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Incorporation of Wheat Bran in Broilers Diets

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Abstract: A total number of 360 day old male Ross broiler chicks were randomly assigned into eight experimental treatment groups (45 each) to study the effect of incorporated 30% wheat bran (WB) in broiler diets and the possibility to improve the feeding value of WB when supplemented with some feed additives. In Treatment 1 birds received control diet and birds in treatment 2 received the basal wheat bran diet (WB-diet). Birds of treatment 3,4,5,6,7 and 8 received the WB-diet supplemented with 0.01% Xylam (E), E +1% Radish extract (RE), 1% Tomato extract (TE), 1%TE +1%RE, 1% Sodium Sulphate (SS) and 1% SS +1% TE. Results showed that there were insignificant differences in weight gain (WG) and feed conversion (FC) between birds fed control diet and WB-diet in all growth periods. In the finisher period, there were insignificant differences among all treatments in WG and FC. The feed additives used failed to improve performance of WB-diet group under the conditions of this study. The WB-diet without or with additives significantly decreased abdominal fat % compared to the control diet. Addition of TE+RE to WB-diet improved the digestibility of all nutrients. WB-diet alone or with E significantly increased plasma antioxidant capacity while it decreased total plasma cholesterol compared to the control diet. The addition of TE alone or with RE to WB-diet significantly increased the level of plasma calcium. The WB-diet alone or with either E+RE or TE significantly increased globulin level in plasma compared to the control diet. It could be concluded that not only 30% WB can be incorporate into broiler diets without adverse effect on performance but also it have a beneficial effect on plasma antioxidant capacity, phosphorus and globulin.

Key words: Incorporated 30% wheat bran, broiler diets, plasma antioxidant capacity

Introduction

Corn is the main source of producing ethanol in some countries and is expected that corn prices will increase significantly. Poor people around the world will suffer as corn based products become more expensive. Higher grain costs can therefore result in greater competitiveness and potentially compensate for the negative effects of higher prices and lower consumption (Aho, 2007). 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.

Roberson *et al*. (2005) found that feeding wheat bran phytase yielded similar bird responses and litter soluble phosphorus as Natuphose when fed to commercial Toms. Zeisel *et al*. (2003) found that wheat bran contains a large amount of betaine (1505.6 mg/100 g). 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). Tome *et al*. (2004) found that wheat bran extract prevented lipid peroxidation more strongly than BHA solution. On the other hand wheat bran contains lower metabolizable energy than many 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). Shyama and Muralikrishna (2004) showed that phenolic acids, such as coumaric and ferulic acid in wheat bran *invitro* decreased by treatment by Horseradish extract (as a source of peroxidases enzyme). Pourreza and Classen (2001) found that addition of xylanase enzyme to broiler diet containing 25% wheat bran improved protein digestibility. Tomatoes (Lycopersicon esculentum) and tomato products are currently of renewed interest in both animal and human nutrition because they are excellent sources of natural antioxidants largely in the form of carotenoids, phenolic compounds, tocopherols and ascorbic acid. (Abushita *et al*., 1997 and Martinez-Valverde *et al*., 2002). Tomato plants are known to contain 13 peroxidase isozyme (Marangoni *et al*., 1989) Tomato fruits also contain 1, 4-Beta glucanase

Table 1: Composition and calculated analysis of control and basal diets (WB-diet)

	Control-Diet			WB-Diet		
Ingredients	starter	grower	finisher	starter	grower	finisher
Yellow corn	61.17	61.10	67.22	37.48	37.41	43.45
Soya bean 44%	23.94	21.68	16.21	17.78	15.56	10.17
Corn gluten 60%	10.00	10.00	10.00	10.00	10.00	10.00
Di-calcium Phosphate	1.98	1.74	1.65	1.62	1.34	1.25
Vit&Min*	0.3	0.3	0.30	0.30	0.30	0.3
Limestone	1.18	1.09	1.05	1.37	1.29	1.25
DL- methionine	0.11	0.14	0.09	0.09	0.12	0.07
L- lystine	0.55	0.54	0.47	0.61	0.59	0.52
Salt	0.37	0.37	0.37	0.35	0.35	0.35
Soya oil	0.40	3.04	2.64	0.40	3.04	2.64
Wheat bran	-	-	-	30.00	30.00	30.00
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis**						
CP%	22.020	21.030	19.000	22.030	21.050	19.04
ME Kcal/kg	3009.000	3178.000	3223.000	2470.000	2639.000	2684.00
Crude fiber%	3.350	3.190	2.930	5.650	5.490	5.24
Crude fat%	3.300	5.910	5.650	3.510	6.114	5.86
Calcium%	1.000	0.904	0.852	1.000	0.903	0.852
Available phosphorus%	0.500	0.451	0.426	0.500	0.450	0.425
Lysine%	1.380	1.310	1.110	1.380	1.310	1.110
Methionine%	0.550	0.570	0.490	0.520	0.540	0.470
Methionine + Cystine%	0.921	0.920	0.820	0.923	0.921	0.822
Sodium	0.160	0.161	0.160	0.161	0.161	0.162

*Premix contain per 3kg vit A 12 000 000, vit D_3 2 500 000 IU, vit E 10000 mg, Vit K_3 1000mg, vit B_1 2000mg, vit B_2 5000mg, vit B_6 2000mg, vit B_{12} 10mg, Pantothenic acid 10000mg, Niacin 30000mg, Biotin 50mg, Folic acid 1000mg, Choline 250gm, Selenium 100mg, Copper 4000mg, Iron 30000mg, Manganess 60000mg, Zinc 55000mg, Iodine 300mg, Cobalt 100mg and $CaCO_3$ to 3000g.
**According to Feed Composition Tables for animal and poultry feedstuffs used in Egypt (2001).

(Maclachlan and Brady, 1992). 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 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. Ali (2002) found with broiler diet contained 30% wheat bran that sodium sulphate, enzyme preparation, Radish extract (as a source of peroxidases 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 incorporate 30% wheat bran in broilers diets on broiler performance and the possibility of increase the utilization of these diets by enzyme preparation, enzyme preparation + Radish extract, Tomato extract, Tomato extract+ Radish extract, sodium sulphate and sodium sulphate + Tomato extract.

Materials and Methods

The present study was carried out at Poultry Research Station belonging to Environmental Studies and Research Institute, Minufiya University, Sadat City, Minufiya Governorate, Egypt. A total number of 360 day old male Ross broiler chicks obtained from El-Wadi Poultry Company were used in this study. Chicks were give a starter control diet (Table 1) for the first week of age and then chicks were wing banded individually weighed and randomly distributed into 8 treatments contained three replicates of 15 birds per replicate in floor brooders. The experimental diets were supplied with required nutrients to satisfy the Recommended Requirement of Ross broilers except metabolizable energy content of wheat bran diets (WB-diet). Anhydrous Sodium Sulphate was supplied by the Egyptian Salt and Mineral Company. Tomato fruits and roots of Radish were purchased from local market in Cairo. Radish extract (RE) and Tomato extract (TE) was prepared by cutting the root of Radish and fruits of Tomato into chips and put the chips into carrot press and juice was

Table 2: Effect of dietary treatments on weight gain(WG) and feed conversion. (FC) in different growth period.

	WG 7-14 day	FC7-14 day	WG 14-28day	FC 14-28 day
Control	300.8^{a}±7.32	0.72^{a}±0.06	684.6ab±9.02	1.57^{ab}±0.02
WB	231.06^{b}±3.71	0.72^{a}±0.01	704.3^{a}±14.44	1.46^{a}±0.03
WB+E	194.5^{c}±6.36	1.10^{bc}±0.04	694.00^{ab}±15.53	1.77^{bc}±0.08
WB+E+RE	234.03^{b}±6.28	0.99^{bc}±0.09	605.6^{c}±30.95	1.69^{abc}±0.03
WB+TE	244.9^{b}±0.10	0.95^{bc}±0.05	634.00^{bc}±5.50	1.66^{ab}±0.11
WB+TE+RE	231.56^{b}±7.58	1.15^{c}±0.07	605.6^{c}±24.57	1.91^{c}±0.13
WB+SS	222.3^{b}±13.69	0.89^{ab}±0.09	630.6^{bc}±33.23	1.61^{ab}±0.03
WB+SS+TE	225.0^{b}±1.52	0.95^{bc}±0.00	602.6^{c}±12.33	1.82^{bc}±0.05

Table 2: (continued)

	WG 28-45 day	FC 28-45 day	WG 7-45 day	FC 7-45 day
Control	934.6±12.8	2.33^{ab}±0.09	1920^{a}±21.03	2.01^{ab}±0.06
WB	932.3±39.38	2.25^{a}±0.13	1867^{ab}±28.41	1.94^{a}±0.03
WB+E	874.0±20.29	2.66^{abc}±0.09	1762^{bc}±18.37	2.32^{cde}±0.05
WB+E+RE	887.0±12.76	2.62^{abc}±0.09	1726^{bc}±46.5	2.35^{cde}±0.08
WB+TE	914.3±47.40	2.47^{ab}±0.12	1793^{abc}±52.33	2.23^{bc}±0.07
WB+TE+RE	912.3±50.4	2.73^{bc}±0.18	1749^{bc}±63.56	2.56^{e}±0.13
WB+SS	934.6±19.15	2.51^{ab}±0.13	1787^{abc}±63.68	2.27^{bcd}±0.10
WB+SS+TE	831±30.83	2.49^{c}±0.10	1659^{c}±40.42	2.51^{de}±0.04

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

collected into glass cups. The enzyme preparation Xylam produced by Nutrex company contained alfa-amylase 4000U/g and 1-4 beta xylanase 6300 U g^{-1}. Chicks were allotted on the following dietary treatments:

1. The control diet (Table 1)
2. WB-diet contained 30% wheat bran in starter, grower and finisher diets(Table 1)
3. WB-diet +100 g/tone Xylam (E)
4. WB-diet + E +1% Radish extract (RE)
5. WB-diet + 1% Tomato extract (TE)
6. WB-diet +1% TE +1% RE
7. WB-diet + 1% anhydrous sodium sulphate (SS)
8. WB-diet +1%SS+1%TE

At the end of the experiment period (45 days) three birds were taken randomly from each treatment and slaughtered to obtain the carcass and edible organs included heart, empty gizzard and liver. Carcass, edible organs and abdominal fat percentage was calculated on the basis of live body weigh. Individual blood samples were taken from birds within each treatment and collected into dry clean centrifuge tubes containing drops of heparin and centrifuged for 20 minutes (3000 rpm). The antioxidant capacity in plasma was determined using commercial kit produced by Biodiagnostic Company. Total cholesterol, phosphorus, calcium, total protein and albumin were determined using suitable commercial kits. Globulin concentration of each assayed sample was calculated by subtracting the albumin value from its total protein concentration .The digestibility coefficients of nutrients of the tested diets were determined at the end of experiment (45 days) using 3 birds from each treatment. Fecal nitrogen was determined by separating method of trichloro acetic acid according to Jakobsen *et al.* (1960). Proximate analysis was determined according to the official methods (A.O.A.C, 1980). The statistical analysis was computed using the general linear models (GLM) procedure and the significant differences among treatments means were separated by Duncan's Multiple Range Test, the procedure described in the SAS (SAS, 1990).

Results and Discussion

Production performance: As shown in Table 2, there were significant differences ($p<0.01$) in WG and FC within the experimental treatments at 14 days. It was surprising that addition enzyme preparation significantly decreased weight gain at 14 days compared to birds fed WB-diet alone. In this respect, Acamovic (2001) showed that endogenous losses can be altered by the presence of supplementary enzymes, as well as by other compounds such as tannins as a result of releasing the contents of the cells of dietary components by enzyme action. Mathlouthi *et al.* (2002) found with laying hens that no beneficial effect of xylanase addition to diet containing 10% WB compared to wheat or wheat-barley diets. However, McNab (1993) showed that for a variety of reasons, microbial feed enzymes may not give a consistent response .In the grower period, there were significant differences ($p \leq 0.01$) in WG and FC values recorded within the experimental treatments. The birds fed WB-alone recorded the highest value while the birds fed WB-diet +SS+TE recorded the lowest value. In the finisher period there were insignificant differences in WG within the different treatments while there were significant differences ($p \leq 0.05$) in FC values. In overall

Table 3: Effect of dietary treatments on carcass characteristics.

	Carcass %	Liver %	Heart %	Gizzard %	Total edible parts %	Abdominal fat %
Control	65.75±1.88	1.95±0.17	0.52±0.06	1.56±0.29	69.79±2.00	1.6^{a}±0.18
WB	64.07±1.01	2.30±0.15	0.28±0.07	2.32±0.21	68.90±0.46	0.94^{b}±0.15
WB+E	65.10±1.54	2.06±0.15	0.52±0.03	1.71±0.12	69.41±1.38	0.79^{bc}±0.19
WB+E+RE	66.58±1.78	1.96±0.13	0.49±0.008	1.71±0.11	70.75±1.96	0.40^{c}±0.07
WB+TE	65.28±0.28	1.91±0.18	0.36±0.07	1.62±0.14	69.19±0.38	0.44^{c}±0.004
WB+TE+RE	63.80±1.96	2.16±0.07	0.52±0.06	1.97±0.19	68.46±1.82	0.68^{bc}±0.05
WB+SS	61.30±0.65	2.10±0.14	0.56±0.10	1.85±0.13	65.82±1.02	0.40^{c}±0.08
WB+SS+TE	64.51±0.36	2.36±0.20	0.44±0.01	2.06±0.08	69.39±0.50	0.59^{bc}±0.09

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

period (7-49days), there were significant differences ($p \leq 0.05$) in WG values within experimental treatments. The birds fed control diets recorded the highest WG value while those fed WB+SS+TE diet recorded the lowest value. Also, significant differences were found in FC values in overall period. The improvement in FC recorded by birds fed WB-diet alone agree with results obtained by Farrell and Martin (1998) who found stimulatory effect of 300 g rice bran kg^{-1} on growth and FC of ducks and they can not explain that. These results disagree with those previously obtained in our lab. Ali (2002) who found with diets contained 30% wheat bran that sodium sulphate, enzyme preparation, Radish extract (as source of peroxidase enzyme) and enzyme preparation plus Radish extract succeeded in improving performance. The difference between results may be due to that the birds reared in this study under cold weather (15°C) while in experiments done by Ali (2002) were in moderate temperature. In this respect, Christopherson and Kennedy (1983) suggested that low temperature increased the rate of passage and reduces the retention time in the digestive tract. The feed additive used in this experiment may need more retention time to affect the fiber matrix and consequently failed to improve the performance of birds. Another reason for difference between our results (Ali, 2002) and our finding herein, is the presence of oil in this experiment. The oil my be accelerate the passage rate and consequently decreased the retention time needed for affecting fiber matrix while in other experiments were done by our lab (Ali, 2002; Abaza *et al.*, 2004, Ali *et al.*, 2006a and Ali *et al.*, 2006b) their diets were free oil. However, Odetallah *et al.* (2002) showed that the effects of dietary enzyme supplementation on performance, fat digestibility and ME content of the diets were much more pronounced in tallow than in containing soy oil. On the other hand, Tome *et al.* (2004) found that wheat bran extract prevented lipid peroxidation more strongly than that BHA solution. The wheat bran contain Ferulic acid which has a high antioxidant potential (Uchida *et al.*, 1996)

The cold temperature and higher metabolic rate of male Ross in this study may increase the demand of nature antioxidants presence in wheat bran. Both cold temperature and rapid growth increase the metabolic rate and produce a high oxygen requirement and thus an imbalance between the respiration system and the high oxygen requirement, leading to a state of systemic hypoxia (Julian, 1993 and Wideman and Kirby, 1995). The resulting systemic hypoxia triggers increased generation of reactive oxygen species (ROS) in mitochondria (Cawthon *et al.*, 2001). Also, inefficiencies associated with mitochondrial dysfunction could be hypothesized to have great impact on the growth performance and phenotypic expression of feed efficiency in animals (Iqbal *et al.*, 2005). From previous discussion we can explain the lower feed conversion recorded by birds fed WB-diet alone. In this respect, Iqbal *et al.* (2005) showed that protein oxidation from increased ROS production might be involved, in part, in the compromised function of mitochondria in low feed efficiency broilers. In previous work done by our lab with broiler (Ali, 2002) local laying hens (Abaza *et al.*, 2004) and quails (Ali *et al.*, 2006b) the feed additive succeeded in improving the performance of birds because its effect of fiber matrix (phenolic compound and other fiber components) and consequently improve the digestion coefficient and nutrients retention. In this experiment, the birds may need natural antioxidants presence in the wheat bran rather than its bad effect on digestive tract. We hypotheses that First, the phenolic compounds and other natural antioxidants presence in wheat bran decreased the performance of birds by its bad effect on digestive tract and other organs and consequently the degradation and detoxification of them by any way will enhance performance. Second, under some conditions, the birds may need these compounds to increase its power capacity of scavenge ROS rather than its bad effect on digestive tract and other organs. Further studies in this area should be conducted with these additives using higher levels of wheat bran such as 50 % in the broiler diets.

Table 4: Effect of dietary treatments on digestion coefficients and nitrogen retention of diets.

	Digestion coefficients %					
Dietary Treatment	CF	EE	CP	NR	NFE	OM
Control	50.61^{ab}±2.5	37.68^{b}±1.95	92.72±1.36	60.37±3.33	79.82±3.47	78.45±5.47
Diet WB	30.57^{b}±5.16	78.66^{a}±2.27	89.61±1.27	46.19±4.12	70.80±2.50	72.47±2.40
WB + E	4.87^{c}±0.42	65.13^{a}±0.15	88.63±0.74	42.69±1.28	72.57±0.90	71.62±0.45
WB + E + RE	33.60^{b}±3.55	72.91^{a}±5.15	92.90±1.43	58.44±3.64	76.20±4.46	76.80±4.13
WB + TE	49.35^{ab}±5.59	74.55^{a}±6.87	91.48±1.81	51.34±5.76	70.87±4.63	73.84±4.19
WB + TE + RE	60.58^{a}±6.5	81.94^{a}±6.09	94.95±1.50	61.05±7.36	77.60±6.19	80.34±6.89
WB + SS	34.48^{b}±2.44	76.86^{a}±2.79	91.81±0.49	44.75±4.20	69.62±2.84	72.47±1.98
WB + SS + TE	31.92^{b}±1.99	76.95^{a}±1.55	91.16±1.29	51.60±1.69	72.46±1.71	74.03±1.43

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

Carcass Characteristics: The date presented in Table 3 showed that there were insignificant differences between experimental treatments in different carcass characteristics except abdominal fat % ($P \leq 0.01$). All birds fed WB-diet alone or with additive recorded values significantly lower than those recorded by the control. The lower of abdominal fat% of WB-diet treatments compared to control diet may be explained as a result of lower metabolizable energy content of WB-diet compared to control diet. However, Ali (2002) found that WB-diet alone or with additives numerically decreased weight of abdominal fat percentage compared to control diet.

Digestion coefficients: The effect of treatments on the digestion coefficients and nitrogen retention of diets are shown in Table 4.There were significant differences ($p \leq 0.01$) in crude fiber digestion coefficient among the experimental treatments. It was surprise that birds fed WB-diet +E recorded the lowest value compared to other treatments. As we mention before that E may increase the endogenous losses and consequently decreases the fiber digestibility. In this respect, Acamovic (2001) showed that endogenous losses can be altered by the presence of supplementary enzymes, as well as by other compounds such as tannins as a result of releasing the contents of the cells of dietary components by enzyme action. The addition of RE to WB-diet + E increased fiber digestibility but without significant differences when compared to those fed WB-diet alone. These results disagree with those obtained previous by our lab. (Ali *et al.*, 2006a) who found that addition of RE to commercial enzyme significantly improved digestion coefficient of crude fiber. The birds fed WB-diet + TE recorded values numerically higher than those fed WB-diet alone and these result can be explained as the TE contain 1,4-Beta glucanase (Maclachlan and Brady 1992) and also peroxidase isozyme (Marangoni *et al.*, 1989). The birds fed WB-diet + TE +RE recorded values significantly higher than those fed WB-diet alone. The RE contain peroxidase enzyme which affect the phenolic compounds while TE contains 1,4 Beta glucanase and peroxidase. The mixture of TE and RE may have a synergetic effect on fiber matrix. There were significant differences in fat digestibility among experimental treatments. It was observed that birds fed control diet recorded the lowest value. The lower temperature during the experiment period may increase the rate of passage and decrease the fat digestibility in control diet. ddition of TE+RE numerical increase the fat digestibility compared to birds fed WB-diet alone. The addition of mixture of TE and RE to WB-diet improve numerically CP digestibility and nitrogen retention compared to birds fed WB-diet alone. However, Ali (2002) found the addition of SS or commercial enzyme plus RE to WB-diet significantly increased CP digestion coefficient. The same trend found was found with NFE and OM digestibility (Table 5). It was observed that birds fed WB-diet alone recorded lower values of digestion coefficients while recorded the best FC (Table 2). As we mention before, some feed additives used in this experiment affect the fiber matrix and consequently increase the digestion coefficient but the birds under some conditions need phenolic compounds to increase plasma antioxidant capacity rather than its bad effect on digestibility of nutrients. On the other hand, Iqpal *et al.* (2005) showed that protein oxidation from increased ROS production might be involved, in part, in the compromised function of mitochondria in low feed efficiency broilers. The birds fed WB-diet alone which have the highest value of plasma antioxidant capacity (Table 5) may be can protect its nutrients ingested from ROS and consequently FC will improve than other treatments which have higher digestion coefficients.

Plasma parameters: The effects of different experimental treatments on plasma parameters are shown in Table 5. There were significant differences ($p \leq 0.01$) in plasma antioxidant capacity values within the experimental treatments. The birds fed WB-diet alone

Table 5: Effect of dietary treatments on some plasma parameters.

	Antioxidant capacity mmol/L	Cholesterol mg/dl	Phosphorus mg/dl	Calcium mg/dl	Total protein g/dl	Albumin g/dl	Globulin g/dl
Control	0.481^{b}±0.01	106.9^{a}±3.89	5.07^{c}±0.48	57.30^{de}±2.59	4.16^{bc}±0.29	2.72^{a}±0.05	1.44^{bc}±0.25
WB	0.810^{a}±0.01	66.13^{b}±4.83	8.50^{a}±0.70	47.19^{de}±3.24	4.51^{ab} ±0.27	1.88^{c}±0.13	2.62a±0.18
WB+E	0.739^{a}±0.06	33.70^{c}±4.83	3.50^{d}±0.26	42.69^{e}±1.47	4.85^{ab}±0.19	2.75^{a}±0.10	2.10^{ab}±0.08
WB+E+RE	0.438^{b}±0.01	31.30^{c}±0.83	6.95^{b}±0.47	55.43^{de}±1.03	5.18^{a}±0.20	2.57^{ab}±0.24	2.61^{a}±0.36
WB+TE	0.438^{b}±0.01	69.98^{b}±2.59	3.66^{d}±0.23	67.41^{cd}±3.20	4.59^{ab}±0.23	2.16^{bc}±0.15	2.43^{a}±0.37
WB+TE+RE	0.440^{b}±0.01	70.51^{b}±2.29	3.10^{d}±0.16	79.02^{bc}±0.85	3.79^{cd}±0.14	2.56^{ab}±0.20	1.23^{c}±0.07
WB+SS	0.445^{b}±0.002	74.26^{b}±3.01	4.111^{cd}±0.409	88.76^{b}±1.88	2.58^{e}±0.10	1.72^{c}±0.008	0.86^{c}±0.10
WB+SS+TE	0.285^{c}±0.06	66.13^{b}±1.29	1.85^{e}±0.15	147.75^{a}±14.32	3.11^{de}±0.46	2.02^{bc}±0.28	1.19^{c}±0.01

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

recorded the highest value and this can be explained as a result of phenolic compounds and other natural antioxidant present in WB-diet. These results agree with Cao *et al.* (1998) who found with human that serum antioxidants capacity increased after the treatments of strawberries and spinach indicating the possible absorption of phenolic compounds in these diets. Also, Ali *et al.* (2007) found with laying hens that addition of thyme or anise increased plasma antioxidant capacity. All feed additives except E significantly decreased plasma antioxidant capacity compared to birds fed WB-diet alone. These results can be explained as the feed additives used in this experiment except E affect the phenolic compounds and consequently decreased the plasma antioxidant capacity. In this respect, Chism and Haard (1996) Showed that disruption of cell walls also releases the oxidative and hydrolytic enzyme that can destroy the antioxidants in fruits and vegetables. The addition of E to WB-diet did not alter the antioxidant capacity and this may be explained as the base that E contains amylase and xylanase and phenolic compounds are not target for those enzymes. In this respect, Yu *et al.* (2002) showed that trichoderma xylanase alone was unable to release *invitro* free ferulic and p-coumaric (phenolic compounds) acids from oat hulls. Addition of TE to WB-diet did not alter the antioxidant capacity. In this respect, Pellegrini *et al.* (2000) found with human that daily ingestion of 25 g tomato pure for 14 d significantly increased lycopene in plasma concentrations without significant changes in the antioxidant capacity of plasma. As we discussed before, under some conditions, the birds may needs the phenolic compounds to increase their power antioxidant capacity rather than its bad effect on digestive tract and other organs. There were significant differences ($p \leq 0.01$) in values of plasma total cholesterol among the experimental treatment groups. The birds fed WB-diet alone or with feed additive recorded values were found to be significantly lower than those fed the control diet. These results disagree with Weiss and Scott (1979) who found that inclusion of 50% WB in the laying hens diets did not affect plasma cholesterol. The addition of E alone or in combination with RE to WB-diet significantly decreased the plasma cholesterol level compared to birds fed WB-diet alone. These results agree with those obtained previously by our lab with laying hens (Ali *et al.*, 2006a) who found that the addition of enzyme preparation to WB-diet (50% wheat bran) significantly decreased cholesterol level compared to hens fed WB-diet. There were significant differences ($p \leq 0.01$) in plasma phosphorus among the different experimental treatments. The birds fed WB-diet alone recorded values higher than those recorded by birds fed the control diets. These results agree with those obtained by Ali *et al.* (2006a) who found that the hens fed WB-diet increased phosphorus serum by 60.38% compared to hens fed control diet. In this respect, Cavalcanti and Behnke (2004) showed that the WB can be utilized as a viable source of phytases. Juanpere *et al.* (2005) found that wheat-based diet had high values of total phosphorus retention indicating that this effect may be due to its endogenous phytase activity. The feed additives used in this study significantly decreased the level of plasma phosphorus compared to birds fed the control diet and we can not explain these results. There were significant differences ($p \leq 0.01$) in values of plasma calcium within different treatments. The incorporated wheat bran in broiler diets did not increase the level of plasma calcium. These results disagree with those obtained by Ali *et al.* (2006a) who found that hens fed 50% wheat bran significantly recorded higher serum calcium compared to hens fed control diet. The addition of SS or SS+TE to WB-diet significantly increased the level of plasma calcium. Also, significant differences were observed in total protein, albumin and globulin values within the different experimental groups. It was observed that birds fed WB-diet recorded the highest value of plasma globulin. The higher antioxidant capacity in this treatment may be the reason of its higher globulin level in plasma.

Conclusion: It could be concluded that not only 30% WB can be incorporate into broiler diets without adverse effect on performance but also it have a beneficial effect on plasma antioxidant capacity, phosphorus and globulin.

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