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IMPROVING THE UTILIZATION OF WHEAT BRAN IN QUAIL DIETS

By

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Abstract: *This work was conducted at the Poultry Research Station, El-Azaab, Fayoum, Egypt, to study the possibility of improving the utilization of wheat bran in quail diets. A total number of 640 one week old unsexed Japanese quail chicks were divided into 8 equal treatments (80 birds each) of approximately similar in body weight. Treatment 1 received the control diet containing 24.03% CP and 2896 kcal ME/kg. Treatment 2 was received the basal wheat bran diet (WB-diet) containing 24.00% CP and 2360 kcal ME/kg. Treatments 3,4,5,6,7 and 8 were received the WB-diet supplemented with either1% radish extract (RE), 1% RE + 0.1 % Avizyme 1500 (E) , 1% RE + 1.0% sodium sulphate (SS) , 0.1% E , 1% SS or 1% SS+0.1% E, respectively.*

All feed additives at 3 weeks of age increased body weight and to some extent improved feed conversion. At 6 weeks of age there was insignificant differences between all dietary treatments. In laying phase (8-20 weeks), all feed additives improved egg number, egg mass and feed conversion compared to the birds fed WB-diet alone. The combination of RE+E, RE+SS and SS+E improved hatchability percentage compared to the birds fed either WB-diet alone or those fed the control diet. It could be concluded that RE, E or SS alone or in combinations can be used to improve the utilization of 30% wheat bran in quail diets in both growing and laying phases.

INTRODUCTION

Wheat bran could be an economical and good source of protein in many tropical countries (Picard *et al*.,1993). Cavalcanti and Behnke (2004) showed that wheat bran can be utilized as a viable source of phytases. Ravindran *et al*., (1995) showed that wheat bran contains approximately 2957 units of phytase /kg. Zeisel *et al* .,(2003) found that wheat bran

contains a large amount of betaine (1505.6 mg/ 100 g) and betaine important because of its role as methyle groups donor to homocysteine to form methionine. Betaine protects chick intestinal cells from coccidian infection, alleviate symptoms and improves performance (Fetterer *et al.*, 2003; Kettunen *et al*.,2001 and Kidd *et al*.,1997). Betaine improves growth and the efficiency of feed utilization and reduces body fat in chicks (Kidd *et al*., 1997 and Saunderson and Mackinlay 1990). Tome *et al*., (2004) found that wheat bran extract prevented lipid peroxidation more strongly than a BHA solution. On the other hand wheat bran contains lower metabolizable energy than other ingredients like corn , sorghum or barley (NRC 1994). Also, wheat bran contains phenolic compounds (Kroon *et al.,* 1997) and phenolic nature of lignin itself may act as an inhibitor of the enzymes (Fahey *et al.*, 1993). Conjugation is a detoxification mechanism that enables an animal to solubilize xenobiotics and excrete them in the urine (Kilic and Lindsay, 2005). Monohydric phenols are commonly conjugated at the hydroxyl group by sulphation, glucuronidation, and to a lesser extent, by acetylation and phosphorylation (Mulder,1990). Bartelt and Kirinya (1976) found that liver slices from geese, ducks and chickens contained high sulphate conjugation enzyme activities. Ohyama *et al.* (2004) found that in rat and quail liver slices, 7-ethoxycoumarin was preferentially conjugated with sulphate. Shyama and Muralikrishna (2004) showed that phenolic acids, such as coumaric and ferulic acids mainly bound to arabinoxylans, in cereals. Peyron *et al.*(2001) found that ferulic acid in wheat bran invitro decreased by treatment by horseradish extract. Many reports have indicated significant improvement of nutritive value of cereal grains such as wheat, barley, oats and rye by enzyme addition (Friesen *et al*.,1992) . Ali (2002) found with broiler diet contained 30% wheat bran that sodium sulphate, enzyme preparation, radish extract (as a source of peroxidase enzyme) and enzyme preparation plus radish extract improved performance and digestibility of all nutrients. Abaza *et al.* (2004) found with local hen diets containing 35% wheat bran that addition of sodium sulphate, enzyme preparation, enzyme preparation plus sodium sulphate, or enzyme preparation plus radish extract improved feed conversion, egg weight and egg mass.

With this aim , an experiment was conducted to examine the effect of radish extract (as a source of peroxidase enzyme), sulphate or enzyme preparations alone or in combination on improving the utilization of diets containing 30% wheat bran by Japanese quail during the growing and laying periods.

MATERIALS AND METHODS

The present study was carried out at El-Azab Poultry Research Station, Fayoum, Egypt. Total number of 640 one-week-old unsexed Japanese quail chicks were used. Chicks were wing banded, individually weighed and distributed randomly according to their weight into 8 dietary treatment groups of 80 chicks each. Birds of each group were subdivided into two replicates of 40 birds each. Chicks were kept under the same management conditions during brooding and were housed in battery brooder. The brooding temperature was about 35° C in the first week of age and then was gradually reduced according to common brooding practices. The control diet and experimental diets were formulated to be isonitrogenous but differ in their metabolizable energy content. The experimental diets were supplied the nutrients to meet the requirements of NRC (1994). Anhydrous Sodium sulphate (SS)was supplied by Egyptian Salt and Mineral Company. Radish extract (RE) was prepared by cutting the root of radish into chips and put the chips into carrot press and the juice was collected into clean glass cups and then mixed with diet every 28 days The inclusion rate was of 10g/kg diet. Avizyme 1500® (E) is a commercial enzyme preparation which contains xylanase, protease and alpha amylase. The inclusion rate was of 1g/kg diet in growing period and 0.75 g/kg diet in laying period. The used feed additives were added to the diets on the expense of yellow corn. The chicks were allotted on the following dietary treatments:

1. The control diet (Table 1).
2. WB-diet contained 30% wheat bran.
3. WB-diet + 1.0 % RE.
4. WB-diet + 1.0% RE + 0.1 % E.
5. WB-diet +1.0% RE + 1.0%SS.
6. WB-diet + 0.1% E.
7. WB-diet + 1.0 %SS.
8. WB-diet + 1.0 % SS +0.1% E.

Feed and water were supplied *ad libitum* and a continuous light was provided (24 hours daily) throughout the growing period. The body weight (BW), feed intake (FI) and body weight gain (BWG) values were weekly recorded while feed conversion (FC) was calculated as a unit of FI per unit of BWG. At the end of growing period, 6 birds from each group (three birds from each replicate) were randomly taken for slaughter test and the calculated values were expressed as a percentage of pre-slaughter live bodyweight. Individual blood samples were taken from six birds from each

treatment after slaughter. The blood samples were collected into dry clean centrifuge tubes containing drops of heparin and centrifuged for 20 minutes (3000 rpm). The plasma sample were stored in the deep freezer at approximately –20° C till the time of chemical analysis. Plasma cholesterol, total lipids, calcium and phosphorus were determined using suitable commercial kits. After 6 weeks of age, 240 of Japanese quail laying hens and 120 male from the former birds were used and kept in the same treatments. The 30 layers and 15 male in each dietary group were subdivided into three replicates and kept in community cages (10 layers and 5 males each). The control laying diet and basal diet (Table 1) were formulated to be isonitrogenous and differ in metabolisable energy content. The experimental diets were supplied to meet the quails requirements according to NRC (1994). Feed and water were provided *ad libtum* during the laying period which lasted for 12 weeks (8-20 weeks). The birds were exposed to constant lights (16 hours per day). Daily FI / group, egg number (EN), egg weight (EW) and egg mass (EM) were calculated weekly. At the 6,8,10 and 12 weeks of the experimental period , a total number of 1200 eggs (150 eggs for each treatment, 50 eggs from each replicate) were incubated to determine the hatchability percentage. Moreover, a sample of radish extract was taken to measure peroxidase activity according to method of Amako *et al.* (1994). The peroxidase activity of radish extract is expressed in a unit / milligram protein. Peroxidase activity was 9.73 units/mg protein. The statistical analysis was computed using analysis of variance procedure and the significant mean differences were separated by Duncan's Multiple Range test procedure described in the SAS, (SAS, 1990).

RESULTS AND DISCUSSION

Growing Phase (0-6 Weeks):

The effect of different treatments on live BW and BWG gain is shown in Table (2). There was a significant difference between treatments, at 3 weeks, the dilution of quail diet by 30% wheat bran significantly decreased BW and BWG by 11.84 and 14.92%, respectively. This negative effect was primarily due to lower energy value of this diet .Elangovan *et al.* , (2004) found that at 5 weeks of age the quails fed diet containing 2903 and 2704 kcal/kg gained more than those fed diets containing 2505 kcal/kg. The addition of RE, SS or E alone or in combination significantly improved similarly BW and BWG at 3 weeks of age compared to birds fed WB-diet alone. The RE may be decreased phenolic compounds in digestive tract and consequently increase availability of the nutrients. In this respect,

Matuschek *et al.*(2001) found that incubation sorghum with polyphenol oxidase had a reducing effect on the total phenol content.Also SS may be conjugate with phenolic compound and detoxification it. Kroon *et al*. (2004) showed that polyphenols are present in plasma and tissues as conjugation with glucuronate or sulphate. Also the enzyme preparation which contains xylanase has been reported to improve body weight. Pourreza and Classen (2001) found that addition of xylanase enzyme to broiler diet containing 25% wheat bran improved protein digestibility. However, Bedford and Schulze (1998) showed that any process which will reduce antinutritional factors concentration will enhance performance and relax some of the constraints on feed formulation. These results were similar to those reported in previous work in our laboratory with broilers by (Ali 2002) and local laying hens (Abaza *et al*., 2004). At 6 weeks of age there were insignificant differences between treatments in BW and BWG. The lake of response to WB without or with feed additivse at 6 weeks may be due to adaptation of digestive tract to digest wheat bran and alleviated antinutritional factors presence in it. However, earlier study by Inman (1973) showed that the adult Bobwhite quail, which is a farmland species of bird, had a significantly higher total percentage of cellulose digested in response to increased dietary fiber. Also, Savory and Gentle (1976) found with quails that birds fed on high-fiber diet, presumably to accommodate the greater bulk of feed eaten, and when the diets were interchanged the gut dimensions of both groups changed at similar rates, reaching the appropriate sizes for the respective diets in 3 to 4 weeks.

There were significant differences between treatments in feed intake from 1 to 3 weeks. The birds fed control diet recorded the lowest value and increased upon inclusion of WB in the diet and these results agree with those of Elagovan *et al.* (2004) who found that feed intake linearly increased as the dietary energy level decreased. The addition of E to WB-diet significantly decreased feed intake (1-3 week) compared to birds fed WB-diet alone. Bedford and Classen, (1992) found that addition of exogenous xylanase has been shown to hydrolyze the high molecular mass subfraction of arabinoxylan and decrease the formation of viscous solution in digestive tracts of broiler chickens. The control diet recorded the lowest value of the feed intake between 3 to 6 or 1 to 6 weeks of age . Angulo *et al.* (1993) suggested that quail could adjust feed intake according to the energy level of the diet. The addition of feed additive did not affect feed intake in the two periods (3-6 or 1-6 weeks). These results agree with those obtained by Elangovan *et al.*(2004) who found that enzyme supplementation did not influence feed intake of quail chicks.

There were significant differences between treatments in feed conversion during 1 to 3 weeks. The addition of RE , SS or E alone or in combination significantly improved FC similarly compared with birds fed the WB diet alone. There were significant differences between treatments in FC in two periods (3-6 and 1-6 weeks). These results disagree with those obtained by Ali (2002) who found that with broiler diet contained 30% wheat bran the addition of RE to enzyme preparation improved FC. The lack of response in FC to feed additive may be due to lower retention time in quail compared to broilers used by Ali (2002).In this regard, Martin and Farrell (1998) reported that AME value of rice bran was 2294.4 kcal ME /kg with chicken at 15 days of age but increasing to between 3513.3 and 3585 kcal ME / kg in adult cockerels. The feed additives used in this study may need more retention time to increase the utilization of WB.

Carcass Traits:

There were insignificant differences between treatments in most of the parameters (Table 3) under study except the relative weight of heart and giblets. In this respect Elangovan *et al.* (2004) found that heart weight emanating from diets containing 2903 kcal ME/kg diet was higher than that of diets with lower energy levels. However, the liver weight and giblets yield were significantly influenced by the interaction between energy level and enzyme supplementation. In this study, the birds fed WB-diet recorded value of ceacal length found to be the highest length value of ceaca . The feed additive may be decrease the microbial numbers and consequently decreased the caecal length. In this manner, the study of Bedford and Apajalahti (2001) demonstrated that in birds fed a reasonable quality wheat-based diet, the addition of xylanase-based enzyme resulted in a 60% reduction in microbial numbers. However, many experiments showed that high fiber diet affects the length and weight of gastrointestinal tract (Savory and Gentle 1976; Moss, 1989; and Savory, 1992)

Blood Constituents:

The effect of dietary treatments on some blood plasma parameters of quails at 6 weeks of age is shown in Table (4). There were significant differences among treatments in plasma total cholesterol. The birds fed WB-diet recorded the lowest value while birds fed WB + SS diet recorded the highest one. The addition of E to WB-diet numerically but not significantly increased plasma cholesterol. These results agree with Patterson and Aman (1992) who found with oat bran based diet that the enzyme supplementation increased serum cholesterol concentrations. The addition of RE to WB-diet

did not affect cholesterol level compared to birds fed WB-diet. In this respect, Balasinska *et al.* (2005) concluded dy that dietary horseradish lowers plasma cholesterol in mice receiving a cholesterol-enriched diet by unknown mechanism.. The addition of SS to WB-diet alone or in combination with other additive significantly increased total plasma cholestrol compared with birds fed WB-diet alone. However, Nockels (1973) reported that addition of sulphate to hen ration in the presence of adequate endogenous ascorbate may be enhance cholesterol mobilization from tissue such as muscle and promote its excretion in the egg.

There was a significant difference between experimental treatments in plasma total lipid value. Fortifying the diet with WB resulted in a significant decrease in plasma total lipids compared to those fed control diet. These results disagree with those obtained by Ali (2002) who found in one of two experiments that broilers fed diet containing 30% wheat bran recorded value of total lipid significantly higher than the control diet. In this respect Abbas (1992) found that sawdust (as a source of fiber) increased total blood lipids.

Analysis of variance for plasma calcium indicated that the differences among the experimental treatments were significant. The birds fed WB-diet recorded significantly higher value of plasma calcium than birds fed the control diet. Ballam *et al.* (1984) showed that phytate hydrolysis by chicks fed a diet containing wheat bran was greater than that of those fed the corn-soybean meal basal diet.Also, Han *et al.*(1998) found that pigs fed 15% wheat middling exhibited greater growth performance, plasma inorganic P concentration and bone strength than those fed corn soya diet. In this study, the phytase in wheat bran may be the reason of increasing plasma calcium by 30.2% compared with birds fed WB-diet alone. These results agree with those obtained by Abaza *et al*. (2004) who found with local laying hen, that diet containing 35% WB increased the serum calcium by 22.6% compared with that obtained from hens fed control diet. The addition of SS or RE alone or in combination did not alter the calcium level while E supplementation increased the level of plasma calcium. Kotber *et al.* (2003) indicated that an additional benefit is the great potential of glyconase in releasing more endogenous phytase activity from the cereal components in feed formulations. There were significant differences among the treatments in plasma inorganic phosphorus. The birds fed the control diet recorded the highest value while birds fed WB-diet + RE recorded the lowest value.

Laying Phase (8 – 20 Weeks) :

As shown in Table (5) there were insignificant differences between treatments in EN, EW or EM. The birds fed WB + RE + E recorded the highest EN value (68.83) while the birds fed WB-diet alone recorded the lowest value (61.50). The dilution of quail diet by 30% wheat bran insignificantly decreased the EN by 4.84% compared with the control. In this respect, Sutton *et al*. (1981) found when they used 56.82% wheat bran in the laying quail diet, that egg production was decreased by 47.95% compared with control diet. The birds fed WB-diet + RE+ E recorded EN value found to be insignificantly higher by 11.91% than birds fed WB-diet alone. Ali (2002) indicated that RE may raise the activity of exogenous enzyme through affecting the phenolic compound which act as enzyme inhibitors (Fahey *et al.*,1993). Also, peroxidase is a ligninolytic enzyme (Monties, 1994) which may be affected the fiber matrix and aid enzyme preparation to release the nutrients. This study were similar to those reported in previous work in our laboratory with local laying hens (Abaza *et al*., 2004 and Ali *et al*., 2006) who concluded that SS or RE is important to achieve the maximum activity of enzyme preparation. There were a significant differences between values of daily feed intake recorded by different treatments. The dilution of the quail hens diet by 30% wheat bran significantly increased FI by 17.99% compared with control diet. The lower energy content in WB-diet compared with control diet caused an increase in FI .Angulo *et al*.(1993) suggesting that quails could adjust their energy intake in diets differing in their energy content . Also, FC increased by 21.88% compared with bird fed the control diet. The feed additive SS, RE or E improved FC compared with birds fed WB-diet alone. The addition of RE alone or in combination with E or SS significantly improved FC by 9.94, 11.87 and 9.39%, respectively compared with birds fed WB-diet alone. The lack of the response of SS , E or SS+E in this study can be explained as a result of shorter intestinal length in quails than previous study with local hen (Abaza *et al* .,2004). Also, the mechanism of detoxification of phenolic compound by SS is depended on conjugation the phenol with it and different from mechanism of detoxification by RE.

The analysis of variance for hatchability % indicated that there were significant differences between treatments. The feed additive used in this study improved hatchability % compared with bird fed WB-diet alone. It was surprise that addition of RE+SS to WB-diet significantly increased hatchability by 8.32% compared with control diet. High rates of energy metabolism in embryo can lead to the production of reactive oxygen species

and other free radicals which can cause damage to cellular macromolecules (Halliwell, 1994).In the chick embryo, protection against peroxidative damage is provided by the concerted action of a range of antioxidant components (Surai *et al*., 1996).Tome *et al*.(2004) found that wheat bran extract prevented lipid peroxidation more strongly than a BHA solution. The SS+RE may be increased hatchability as a result of increased antioxidant factors in the egg. In this respect, Rondini *et al*. (2004) reported that plasmas of rats fed wheat bran show a better antioxidant activity than the control groups.

Egg Quality:

The effect of dietary treatments on egg quality are shown in Table 6.There were insignificant differences between treatments in most of the parameters under study. The analysis of variance indicated that there was a significant differences between treatments in yolk color. The decrease in yolk color in WB-treatments compared to control treatment may be due to lower pigments as a result of lower yellow corn percentage in these diets. In this respect, Patterson *et al*. (1988) found that the addition of 89% wheat middling to hen diets decreased yolk color score compared to control diet.

CONCLUSION

It is concluded from this study that radish extract , enzyme preparation and sodium sulphate either alone or in combination can be used to improve the utilization of wheat bran in quail diets during either growth phase or laying phase. Further studies in this area should be conducted to study the effect of RE or SS alone or in combination in improving the hatchability of quail egg and elucidate the mechanisms of them**.**

Table (1): Composition and calculated analysis of the control and wheat bran containing diet (WB-diet) in both growing and laying periods.

Ingredients %	growing Period		Laying Period	
	Control	WB diet	Control	WB diet
Yellow corn	55.39	31.89	61.90	38.21
Wheat bran	00	30.00	00.00	30.00
Soybean meal (44%)	34.35	28.02	20.21	14.05
Corn gluten	7.30	7.30	10.00	10.00
Di calcium phosphate	0.80	0.40	1.21	0.82
Lime stone	1.35	1.53	5.80	6.00
Salt	0.35	0.33	0.35	0.32
Premix*	0.30	0.30	0.30	0.30
DL- methionine	0.05	0.06	0.03	0.04
L-lysine Hcl	0.11	0.17	0.20	0.26
Total	100	100	100	100
Calculated analysis**				
CP%	24.03	24.00	20.06	20.09
Kcal ME /kg	2896	2360	2901	2363
Crude fiber%	3.92	6.22	3.09	5.40
Crude fat %	2.77	2.99	2.87	3.08
Calcium %	0.80	0.80	2.51	2.51
Available phophorus %	0.30	0.30	0.35	0.35
Lysine %	1.30	1.30	1.00	1.00
Methionine %	0.50	0.50	0.45	0.45
Methionine + cystine%	0.90	0.93	0.80	0.82
Sodium%	0.150	0.152	0.154	0.152

* Premix contains per 3kg vit. A 12 000 000, vit. D3 2200 000 IU, vit. E 10000mg, Vit. K3 2000mg , vit. B1 1000mg, vit. B2 5000mg, vit. B6 1500mg, vit. B12 10mg, pantothenic acid 10000mg, Niacin 30000mg, Biotin 50mg, Folic acid 1000mg, Choline 250gm, Selenium 100mg, copper 10000mg, iron 30000mg, manganess 60000mg, zinc 50000mg, iodine 1000mg, cobalt 100mg and $CaCO_3$ to 3000g.

** According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

Table (2) : Effect of dietary treatments on body weight, weight gain, feed intake and feed conversion.

Treatments / Item	Control	WB	WB+RE	WB+RE+E	WB+RE+SS	WB+E	WB+SS	WB+SS+E
BW at 3 wks (g)	105.5^{a} ±1.50	93.00^{b} ±2.00	104.5^{a} ±1.50	105.5^{a} ±2.50	105.5^{a} ±0.5	105.0^{a} ±1.00	103.5^{a} ±3.50	109.00^{a} ±2.00
BW at 6 wks (g)	203.5 ±2.50	201.5 ±5.50	210.0 ±3.00	205.5 ±3.50	208.0 ±4.00	206.5 ±7.50	205.0 ±2.00	203.5 ±1.50
WG 1-3 wks (g)	76.04^{a} ±0.66	64.67^{b} ±2.05	75.91^{a} ±0.96	77.59^{a} ±1.48	77.75^{a} ±0.54	75.1^{a} ±0.69	74.5^{a} ±2.42	79.3^{a} ±1.51
WG 3-6 wks (g)	98.00 ±1.00	108.50 ±3.5	105.5 ±1.50	100.0 ±1.00	102.50 ±4.50	101.50 ± 6.50	101.50 ±1.50	94.5 ±0.50
WG 1-6 wks (g)	174.0 ±1.66	173.1 ±5.5	181.4 ±2.46	177.59 ±2.48	180.25 ±3.95	176.6 ±7.19	176.0 ±0.92	173.8 ±1.01
FI 1-3 wks (g)	171.3^{e} +0.50	207.6^{b} ±0.50	208.4^{b} ±0.40	214.6^{a} ±0.33	206.8^{b} ±0.40	195.9^{d} ±0.50	199.4^{c} ±1.50	212.2^{a} ±1.50
FI 3-6 wks (g)	499.3^{b} ±13.50	570.2^{a} ±14.9	569.2^{a} ±16.80	571.4^{a} ±12.05	593.6^{a} ±8.65	567.9^{a} ±13.50	602.1^{a} ±12.7	571.0^{a} ±1.30
FI 1-6 wks (g)	670.6^{a} ±13.00	777.0^{a} ±14.4	777.0^{a} ±16.30	786.0^{a} ±11.55	800.4^{a} ±9.1	763.8^{a} ±14.00	801.5^{a} ±11.20	783.2^{a} ±0.20
FC 1-3 wks (g)	2.25^{a} ±0.02	3.21^{c} ±0.10	2.74^{b} ±0.04	2.76^{b} ±0.04	2.65^{b} ±0.01	2.60^{b} ±0.01	2.67^{b} ±0.10	2.67^{b} ±0.06
FC 3-6 wks (g)	5.09^{a} ±0.08	5.25^{ab} ±0.03	5.39^{abc} ±0.08	5.71^{abcd} ±0.17	5.80^{bcd} ±0.33	5.60^{abcd} ±0.22	5.93^{cd} ±0.21	6.04^{d} ±0.04
FC 1-6 wks (g)	3.85^{a} ±0.03	4.49^{b} ±0.06	4.28^{b} ±0.03	4.42^{b} ±0.12	4.44^{b} ±0.14	4.32^{b} ±0.09	4.55^{b} ±0.03	4.50^{b} ±0.02

$^{a-d}$ Means in the same row with different letters, differ significantly ($P \leq 0.05$). Means ± standard error

Table (3): Effects of dietary treatments on carcass traits.

Parameters*	Treatments							
	Control	WB	WB+RE	WB+RE+E	WB+RE+SS	WB+E	WB+SS	WB+SS+E
Carcass%	71.10 ±0.72	69.43 ±0.25	70.32 ±0.82	69.21 ±0.71	69.67 ±0.89	70.47 ±0.52	65.99 ±3.76	66.89 ±0.84
Heart%	0.91^{ab} ±0.03	0.99^{a} ±0.06	0.91^{ab} ±0.04	0.78^{b} ±0.02	0.86^{ab} ±0.02	0.80^{b} ±0.04	0.91^{ab} ±0.03	0.79^{b} ±0.03
Liver%	1.97 ±0.20	2.28 ±0.19	1.74 ±0.07	2.12 ±0.12	1.93 ±0.13	1.77 ±0.14	1.89 ±0.08	1.82 ±0.21
Gizzard%	2.04 ±0.05	2.54 ±0.16	2.40 ±0.04	2.42 ±0.17	2.47 ±0.16	2.28 ±0.09	2.14 ±0.09	2.63 ±0.25
Giblets%	4.94^{b} ±0.23	5.82^{a} ±0.19	5.05^{b} ±0.07	5.33^{ab} ±0.29	5.27^{ab} ±0.26	4.86^{b} ±0.11	4.94^{b} ±0.19	5.25^{ab} ±0.32
Total Edible Parts%	76.04 ±0.61	75.25 ±0.27	75.38 ±0.77	74.54 ±0.68	74.95 ±0.75	75.34 ±0.47	70.94 ±1.77	72.14 ±0.61
Intestinal length(cm)	63.6 ±3.20	65.28 ±1.57	61.50 ±3.94	63.16 ±3.08	62.58 ±1.89	64.25 ±2.17	60.41 ±2.25	67.33 ±1.40
Ceacal length(cm)	8.40 ±0.18	8.92 ±0.53	7.83 ±0.49	9.00 ±0.46	8.50 ±0.25	8.33 ±0.38	8.00 ±0.44	8.58 ±0.43

[a-b] Means in the same row with different letters, differ significantly (P≤0.05). Means ± standard error.

* Relative to live BW.

Table (4): Effect of dietary treatments on some blood plasma parameters.

Parameters	Treatments							
	Control	WB	WB+RE	WB+RE+E	WB+RE+SS	WB+E	WB+SS	WB+SS+E
Cholesterol mg/dL	174.81^{abc} ±5.42	151.21^{c} ±10.79	154.05^{bc} ±5.02	152.07^{c} ±10.34	182.61^{ab} ±9.76	177.20^{abc} ±5.02	203.5^{a} ±8.20	195.22^{a} ±12.22
Total lipid g/L	3.99^{ab} ±0.40	3.10^{c} ±0.22	2.98^{c} ±0.18	3.20^{bc} ±0.16	4.31^{a} ±0.18	3.91^{ab} ±0.35	4.07^{a} ±0.27	3.56^{abc} ±0.38
Calcium mg/dL	25.30^{b} ±2.34	32.95^{a} ±1.85	25.35^{b} ±1.23	26.17^{b} ±0.77	25.59^{b} ±1.33	29.11^{ab} ±2.22	25.66^{b} ±1.28	27.32^{b} ±0.92
Phosphorus mg/dL	9.47^{a} ±0.61	8.69^{ab} ±0.60	6.50^{c} ±0.46	7.05^{c} ±0.48	8.12^{abc} ±0.51	6.93^{c} ±0.63	6.86^{c} ±0.53	7.22^{bc} ±0.31

[a-c] Means in the same row with different letters, differ significantly (P≤ 0.05).

Means ± standard error.

Table(5): Effect of experimental treatments on productive performance parameters.

Parameters	Treatments							
	Control	WB	WB+RE	WB+RE +E	WB+RE +SS	WB+E	WB+SS	WB+SS +E
EN/bird	64.63 ±2.39	61.50 ±0.87	66.90 ±1.72	68.83 ±2.04	68.50 ±1.53	65.13 ±2.17	66.00 ±1.08	65.53 ±2.08
EW(g)	12.34 ±0.17	12.54 ±0.08	12.79 ±0.17	12.62 ±0.15	12.39 ±0.24	12.46 ±0.05	12.57 ±0.10	12.37 ±0.22
EM(g)	797.8 ±34.8	771.88 ±13.57	855.34 ±10.40	869.75 ±49.23	849.79 ±35.21	811.31 ±26.74	829.70 ±19.82	810.34 ±21.65
FI(g)	28.18^{b} ±0.76	33.25^{a} ±0.81	33.26^{a} ±0.22	32.98^{a} ±1.21	33.18^{a} ±0.83	33.78^{a} ±0.30	33.17^{a} ±0.61	34.51^{a} ±0.19
FC (g feed /g egg)	2.97^{a} ±0.15	3.62^{d} ±0.08	3.26^{abc} ±0.05	3.19^{ab} ±0.06	3.28^{abc} ±0.05	3.50^{bcd} ±0.11	3.36^{bcd} ±0.10	3.58^{cd} ±0.09
Hatchability %	65.47^{bc} ±0.99	61.15^{c} ±0.77	64.30^{bc} ±1.58	69.02^{ab} ±1.34	70.92^{a} ±2.59	62.07^{c} ±1.52	61.52^{c} ±0.86	69.12^{ab} ±1.54

[a-d] Means in the same row with different letters, differ significantly ($P \leq 0.05$).

Means ± standard error.

Table (6): Effect of dietary treatments on egg and shell quality.

Parameters	Treatments							
	Control	WB	WB+RE	WB+RE+E	WB+RE+SS	WB+E	WB+SS	WB+SS+E
Egg length (mm)	33.60 ±0.44	33.22 ±0.36	33.88 ±0.53	33.55 ±0.50	33.00 ±0.44	33.77 ±0.46	34.44 ±0.17	32.77 ±0.52
Egg Breath (mm)	25.66 ±0.16	25.77 ±0.32	26.11 ±0.26	26.00 ±0.33	25.88 ±0.30	25.55 ±0.29	26.33 ±0.28	25.33 ±0.37
Yolk height (mm)	12.83 ±0.16	12.00 ±0.28	12.50 ±0.09	12.43 ±0.22	12.48 ±0.26	12.44 ±0.15	12.73 ±0.09	12.41 ±0.18
Albumin height (mm)	5.10 ±0.25	5.32 ±0.25	5.30 ±0.21	4.98 ±0.25	4.91 ±0.36	5.36 ±0.23	4.62 ±0.22	5.16 ±0.28
Shell weight (g)	1.12 ±0.03	1.13 ±0.04	1.13 ±0.02	1.18 ±0.04	1.15 ±0.03	1.13 ±0.03	1.17 ±0.04	1.06 ±0.02
Shell thickness (mm)	0.218 ±0.004	0.214 ±0.004	0.207 ±0.005	0.211 ±0.005	0.215 ±0.001	0.208 ±0.003	0.208 ±0.005	0.208 ±0.005
Yolk width	24.88^{b} ±0.42	24.88^{b} ±0.56	24.54^{b} ±0.17	25.77^{ab} ±0.32	24.55^{b} ±0.62	25.66^{ab} ±0.66	26.55^{a} ±0.44	25.66^{ab} ±0.33
Yolk color	10.38^{a} ±0.16	9.88^{ab} ±0.26	9.44^{b} ±0.28	10.00^{ab} ±0.22	10.05^{ab} ±0.10	9.61^{b} ±0.13	9.72^{b} ±0.16	9.88^{ab} ±0.18
Yolk weight (g)	3.92 ±0.08	3.86 ±0.16	3.83 ±0.07	3.99 ±0.14	3.91 ±0.15	3.92 ±0.14	4.15 ±0.13	3.87 ±0.16
Yolk weight (%)	30.52 ±0.39	29.77 ±0.92	29.03 ±0.44	29.89 ±0.49	29.85 ±0.51	29.85 ±0.38	30.47 ±0.57	31.43 ±0.55
Albumin weight%	60.76 ±0.51	61.40 ±1.05	62.39 ±0.54	61.25 ±0.59	61.31 ±0.56	61.43 ±0.29	60.92 ±0.53	59.85 ±0.41
Shell weight%	8.71 ±0.21	8.81 ±0.32	8.57 ±0.19	8.85 ±0.16	8.83 ±0.14	8.70 ±0.20	8.59 ±0.22	8.70 ±0.23
Shape index	76.33 ±1.07	77.61 ±0.77	77.16 ±1.13	77.58 ±1.26	78.49 ±0.79	75.71 ±0.84	76.45 ±0.74	77.32 ±0.69

[a-b] Means in the same row with different letters, differ significantly ($P \leq 0.05$). Means ± standard error.

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الملخص العربى

تحسين الاستفادة من نخالة القمح في علائق السمان

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هذه التجربة اجريت في محطة الدواجن – العزب - الفيوم – مصر لدراسة تحسين الاستفادة من نخالة القمح في علائق السمان .

تم تقسيم ٦٤٠ طائر سمان عمر اسبوع على ٨ معاملات كل معاملة ٨٠ طائر باوزان متساوية تقريبا ، المعاملة الأولى غذيت على عليقة قياسية ٢٤,٠٣% بروتين خام و كذلك ٢٨٩٦ كيلو كالوري طاقة ممثلة / كجم علف. المعاملة الثانية غذيت على عليقة اساسية تحتوي على ٣٠% نخالة قمح و ٢٤% بروتين خام و ٢٣٦٠ كيلو كالوري طاقة ممثلة لكل كجم علف. المعاملات ٣،٤،٥،٦،٧ و كذلك ٨ غذيت على عليقة اساسية مضاف اليها على الترتيب ١% مستخلص الفجل ، ١% مستخلص الفجل + ٠,١% مستحضر افيزيم ، ١% كبريتات صوديوم + ١% مستخلص فجل ، ٠,١ % مستحضر افيزيم ، ١% كبريتات صوديوم ، ١% كبريتات صوديوم + ٠,١% مستحضر افيزيم .

- حسنت الاضافات الغذائية عند عمر٣ اسابيع من وزن الجسم و الى حد ما الكفاءة الغذائية ، ولا يوجد اي فروق معنوية بين معاملات التجربة عند عمر ٦ أسابيع .

- حسنت الاضافات الغذائية في فترة وضع البيض (٨ – ٢٠ اسبوع) الأداء الأنتاجى من حيث عدد البيض وكتلة البيض و الكفاءة الغذائية بالمقارنة بالطيور التي تناولت العليقة

الاساسية بدون اضافات.

- مخاليط الأضافات الغذائية خلاصة الفجل + المستحضر الانزيم افيزيم ، خلاصة الفجل + كبريتات الصوديوم او كبريتات الصوديوم + المستحضر الانزيم افيزيم حسنوا نسبة الفقس بالمقارنة بمعاملة العليقة القاعدية او الكنترول .

- عموما النتائج تشير الى امكانية استخدام خلاصة الفجل ، انزيم افيزيم او كبريتات الصوديوم متفردين أو في صورة مخاليط زوجية يؤدى لتحسين الاستفادة من العلائق المحتوية على ٣٠% نخالة قمح في علائق السمان سواء في مرحلة النمو أو مرحلة انتاج البيض .