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RESPONSE OF GROWING RABBITS TO DIETS CONTAINING DIFFERENT LEVELS OF WHEAT SCREENING BY-PRODUCT WITH OR WITHOUT ENZYME SUPPLEMENTATION

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ABSTRACT:

A total number of one hundred weanling New Zealand White rabbits aged five weeks were used in this study. Rabbits were randomly distributed into ten experimental treatments; each one contains 5 males and 5 females in individual cages. Five levels (0, 5, 10, 15 and 20 %) of wheat screening by-product (WSP) and each level was fed without or with addition of enzyme preparation in 5×2 factorial design arrangement. Enzyme preparation (containing β-Xylanase and α-Amylase) was added at 0 and 500 g/ ton of diets, during the experimental period from 5 to 12 weeks of age.

The obtained results could be summarized as follows: *The rabbits fed diet containing 5% WSP with enzymes significantly recorded the highest values of body weight, body weight gain and relative growth rate followed by those fed diet containing 10% WSP with enzyme addition. The rabbits fed diet containing 20% WSP without enzymes recorded the lowest significant values in these respects. The rabbits fed diet containing 20% WSP with enzymes consumed the highest amount of feed compared with those for other groups. The best feed conversion ratio was recorded for rabbits fed diet containing 5% WSP with enzymes additions followed by those for control, 10 and 15% WSP with enzymes addition compared with all other dietary treatments. Enzymes supplementation in diets containing WSP significantly improved the digestibility coefficients of nutrients and carcass traits of rabbits compared with other groups. Total protein, cholesterol and urea were significantly decreased by increasing the level of WSP in the experimental diets. However, the differences between rabbits fed diets containing different levels of WSP with or without enzymes addition and the control diet in albumin and globulin was not significant. Rabbits fed diets containing different levels of WSP and provided with enzymes recorded significantly the lowest values of cholesterol compared with those fed the diets containing WSP without enzymes and control diet.*

The addition of enzymes in diets containing WSP significantly improved the liver functions. Chemical composition of meat did not significantly differ with the WSP and enzymes addition. Results showed an improvement in average values of net revenue, economical efficiency and relative economical efficiency due to feeding growing rabbits on diet containing 5% WSP with enzyme preparation.

***In conclusion**, use of the WSP can be successfully fed at level 5 % of growing rabbit diets with enzymes supplementation (β-*xylanase; *α-*amylase*) without any adverse effect on growth performance and economical efficiency*, under Egyptian conditions.

Keywords: Wheat screening; digestibility; *β*-xylanase; *α*-amylase; rabbit**s.**

INTRODUCTION

Wheat screening by-product (WSP) is a fine by-product produced when the grains stored at the tower silos are cleaned by vacuum screening. Because of its high fiber content, it might be a useful feed ingredient in animal diets. In the light of these statements, when corn and barley are expensive or unavailable, WSP can replace their in animal feeding. In addition, WSP is available in reasonable quantities in Egypt from wheat storage silos. It is well known now that the nutritive value of WSP is adversely affected by the presence of certain non-starch polysaccharides (NSP) in its endosperm cell walls. An important feature of the NSP is the mixed linked arabinoxylan and glucan.

Using enzymes is well documented across different types of monogastric animal diets for different purposes such as keeping the gut healthy (Ferket, 2011), improving the utilization of nutrients (Selim *et al*., 2009), improving the performance of intestine and elevating the nutritive value of the diets (Bedford and Morgan, 1996 and Tawfeek, 1996). The addition of dietary enzymes preparation could be largely attributed to the degradation of the viscosity of intestinal digesta Sullivan (1987) and Easter (1988) in diets which contain high level of NSP. It has been shown that the anti-nutritional activity of arabinoxylans in monogastric animal is not a function of the polymers, but of the intestinal viscosity that they create, it may be concluded that the nutritional and, therefore, economic value of barley, oats, rye and even wheat can be improved by the addition of the appropriate preparation of xylanase and β-glucanase enzymes (Campbell and Bedford, 1992; Chesson, 1993 and Walsh *et al*., 1993). Dietary enzymes preparation product contains xylanase reduces viscosity and breaks down cereal cell walls (Cowieson *et al.*, 2005), amylase improves starch utilization (Jiang *et al*., 2008 and (Pérez-Vendrell *et al*., 2009) may be effective in improving energy utilization in corn-soy diets Michael

(2002). Endoxylanase degrades the xylan (backbone of arabinoxylan) into smaller units (xylose), which have several beneficial consequences and are more available to monogastrics (Odetallah 2000).

The aim of the present study was to evaluate the effect of using wheat screening by-product (WSP) at levels of 0, 5, 10, 15 and 20 % and each level was fed without or with enzyme preparation (*β*-Xylanase and α-Amylase) in experimental diets on growth performance, digestibility of nutrients, carcass traits, some blood constituents, composition of meat and economic efficiency of NZW rabbits, under Egyptian conditions.

MATERIALS AND METHODS

The present study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agriculture Research Center, Egypt, from April to June, 2010. The wheat screening by-product (WSP) used in this study was kindly taken from silo in Kafr El Sheikh Government.

Rabbits

A total number of one hundred weanling New Zealand White (NZW) rabbits of five weeks of age were assigned at random to ten groups (5 males and 5 females) per each. The 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 were offered to the rabbits *ad-libitum*, during the experimental period (5 to 12 weeks of age).

Experimental diets

The ten experimental treatments were arranged as 5×2 factorial design with five levels (0, 5, 10, 15 and 20 %) of wheat screening by-product (WSP) and each level was fed without or with enzyme preparation (*β-Xylanase and α-Amylase)* in the experimental diets. A commercial enzyme preparation "Xylam as product of Nutrex Co. Belgium." was added at 0 and 500 g/ ton of the experimental diet. Each gram of Xylam contained 1260 IU 1-4 β-Xylanase and 8000 IU α-Amylase.

Accordingly, there were 10 experimental diets (D) as follows: D1: containing 0 % WSP without enzyme preparation (control diet), D2: containing 0 % WSP with enzyme preparation, D3: containing 5 % WSP without enzyme preparation, D4: containing 5 % WSP with enzyme preparation, D5: containing 10 % WSP without enzyme preparation, D6: containing 10 % WSP with enzyme preparation, D7: containing 15 % WSP without enzyme preparation, D8: containing 15 % WSP with enzyme

preparation. D9: containing 20 % WSP without enzyme preparation, D10: containing 20% WSP with enzyme preparation.

All diets were nearly iso- nitrogenous of about 16.5% crude protein, iso- caloric of about 2410 Kcal DE. All experimental pelleted diets were formulated as recommended by the National Research Council (NRC, 1994). The formulation and chemical composition of experimental diets D1, D3, D5, D7 and D9 are shown in Table 1.

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.

At the end of the growth performance experiment, four males 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 60º C 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. At the end of the experiment (12 weeks of age), four rabbits from each treatment were fasted for 12 hours, weighed and slaughtered to estimate some of carcass and blood constituents.

Blood samples were taken from each rabbits during slaughter to determine total protein, albumin and total cholesterol which determined according to Gornal *et al.* (1949), Doumas (1971) and Zollner, and Kirsch (1962), 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 urea were determined by kits from Bio-Merieux (France) according to the procedure outlined by the manufacturer.

The chemical composition of WSP, 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). Digestible energy (DE) of WSP was calculated according to Fonnesbeck *et al*. (1974) as follows:

DE (Kcal/g diet) = 4.36-0.0491 (NDF%), Neutral detergent fiber (NDF) was calculated according to Pagano Toscano *et al*. (1986) as follows: NDF% = 28.924 + 0.657 (CF% on DM basis).

Table 1: Formulation and chemical composition of the experimental diets.

Ingredients	Experimental diets				
	D1	**D3**	**D5**	**D7**	**D9**
WSP[1]	-	5.0	10.0	15.0	20.0
Yellow corn	20.0	15.0	10.0	5.0	-
Soybean meal 44 %	17.30	17.0	17.1	17.7	18.0
Alfalfa dehydrate 12 %	28.85	25.69	22.39	20.39	18.80
Barley	15.53	18.13	22.63	30.03	36.33
Wheat bran	12.0	13.3	12.0	6.0	1.0
Molasses	2.7	2.7	2.7	2.7	2.7
Di calcuim Phosphate	2.4	2.4	2.4	2.4	2.4
Limestone	0.55	0.11	0.11	0.11	0.10
DL-Methionine	0.07	0.07	0.07	0.07	0.07
Vit. and Min. premix [2]	0.3	0.3	0.3	0.3	0.3
Salt (NaCl)	0.3	0.3	0.3	0.3	0.3
Total	**100**	**100**	**100**	**100**	**100**
Calculated chemical analysis[3](%)					
Crud protein (C.P) %	16.58	16.57	16.56	16.57	16.51
Ether extract (E.E) %	2.42	2.33	2.18	1.93	1.7
Crude fiber (C.F) %	12.45	12.27	12.30	12.18	12.21
Calcium %	1.28	1.08	1.04	1.01	1.00
Available Phosphorus, %	0.56	0.55	0.54	0.53	0.52
Methionin,%	0.32	0.33	0.33	0.33	0.33
Lysin,%	0.86	0.86	0.87	0.89	0.89
Digestible energy(kcal/kg)[4]	2412.6	2413.4	2411.4	2410.8	2404.9
Price per 100 kg (L.E)[5]	162.56	163.10	163.20	161.76	159.60

1- WSP = Wheat screening by-product

2- ***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. B_1 1000 mg, Vit. B_2 4000 mg, Vit. B_6 1500 mg, Vit. B_{12} 10 mg, Pantothenic Acid 10000 mg,Niacin 20000 mg, Biotine 50 mg, Folic Acide 1000 mg,Choline choloride 500mg, selenium 100mg, Manganese 55 gm, Zinc 50 gm, Fe 60 gm, CU 2.5 gm, CO 6 mg and Iodine 1 gm.

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

4-Calculated according to Fonnesbeck *et al.* (1974)

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

Economical efficiency (EEF)

Economical efficiency (EEF) of the experimental diets were calculated from the input/output analysis according to the price of the experimental diets and live body weight. Values of E.E.F were calculated according to the following equation.

$$E.E.F = A / B \times 100 \qquad A = C - B$$

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

Statistical analysis

Data from all response variables were subjected to a (5x2) factorial analysis using SAS (1996). The statistical model as factorial design was used as follows:

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

Y_{ijk}: Observation measured , μ: Overall mean , T_i: Effect of WSP (i= 1,……5) ,E_j: Effect of Enzymes (j=1, 2) , T_iE_j: Effect of WSP x Enzyme interaction ($_{ij}$= 1, ……...10), e_{ijk}: Experimental error.

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

RESULTS AND DISCUSSION

Approximate Analysis of WSP

The same nearly chemical composition of wheat screening by-product (WSP) and yellow corn are presented in Table 2. Generally, the chemical analysis value of WSP is in agreement with those reported by Ismail (2004). The results revealed that calculated values of WSP for NDF and DE were 39.87 % and 2402 Kcal/kg, respectively. The chemical composition of WSP showed that it is a suitable ingredient in feeding rabbits. In this respect Abuo-Raya and Galal (1971) reported that any ingredient had 70 % digestible organic matter could consider as a good feedstuff for livestocks.

Table 2: Chemical composition of WSP & YC used in the experiment as air dry basis.

Items	DM %	OM %	CP %	CF %	EE %	Ash %	NFE %
WSP	86.25	76.80	8.53	16.66	1.35	15.75	57.71
YC	87.80	78.30	8.50	2.20	4.10	1.56	83.64

WSP = Wheat screening by-product, YC= Yellow corn, DM=Dry matter, OM=Organic matter, CP=Crude protein, CF=Crude fiber, EE=Ether extract, NFE= Nitrogen free extract.

Growth performance:

Wheat screening by-product (WSP) effect

The data obtained in Table 3 revealed that diets containing WSP at levels of 5, 10, 15 and 20 % had no significant effects on final BW, DBG and RGR compared with those of the control group. The present results are in agreement with the finding of Ismail (2004) who found that using of WSP at levels of

6.25, 12.5, 18.75 and 25% in rabbit diets had no significant effects on BW and DBG. Also, Saki and Alipana (2005) reported that WSP at levels of 10, 20 and 30% had no significant effects on BW and DBG of broiler. Also, the present results are supported with reports of other researchers (Wold-Tsadick and Bragg, 1980 and Audren *et al*., 2002). Increasing the level of WSP in the rabbit diets significantly increased DFI. The highest consumed DFI was recorded for rabbits fed diet containing 20% WSP compared with those of the control group and other treatments. For the whole experimental period, there were erratic differences in FC among dietary treatments but did not significantly differ than that of the control group. The results are in harmony with those of Saki and Alipana (2005) who reported that WSP at levels of 10, 20 and 30 % had no significant effects on FC of broiler.

Enzymes effect

The data indicated that enzymes addition in rabbit diets significantly ($P<0.05$) increased final BW, DBG and RGR compared with those fed diets without enzymes addition. The improvement in live BW and DBG may be due to the enhancing effect of enzymes in microflora growth in gut and cecumm, as well as, increase in volatile fatty acids production and organic matter digestibility**.** These results agree with the finding of Gutierrez *et al.* (2002) who showed that BW and DBG of rabbits were increased as a result of included Porzyme multi-enzymes and NSP digesting enzyme Xylanase and Pectinase from 25 to 39 days of age. Also, Jakic *et al.* (1998) indicated that BW of broiler fed diet supplemented with multi-enzymes was higher at 42 days of age as compared with the control group. Graham and Pettersson (1992) reported that dietary enzymes preparation supplemented to wheat based rations significantly improved birds DBG. The data indicated that enzymes addition in rabbits diets significantly ($P<0.05$) increased DFI compared with those fed diet without enzymes addition. These results are similar to those for 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 results showed that enzymes addition in rabbits diets improved FC compared with those fed diet without enzymes addition. The enhancement in FC as a result of adding enzymes may be due to the effect of enzymes in improving the digestibility of nutrients as reported by El-Mandy *et al.*(2002). The present results of FC are in disagreement with the findings of Sarhan (2001) who found that FC was significantly improved due to optizyme-enzymes supplementation for growing rabbits.

Interaction effect

The interaction between WSP levels replacement and enzymes addition had significant effect on BW, DBG and RGR, where the highest significant ($P<0.05$) values were obtained in rabbits fed diet containing 5% WSP with enzymes followed by those fed diet containing 10% WSP with enzyme addition. The rabbits fed diet containing 20% WSP without enzymes recorded the lowest significant ($P<0.05$) values of final BW, DBG and RGR compared with the other experimental groups. The interaction between levels of WSP replacement and enzymes addition had significant effect on DFI. The rabbits fed diets containing 20% WSP provided with enzymes consumed significantly the highest DFI level while, those fed control diet consumed the least level. The best FC was recorded with rabbits fed diet containing 5% WSP with enzymes additions followed by those fed diets containing 10, 15% WSP and control with enzyme addition compared with the other groups.

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, reduces the viscosity of intestinal content and improves nutrients absorption (Sullivan,1987). 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. The viability showed differences among treatment groups and it ranged between 80 and 100 % (Table 3).

Digestibility coefficients:

Wheat screening by-product (WSP) effect

The results showed in Table 4 that all digestibility coefficients were significantly decreased with increasing of the WSP level in the experimental diets. These results may be due to the effect of NSP presented in the WSP in the diets of monogastric animals is an increase in viscosity of digesta and the excretion of sticky dropping. This is considered to be the main influence of NSP on productivity as reported by Salih *et al.* (1990), Classen and Bedford (1991), Smits and Annison (1996).

Enzymes effect

The results present in Table 4 showed that the supplementation of the enzymes to rabbits diets was significantly ($P<0.05$) improved digestibility of OM, CP, CF, EE and NFE compared with those fed diets without enzymes.

Table 4: Digestibility coefficients of rabbits fed the experimental diets

Items	Organic matter	Crude protein	Crude fiber	Ether extract	Nitrogen free extract
WSP effects, %	*	*	*	*	*
Control	78.94^{a} ±1.54	73.29^{a}±0.87	43.92^{a}±1.18	70.66^{a}±3.02	69.35^{a}±0.53
5 %	78.66^{ab}±1.36	72.34^{b}±0.86	43.39^{b}±0.86	68.82^{b}±2.68	68.87^{b}±0.71
10%	78.02^{bc}±1.69	72.11^{b}±1.35	41.67^{c}±0.86	68.01^{c}±2.68	68.42^{c}±1.18
15%	77.46^{cd} ±1.55	70.01^{c} ±0.68	40.17^{d}±0.69	67.12^{d}±2.64	67.09^{d}±0.69
20%	76.96^{d} ±1.55	68.32^{d}±1.02	38.52^{e}±0.85	66.11^{e}±2.64	66.06^{e}±0.69
Enzymes effects	*	*	*	*	*
Without enzymes	74.95^{b} ±0.16	70.69^{b}±0.17	40.40^{b}±0.12	61.62^{b}±0.16	67.81^{b}±0.23
With enzymes	82.55^{a} ±0.12	74.06^{a}±0.28	44.15^{a}±0.23	76.33^{a}±0.12	70.20^{a}±0.33
Interaction effects	*	*	*	*	*
Control	74.35^{d} ±0.16	70.69^{e}±0.17	40.40^{e}±0.12	61.62^{f}±0.16	67.81^{d}±0.23
Control x Enz.	83.53^{a} ±0.23	75.89^{a}±0.17	47.44^{a}±0.12	79.70^{a}±0.23	70.89^{b}±0.17
5 %WSP	74.61^{d} ±0.21	69.79^{f}±0.18	40.87^{e}±0.32	60.79^{g}±0.16	66.77^{e}±0.23
5 %WSP x Enz.	82.7^{abc}±0.23	74.89^{b}±0.17	45.91^{b}±0.12	76.85^{b}±0.23	70.97^{b}±0.17
10%WSP	73.00^{e} ±0.51	68.06^{g}±0.18	39.15^{f}±0.32	59.98^{h}±0.16	64.90^{f}±0.23
10%WSP x Enz.	83.04^{ab}±0.23	76.15^{a}±0.16	44.19^{c}±0.12	76.04^{c}±0.23	71.94^{a}±0.17
15%WSP	72.92^{e} ±0.62	68.00^{g}±0.18	38.15^{g}±0.32	59.20^{i}±0.16	65.05^{f}±0.28
15%WSP x Enz.	81.99^{bc}±0.47	72.01^{c}±0.16	42.19^{d}±0.12	75.03^{d}±0.23	69.13^{c}±0.17
20%WSP	72.42^{e} ±0.62	65.29^{h}±0.17	36.01^{h}±0.32	58.19^{j}±0.16	64.04^{g}±0.28
20%WSP x Enz.	81.49^{c} ±0.47	71.35^{d}±0.16	41.02^{e}±0.12	74.02^{e}±0.23	68.08^{d}±0.17

Means having different letters at the same column within each factor are differ significantly.
* = P<0.05.
WSP= Wheat screening by-product, Enz.=Enzymes (1-4 β-xylanase and α-amylase)

Interaction effect

Rabbits fed control diet and diets containing WSP at levels of 5 and 10% with enzymes had significantly (P<0.05) the highest OM digestibility. In addition rabbits fed control diet or 10% WSP diet with enzymes had significantly the highest CP digestibility. The digestibility CF and EE in rabbits fed control diet with enzymes recorded the highest contents. Rabbits fed diet containing 10% WSP with enzymes had the highest values of NFE digestibility. In general, it could be noticed that the supplementation of enzyme significantly (P<0.05) improved the nutrients digestibility coefficients in the all studied levels of WSP diets.

The addition of preparation enzymes which include 1-4 β-xylanase and α-amylase activity undoubtedly enhanced the nutritive value of WSP based diets for rabbits. Also, the enzymes may improve the release of cell bound nutrients and the activity of gut ecology and nutritive values Makled et al. (2005). In addition, the improvement in digestibility coefficients of nutrients especially CF fiber may be due to the presence of 1-4 β-xylanase and α-amylase enzymes which may improve the digestion. Parallel to our reported

results Makled *et al.* (2005) found that 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 nutrients, compensate for the decrease in the endogenous enzymes and improve the activity of gut ecology. The reduction in nutrient digestibility of rabbits fed all levels of WSP diets may be due to the most noticeable effect of NSPs in the diets of monogastric 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 and Bedford, 1991; Smits and Annison, 1996).

Carcass traits:

Wheat screening by-product (WSP) effect

Results of carcass traits are recorded in Table 5. Significant reductions were observed in carcass, dressing and giblet percentages by increasing the level of WSP in the experimental diets. Same results were mentioned by Ismail (2004) who reported that dressing percentage was significantly ($P<0.05$) affected by dietary treatments, showing gradual reduction by increasing the levels of WSP in the rabbit diets. The highest significant ($P<0.05$) values of stomach and caecum were observed with rabbits fed diet containing 20% WSP followed by those fed 15% WSP diet. The present results of caecum are in agreement with the finding of Ismail (2004) who found that weight of the caecum was significantly ($P<0.05$) affected by dietary treatments, being higher for the diets containing WSP than the control one.

Enzymes effect

The data revealed that rabbits fed on diet provided with enzymes recorded better significant ($P<0.05$) values of carcass, dressing, stomach and caecum compared with others fed diet without enzymes (Table 5).

Interaction effect

The interaction between WSP levels replacement and enzymes addition had a significant effect on carcass traits (Table 5). Rabbits fed diets containing different levels of WSP with enzymes addition recorded the best significant ($P<0.05$) values of carcass, dressing, stomach and caecum percentages compared with those fed WSP without enzymes. The highest significant ($P<0.05$) values of carcass and dressing percentages were recorded by rabbits fed control diet with enzymes followed by those fed diet containing 5% WSP with enzyme addition. While, rabbits fed diet containing 20% WSP without enzymes recorded the lowest significant ($P<0.05$) values of carcass and dressing compared with those fed the other diets. The highest significant

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

Items	Carcass %	Dressing[1] %	Giblet [2] %	Stomach %	Caecum %
WSP effects,%	*	*	*	*	*
Control	56.79^{a} ±1.22	62.49^{a}±0.79	5.76^{a} ±0.11	5.28^{c} ±0.16	6.48^{c} ±0.15
5 %	56.40^{a} ±1.17	62.16^{a}±0.83	4.62^{b} ±0.12	5.61^{b} ±0.10	6.71^{b} ±0.15
10%	54.91^{ab}±1.03	60.09^{b}±0.82	4.45^{b} ±0.10	5.65^{b} ±0.10	6.83^{b} ±0.14
15%	52.79^{b} ±0.93	58.73^{bc}±0.81	4.42^{b} ±0.10	6.08^{a} ±0.11	7.34^{a} ±0.12
20%	52.61^{b} ±0.96	57.10^{c} ± 0.73	4.36^{b} ±0.10	6.24^{a} ±0.11	7.36^{a} ±0.08
Enzymes effects	*	*	NS	*	*
Without enzymes	53.57^{b} ±0.66	58.68^{b} ±0.59	4.78 ±0.15	5.55^{b} ±0.10	6.72^{b} ±0.11
With enzymes	55.82^{a} ±0.77	61.55^{a} ±0.59	4.67 ±0.13	6.01^{a} ±0.09	7.16^{a} ±0.11
Interaction effects	*	*	*	*	*
Control	55.25^{ab}±1.63	61.21^{abc}±0.87	5.89^{a} ±0.16	4.97^{g} ±0.21	6.21^{f} ±0.19
Control x Enz.	58.32^{a} ±1.63	63.76^{a} ±1.04	5.64^{a} ±0.16	5.59^{def}±0.11	6.68^{def}±0.19
5 %WSP	54.96^{ab}±1.51	60.71^{bc}±0.87	4.74^{b} ±0.17	5.42^{f} ±0.10	6.47^{ef} ±0.19
5 %WSP x Enz.	57.83^{a} ±1.66	63.62^{a} ±1.04	4.51^{b} ±0.16	5.81^{cde}±0.10	6.95^{cde}±0.19
10%WSP	53.80^{ab}±1.34	58.65^{cd}±0.85	4.49^{b} ±0.17	5.45^{ef} ±0.10	6.59^{def}±0.17
10%WSP x Enz.	56.02^{ab}±1.52	61.54^{ab}±1.02	4.42^{b}±0.14	5.85^{cd} ±0.10	7.08^{bcd}±0.17
15%WSP	52.10^{b}±4.34	57.17^{de}±0.85	4.39^{b}±0.15	5.87^{cd} ±0.10	7.08^{cd} ±0.09
15%WSP x Enz.	53.48^{ab}±1.34	60.29^{bc}±0.85	4.48^{b}±0.16	6.30^{ab} ±0.11	7.61^{a} ±0.11
20%WSP	51.76^{b}±1.36	55.67^{e} ±0.85	4.39^{b}±0.13	6.03^{bc} ±0.11	7.27^{bc} ±0.12
20%WSP x Enz.	53.47^{ab}±1.40	58.53^{cd}±0.64	4.34^{b}±0.17	6.46^{a} ±0.11	7.46^{ab} ±0.09

Means having different letters at the same column within each factor are differ significantly.
* = (P<0.05), NS= Not significant.
1-Dressing % = (Carcass weight + Giblets / Live body weight) × 100.
2- Giblets = Heart + Liver + Kidneys, WSP= Wheat screening by-product.
Enz.=Enzymes (1-4 β-xylanase and α-amylase)

(P<0.05) values of giblet, stomach and caecum percentages were recorded by rabbits fed control diet followed by those fed diets containing 20 and 15% WSP with enzyme addition (Table 5).

Blood constituents:

Wheat screening by-product (WSP) effect

Results of total protein, albumin, globulin, cholesterol, AST, ALT and urea are recorded in Table 6. Significant reductions were detected in total protein, cholesterol and urea by increasing the level of WSP in the experimental diets.

Enzymes effect

The data in Table 6 revealed that diets provided with enzymes had no significant effect on total protein, albumin, globulin and urea compared with diets without enzymes. Results regarding albumin and globulin are in agreement with those reported by Veselin *et al.* (2003) who found no significant changes in the albumin and globulin levels in the blood of rabbits

fed concentrate mixture diets supplemented with Protozin multi-enzymes (19 mg/kg diet). However, rabbits fed on diet provided with enzymes had significant decrease in its plasma total cholesterol compared with those fed diet without enzymes. These results are in disagreement with results reported by Attia et al. (2001a & b), and Shakmak (2003) who mentioned that Avizyme product which contains xylanase, α-amylase and protease had no effect on the plasma total cholesterol level. Also Zeweil et al. (2005) reported that enzymes (xylanase, α-amylase and protease) had no significant effect on Japanese quail plasma cholesterol levels. Abou El–Wafa et al. (2002) reported that there was a significant increase in plasma total cholesterol with the addition of Avizyme, (1 Kg/ton) to corn-soy broiler diet.

Moreover, the supplementation of enzymes to rabbit diets significantly decreased blood AST and ALT concentration than those fed diets without enzymes supplementation. addition of enzymes improved the liver functions AST and ALT. 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.

Interaction effect

The interaction between WSP levels replacement and enzymes supplementation had a significant effect on total protein, cholesterol and urea (Table 6). However, the differences between rabbits fed all levels of WSP with or without enzymes and the control diet in albumin and globulin were not significant. The data revealed that rabbits fed diets containing different levels of WSP and provided with enzymes recorded the lowest significant ($P<0.05$) values of plasma cholesterol compared with those fed diets containing WSP without enzymes and control diet. The present results of blood parameters fell within the physiological normal values for rabbits as reported by Abd El-Khalek *et al*. (2000) and Ashour (2001). These values may indicate the possibility of incorporation of different levels of WSB in diets of rabbits without adverse effects on protein and cholesterol metabolism.

However, the interaction between WSP levels replacement and enzymes supplementation had a significant effect on AST and ALT concentration. Rabbits fed diets containing different levels of WSP and provided with enzymes recorded the lowest significant ($P < 0.05$) values of AST and ALT compared with those fed the WSP diets without enzymes or the

control diet. Also, data in Table 6 revealed that better values of both AST and ALT were recorded for rabbits fed diets containing WSP with enzymes supplementation compared with those fed diets containing WSP without enzymes or control diet (Table 6).

Chemical composition of meat:

Results in Table 7 represent the chemical composition of meat rabbits as affected by the WSP replacement with or without enzymes in diets. The comparison among the experimental groups showed that rabbit meats had nearly similar contents of dry matter, protein, ether extract and ash for all experimental groups. These findings clearly showed the absence of any significant differences in the chemical composition of rabbits meat due to the effect of dietary treatments. The present 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.

Table 7: Meat composition of growing rabbits as affected by different experimental treatments

Items	Meat composition (%)			
	Dry matter	Crude protein	Ether extract	Ash
WSP effect, %				
0 (Control)	28.23±0.22	20.67 ± 0.18	4.24 ± 0.03	3.43 ±0.03
5 %	27.97±0.21	20.42 ± 0.16	4.01 ± 0.02	3.53 ±0.04
10%	27.86±0.19	20.49 ± 0.18	4.05 ± 0.04	3.30 ±0.05
15%	28.99±0.21	20.32 ± 0.16	4.26 ± 0.04	3.43 ±0.02
20%	28.19±0.18	20.59 ± 0.27	4.18 ± 0.03	3.39 ±0.02
Enzymes effects				
Without enzymes	28.18±0.20	20.47 ± 0.26	4.26 ± 0.04	3.38 ±0.02
With enzymes	28.24±0.18	20.67 ± 0.23	4.12 ± 0.08	3.46 ±0.06
Interaction effects				
0(Control)	28.10±0.21	20.47 ± 0.26	4.26 ± 0.04	3.38 ±0.02
0(Control) x Enz.	28.54±0.11	20.87 ± 0.26	4.22 ± 0.04	3.48 ±0.03
5 %WSP	27.66±0.15	20.19 ± 0.02	4.02 ± 0.04	3.47 ±0.07
5 %WSP x Enz.	28.24±0.17	20.66 ± 0.28	4.00 ± 0.04	3.59 ±0.03
10%WSP	27.66±0.21	20.33 ± 0.23	4.09 ± 0.04	3.27 ±0.07
10%WSP x Enz.	27.97±0.23	20.66 ± 0.27	4.00 ± 0.06	3.32 ±0.07
15%WSP	27.75±0.19	20.08 ± 0.01	4.30 ± 0.04	3.39 ±0.02
15%WSP x Enz.	28.23±0.21	20.57 ± 0.29	4.22 ± 0.06	3.45 ±0.02
20%WSP	28.10±0.16	20.57 ± 0.31	4.20 ± 0.04	3.34 ±0.02
20%WSP x Enz.	28.20±0.24	20.62 ± 0.49	4.15 ± 0.04	3.44 ±0.02

WSP= Wheat screening by-product, Enz.=Enzymes (1-4 β-xylanase and α-amylase).

Economic efficiency:

The effect of dietary WSP replacement with or without enzymes on of both of E.E.F and R.E.E.F are presented in Table 8. During the whole experimental period, rabbits fed diet containing 5% WSP with enzyme showed higher net revenue, E.E.F and R.E.E.F(%) followed by those fed diets containing control, 10% WSP and 15% WSP with enzymes than other experimental groups. The increasing in body weight gain as a result of providing rabbits with enzymes reduced the total cost of DBG of these rabbits as compared with those fed diets without enzymes supplementation in diets.

Table 8. Economical efficiency (E.E.F) and relative economical efficiency (R.E.E.F) of rabbits as affected by experimental treatments

Treatment groups	B.W.G (gm)	F.I (gm)	Price kg/ Feed (p.t)	Feed cost (L.E.)	Net Reven. (L.E)	E.E.F	R.E.E.F %
Control	1175.00	4817.09	162.56	7.831	21.150	2.701	100.0
Control x Enz.	1287.90	4978.25	166.06	8.267	23.182	2.804	103.8
5 %WSP	1164.50	4970.17	163.10	8.106	20.961	2.586	95.7
5 %WSP x Enz.	1367.10	5156.12	166.60	8.590	24.608	2.865	106.1
10%WSP	1150.80	5086.59	163.20	8.301	20.714	2.495	92.4
10%WSP x Enz.	1356.50	5247.70	166.70	8.748	24.417	2.791	103.3
15%WSP	1131.50	5219.82	161.76	8.444	20.367	2.412	89.3
15%WSP x Enz.	1333.00	5248.68	165.26	8.674	23.994	2.766	102.4
20%WSP	1121.90	5371.53	159.60	8.573	20.194	2.356	87.2
20%WSP x Enz.	1316.70	5548.17	163.10	9.049	23.701	2.619	97.0

Price of kg live body weight was 18.0 L.E, Price of kg Xylam was 70.0 L.E at experimental period .

Net revenue = body revenue – feed cost. * E.E.F = (Net revenue / feed cost).

R.E.E.F, assuming control treatment = 100%, Enz.=Enzymes (1-4 β-xylanase and α-amylase)

WSP= Wheat screening by-product.

In general, it could be noticed that all dietary treatments achieved profit hence the greatest profit calculated for rabbits fed 5% WSP containing diet and provided with enzyme among the enzymatic treatments. The obtained results is inagreement with finding by Sarhan (2001) who found that E.E.F improved during the period from 3 to 10 and from 10 to 12 weeks of age due to optizyme supplementation in rabbits diet. Makled *et al.* (2005) indicated that E.E.F of rabbits was improved during the period from 8-10 and from 10-12 weeks of age by adding 500 or 750 optizyme / kg feed in supplemented groups compared with the un-supplemented one. This may be related to the price reduction of the WSP containing diets. Generally, the use of agricultural by-products in rabbit diets has been resulted in high E.E.F and R.E.E.F, as supported by Ismail and Gippert (1999).

Conclusively, it could be concluded that the present results showed that use of WSP can be successfully fed at level 5 % of growing rabbits diet

supplemented with enzymes (xylanase and amylase) without any adverse effect on growing rabbits performance and economical efficiency, under Egyptian conditions.

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استجابة الأرانب النامية للعلائق المحتوية على مستويات مختلفة من مخلفات غربلة القمح مع أو بدون إضافة الإنزيمات

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استخدم فى هذة الدراسة عدد ١٠٠ ارنب نيوزيلاندى ابيض عمر ٥ اسابيع٠ قسمت عشوائيا الى ١٠ معاملات تجريبية و بكل معاملة (عدد ٥ ذكور + ٥ اناث) فى اقفاص فردية٠ تم استخدام خمسة مستويات من مخلفات غربلة القمح (WSP) و هى ٠، ٥، ١٠، ١٥، ٢٠% فى العلائق مع اضافة او بدون اضافة مخلوط انزيمى بمستويات صفر او ٥٠٠ جم /طن علف (كل جرام من المخلوط الانزيمى احتوى على ١٢٦٠ وحدة دولية من الزيلينيز ، ٨٠٠٠ وحدة دولية من الاميليز)٠ تم تقديم المياة و العلائق بصورة حرة خلال فترة التجربة التى استمرت من ٥ الى ١٢ اسبوع من العمر ٠

تتلخص النتائج المتحصل عليها فيما يلى:

سجلت الارانب التى تم تغذيتها على عليقة تحتوى على ٥% مخلفات غربلة القمح مع اضافة الانزيمات اعلى القيم معنويا لوزن الجسم و الذيادة فى وزن الجسم و معدل النمو النسبى و تبعتها التي تغذت على عليقة تحتوى على ١٠% مخلفات غربلة القمح مع اضافة الانزيمات٠

استهلكت الأرانب التي تم تغذيتها على عليقة تحتوى على٢٠% مخلفات غربلة القمح مع اضافة الانزيمات اعلى كمية استهلاك للعلف بالمقارنة بالتى تم تغذيتها على عليقة المقارنة و المعاملات الاخرى٠

سجلت الأرانب التي تم تغذيتها على عليقة تحتوى على ٥% مخلفات غربلة القمح مع اضافة الانزيمات افضل كفاءة تحويل غذائى و تلتها المجموعة التى غذيت على عليقة المقارنة و ١٠ و ١٥% مخلفات القمح مع اضافة الانزيمات على التوالى بالمقارنة بالمعاملات الاخرى٠

إضافة الإنزيمات للعلائق التي احتوت على مخلفات غربلة القمح حسنت معنويا معاملات هضم العناصر الغذائية و صفات الذبيحة بالمقارنة بالمجموعات التى تم تغذتها على اعلاف بدون اضافة انزيمات٠

بزيادة مستوى مخلفات غربلة القمح فى العلائق انخفضت معنويا قيم البروتين الكلى و الكوليسترول و اليوريا فى دم الارانب٠

في حين لم تظهر المعاملات المختلفة تأثيرا معنويا على البيومين و جلوبيولين الدم٠

سجلت الأرانب التي تم تغذيتها على العلائق المحتوية على المستويات المختلفة من مخلفات غربلة القمح مع اضافة الانزيمات اقل قيم من الكوليسترول بالمقارنة بالتى تم تغذتها على علائق تحتوى على مخلفات غربلة القمح بدون اضافة انزيمات و عليقة المقارنة٠

كما أظهرت النتائج أن إضافة الإنزيمات للعلائق المحتوية على مخلفات غربلة القمح ادت الى تحسن معنوي فى وظائف الكبد كما ان التركيب الكيمائى للحم لم يتأثر معنويا بالمعاملات التجريبية المختلفة٠

التوصيـــة :إضافة الإنزيمات لعلائق الارانب النامية حسنت في أداء النمو و معاملات الهضم و صفات الذبيحة و نشاط الكبد و الكفاءة الاقتصادية بالمقارنة بالتي لم يتم تغذيتها على علائق بدون إضافة الانزيمات٠ يمكن استخدام مخلفات غربلة القمح حتى مستوى ٥% فى علائق الارانب النامية مع اضافة انزيمات الزيلينيز و الاميليز دون اى تأثير سلبى على اداء النمو و الكفاءة الاقتصادية للأرانب النامية٠