدد ٥ ذكور + ٥ إناث) فى أقفاص فردية ، تم استخدام ثلاثة مستويات من قوا لح الذرة و هى ٠، ١٠، ٢٠% فى العلائق مع إضافة او بدون إضافة مخلوط انزيمى يحتوى على (سليوليز، بيتا جلوكانيز ، ألفا اميليز ، بروتييز ، ليبيز) بمستويات صفر أو ٥٠٠ جم /طن علف ، تم تقديم المياه والعلائق بصورة حرة خلال فترة التجربة التى استمرت من ٥ إلى ١٢ اسبوع من العمر.

تتلخص النتائج المتحصل عليها فيما يلى:

- سجلت الأرانب التى تم تغذيتها على عليقة الكونترول و ١٠% قوالح ذرة مع إضافة الإنزيمات اعلى القيم معنويا لوزن الجسم و الزيادة فى وزن الجسم و معدل النمو النسبى بينما سجلت الأرانب التى تم تغذيتها على ٢٠% قوالح الذرة بدون إضافة الإنزيمات اقل القيم معنويا.
- استهلكت الأرانب التى تم تغذيتها على عليقة الكونترول مع إضافة الإنزيمات اعلي كمية علف و تبعتها التى تم تغذيتها على العليقة التى احتوت على ١٠% قوالح الذرة مع إضافة الإنزيمات بالمقارنة بالمعاملات الاخرى.
- سجلت الأرانب التى تم تغذيتها على عليقة الكونترول أفضل كفاءة تحويل غذائى و تبعتها التى تغذت على عليقة احتوت على ١٠% قوالح الذرة مع إضافة أو عدم إضافة الإنزيمات على التوالى بالمقارنة بالمعاملات الاخرى.
- إضافة الإنزيمات للعلائق التى احتوت على قوالح الذرة حسنت معنويا معاملات هضم العناصر الغذائية بالمقارنة بالمجموعات التى تغذت على أعلاف بدون إضافة انزيمات.
- لم تؤثر المعاملات المختلفة معنويا على نسبة الذبيحة.
- بزيادة مستوى قوالح الذرة فى العلائق انخفضت معنويا قيم البروتين الكلى و الالبيومين والجلوبيولين فى دم الارانب.
- إضافة الإنزيمات للعلائق المحتوية على قوالح الذرة حسنت معنويا وظائف الكبد
- لم يتأثر التركيب الكيمائى للحم معنويا بالمعاملات التجريبية المختلفة
- سجلت الأرانب المغذاه على العليقة المحتوية على ١٠% قوالح ذرة مع إضافة الأنزيمات أعلى كفاءة اقتصادية.

التوصية : من خلال النتائج المتحصل عليها يمكن التوصية باستخدام قوالح الذرة حتى مستوى ١٠% من العليقة فى علائق الأرانب النامية مع إضافة الإنزيمات دون تأثير سلبى على أداء النمو للأرانب النامية.