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THE USE OF RICE BRAN OR WHEAT BRAN IN DIETS OF BROILER CHICKS

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ABSTRACT

Three 4×2 factorial experiments were carried out to reevaluate the response of Hubbard broiler chicks to feeding on isocaloric (ME; 3100 kcal/kg) and isonitrogenous (about 19% CP) diets; containing graded levels [0.0 (control), 15, 20 or 25%] of each of cereal grain by-products (CGB), namely rice bran (RB) in experiment 1, wheat bran (WB) in experiment 2 or their combination (RWB) in experiment 3, with or without exogenous enzyme (EA) mixture [Phytase, 150 g/ton and Avizyme-1500 (xylanase, amylase and protease), 1.5 kg/ton], from 2 to 6 weeks of age. Criteria of response were the performance of chicks for body weight gain (BWG), feed intake (FI) and feed conversion (FC), economic efficiency (EEF), nutrients digestibility, some carcass traits, and certain blood plasma constituents (glucose, total protein, total lipids, cholesterol, Ca and inorganic P). The results obtained can be summarized as follows: Regardless of dietary EA, increasing dietary level of RB UP to 20 or 25% significantly increased FI and decreased FC; digestibilities of DM and OM also increased with the highest inclusion level of RB, whereas all other criteria were not affected. Feeding diets containing up to 25% WB, however, significantly improved EE digestibility but negatively affected EEF, all other measurements were not affected. On the other hand, feeding up to 20 or 25% of RWB-containing diets significantly depressed FC and EEF but had no effect on all other parameters. Dietary EA, independent of dietary type and level of CGB, significantly depressed EEF but had no effect on all other parameters. No significant CGB by EA interactions were observed for all criteria measured. Generally; from an economic point of view, it may be concluded that, rice bran, wheat bran or their combination can be incorporated into broilers' diets at an inclusion rate of 15%, with no detrimental effects on the performance of chicks for growth and feed conversion. Also, under the conditions of the present study, the dietary supplementation with the exogenous enzyme mixture was an undue extravagance and failed to elicit any effect on either performance of chicks or nutrients digestibility. Thus it can be recommended that, such enzyme preparations should be subjected to an *in vitro* laboratory test to make sure of its activity; prior to using it in the application field as a feed supplement.

Keywords: Cereal grain by-products, enzyme addition, performance, broiler chicks

INTRODUCTION

Because of the high cost of cereal grains as a major energy source of poultry diets, nutritionists, particularly in the developing countries, are continually looking for making use of the uncommonly feedstuffs. Cereal grain by-products such as rice bran and wheat bran are an example of such feedstuffs. In general, rice by-products (including broken rice, rice polishings, rice bran and rice hulls) differ from wheat by-products (including wheat bran, wheat shorts, wheat mill-run and wheat screenings) in that they are much higher in fat and somewhat lower in fiber contents (Leung *et al.*, 1972). It is interesting, however, to note that the use of rice bran (RB) and wheat bran (WB) as feed ingredients for poultry is not a new practice.

Internationally, two types of RB are produced: the major portion is in the form of raw or full-fat rice bran (FFRB) and minor amounts in the form of defatted rice bran (DFRB). Although DFRB contains a higher concentration of crude protein than FFRB (Houston, 1972), it also contains greater concentrations of the fibrous substances (neutral detergent fiber, acid detergent fiber and lignin), phytate P, and smaller concentrations of fat (Warren and Farrell, 1990a). In addition, the N-corrected metabolizable energy (ME_n) value of DFRB has been reported to be 75% of that of FFRB (Ravindran and Blair, 1991); however, DFRB gives the same performance as FFRB when equalized for ME (Farrell, 1994).

In regard to the nutritive value of RB, Kratzer *et al.* (1974) reported in an early study that growth of chicks was greatly depressed when its level of inclusion reached 60% of the diet. Recently, it has been reported that it is rich in B vitamins, fat and protein, and has a high content of fiber (Warren and Farrell, 1990a,b,c,d; and 1991). However, the nutritional potential of RB as a poultry feedstuff has not been adequately realized due to inconsistent chemical composition and rancidity problems associated with its lipid component (Ravindran and Blair, 1991; Farrell, 1994). They also reviewed that the major problem with RB for poultry is its variability in chemical composition and nutritive value, associated mainly to processing and storage conditions, cultivar and geographical region. In this regard, Farrell (1994) stated that its amino acid profile is generally superior to that of cereal grains. More recently, some studies have indicated that the performance of chickens is depressed with increasing the inclusion level of RB in their diets (Farrell, 1994; Madrigal *et al.,* 1995; Wang *et al.,* 1997; Farrell and Martin, 1998). However, WB is rich in fiber and crude protein (CP), and its amino acid profile is comparable to that of the whole grain, its high fiber and low ME contents account for its limited use in poultry nutrition (Larbier and Leclercq, 1994; Leeson and Summers, 1997).

In fact, both RB and WB are considered to be rich sources of P (Corley *et al.*, 1980) and Mn (Halpin and Baker, 1986). Unfortunately, much of the phosphorus in RB and WB exists in the phytate form (O'Dell *et al.,* 1972; De Boland *et al.,* 1975). Phytate-bound P is poorly utilized by single-stomached animals, due to insufficient phytase activity under normal dietary conditions (Nelson, 1967; Ravindran *et al.*, 1995; Selle *et al.,* 2000). On the other hand, it is generally accepted that the nutritive value of a feedstuff for poultry is indirectly related to its fiber content. Also, the presence of antinutritional substances, particularly phytic acid, is considered as an important complicating factor in that respect. In addition, the use of exogenous fiber-degrading enzymes and phytase in poultry diets has proved to be an effective means for improving the digestibility of nutrients and productive performance of the birds (Ferket, 1993; Bedford, 1996; Bedford and Morgan, 1996; Osei and Oduro, 2000). Therefore, the aim of the present study was to reevaluate the response of broiler chicks to diets containing different levels of rice bran, wheat bran or their combinations, in the presence or absence of a cocktail enzyme preparation. The response was measured as growth performance, economic efficiency, digestibility of nutrients, carcass characteristics and some blood constituents.

MATERIALS AND METHODS

The present experiments were conducted during January and February, 2002 at the Agricultural Experiments and Researches Station, Poultry Production Farm, Faculty of Agriculture, Mansoura University, Egypt.

Experimental birds and diets

A total number of 480, one-day old Hubbard broiler chicks were used, and fed on a common corn-soybean meal practical starter diet [contained about 22.5% CP and ME value of about 3100 kcal/kg] from day-old to 14 days of age. Then, birds were randomly distributed to 20 equal treatment-groups of four replications each (4×6 birds), and fed *ad libitum* on the experimental diets until 42 days of age. Ten experimental diets containing graded levels (0.0, 15, 20 or 25%) of rice bran (RB; Exp. 1), wheat bran (WB; Exp. 2) and their combinations (RB+WB, 1:1 wt/wt, designated as RWB; Exp. 3) were formulated. These diets were used without or with an enzyme addition (a mixture of two enzyme preparations; Phytase, 150 g/ton and Avizyme-1500, 1.5 kg/ton). Concerning the activities of the enzyme preparations, used herein, the manufacturer declared that the activity of microbial phytase is 5000 U/g of the product. Also, it was declared that each gram of Avizyme-1500 contains 800 IU xylanase, 2000 IU amylase and 6000 IU protease. The experimental diets were isocaloric (ME of about 3100 kcal/kg) and isonitrogenous (CP of about 19.4%); all other nutrients either met or slightly exceeded the requirements of broiler chicks, as specified by NRC (1994). Thus, the experimental design consisted of a factorial arrangement of treatments [4×2; 4 levels of each of cereal grain by-products (CGB) by two levels of enzyme addition (EA)]; but for the sake of simplicity, only two groups of chicks fed on diets containing no CGB (0.0%) with or without supplemental enzymes were purposefully served as controls (CON) for the other experimental chick groups which fed on diets containing the other levels (15, 20 or 25%) of CGB (RB, WB or RWB) in experiments 1, 2 and 3, respectively. The composition and chemical analyses of the experimental diets are given in Table 1. Criteria of response were performance of chicks, nutrients digestibility, carcass traits, and some blood constituents.

Growth performance of chicks

The growth performance of chicks during the grower-finisher periods, as affected by feeding the experimental diets, was evaluated as live body weight (LBW), body weight gain (BWG), feed intake (FI) and feed conversion (FC). BWG, FI and FC were determined on a replicate group basis. The economic efficiency of feeding (EEF) was also determined for the entire experimental period. EEF was calculated as net profit per kg gain times 100 divided by feed cost per kg gain. Net profit/kg gain was computed as price per kg gain (i.e. sale price per kg of live birds) minus feed cost per kg gain. Cost per kg diet (Table 1) and values of FC for the four replicate groups of each dietary treatment were used to calculate the feed cost per kg gain.

Table 1: Compositions and chemical analyses of the experimental diets****

Feed ingredients (%)	CON	RB (%; Exp. 1)			WB (%; Exp. 2)			RWB (%; Exp. 3)		
	0.0	15	20	25	15	20	25	15	20	25
Yellow corn	67.65	55.30	51.20	47.20	56.65	51.70	47.40	57.18	53.20	47.70
Soybean meal; 44%	21.30	17.00	15.80	14.20	8.00	5.50	2.00	10.00	7.50	7.10
Corn gluten meal; 60%	6.50	8.10	8.40	9.00	13.50	14.80	16.55	12.50	13.50	13.50
Rice bran; RB	0.00	15.00	20.00	25.00	0.00	0.00	0.00	7.50	10.00	12.50
Wheat bran; WB	0.00	0.00	0.00	0.00	15.00	20.00	25.00	7.50	10.00	12.50
Sunflower oil	1.25	1.30	1.30	1.30	3.40	4.50	5.50	1.82	2.30	3.20
Dicalcium phosphate	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Limestone	1.45	1.45	1.45	1.40	1.45	1.45	1.50	1.50	1.50	1.50
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vit. & Min. Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Lysine.HCl	0.15	0.15	0.15	0.20	0.30	0.35	0.35	0.30	0.30	0.30
Total	100	100	100	100	100	100	100	100	100	100
Cost/kg diet (-); P.T.	88.70	82.80	80.60	79.50	92.70	94.60	95.50	88.40	87.80	87.90
Cost/kg diet (+); P.T.	93.90	88.0	85.80	84.70	97.9	99.8	100.7	93.60	93.00	93.10
	Calculated analyses (NRC, 1994)									
ME; kcal/kg	3111	3112	3108	3112	3116	3116	3121	3114	3116	3116
Crude protein; %	19.33	19.32	19.27	19.30	19.42	19.55	19.51	19.51	19.41	19.48
Ether extract; %	4.15	5.69	6.18	6.68	6.40	7.48	8.48	5.59	6.32	7.41
Crude fiber; %	3.06	4.22	4.62	5.00	3.63	3.91	4.15	3.80	4.11	4.52
Calcium; %	0.87	0.86	0.86	0.84	0.85	0.85	0.86	0.87	0.87	0.87
Nonphytate P; %	0.31	0.32	0.32	0.33	0.30	0.30	0.30	0.31	0.31	0.31
Lysine; %	0.97	0.92	0.91	0.94	0.89	0.91	0.85	0.94	0.90	0.90
Methionine; %	0.35	0.36	0.37	0.37	0.39	0.39	0.40	0.39	0.39	0.39
Meth.+Cyst.; %	0.68	0.71	0.71	0.71	0.79	0.75	0.76	0.74	0.75	0.75
	Determined analyses on dry matter basis (AOAC, 1984)									
Dry matter; %	91.63	91.58	91.28	91.35	91.43	91.37	91.59	91.07	91.55	91.61
Organic matter; %	93.47	93.28	92.93	92.53	93.21	92.62	92.25	93.31	93.11	92.86
Ash; %	6.53	6.72	7.07	7.47	6.79	7.38	7.75	6.69	6.89	7.14
Crude protein; %	20 83	20.87	21.07	20.99	20.90	21.09	20.65	21.09	20.89	20.79
Ether extract; %	3.08	5.52	5.98	6.32	6.12	7.18	8.12	5.49	6.14	7.09
Crude fiber; %	3.46	4.67	4.94	5.32	4.09	4.35	4.59	4.15	4.52	4.85
N-free extract; %	66.10	62.22	60.94	59.90	62.10	60.00	58.89	62.58	61.56	60.13

***: Each 3 Kg of the product contains: Vit. A, 12,000,000 IU; Vit. D_3, 2,500,000 IU; Vit. E, 10 g; Vit. K, 2.5 g; Vit. B_6 1.5 g; Vit. B_{12}, 10 mg; Biotin, 50 mg; Folic acid, 1.0 g; Nicotinic acid, 30 mg; Pantothenic acid, 10 g; Antioxidant, 19 g; Mn, 60 g; Cu, 10 g; Zn, 55 g; Fe, 35 g; I, 1.0 g; Co, 250 mg and Se, 150 mg.**

****: All diets were fed without (-) and with (+) an enzyme preparation (Phytase, 150 g/ton and Avizyme-1500, 1.5 kg/ton).**

Digestibility trials

When the birds were 5 weeks of age, digestibility trials were set up in order to evaluate the digestion coefficients of nutrients in the experimental diets. Six birds per treatment, with an equal average body weight, were chosen and kept in a separate division of a growing battery, fitted with galvanized metal trays. Each experimental group of birds was fed its respective experimental diet for a two-day pretest adaptation period, followed by a three-day test period during which daily FI and total excreta voided were quantitatively determined. The proximate analyses for the experimental diets and dried excreta samples were carried out according to AOAC (1984). To estimate protein digestibility fractions of fecal and urinary N of the excreta were chemically separated according to the procedure described by Jakobsen *et al.* (1960). The percent of urinary organic matter was calculated by multiplying the percentage of urinary N by the factor 2.62 (Abou-Raya and Galal, 1971). Digestibility coefficients were calculated for dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen-free extract (NFE).

Carcass characteristics

At the end of each experiment (42 days of age), 6 chicks per treatment, with an approximately equal average body weight, were selected, individually weighed and immediately sacrificed. Immediately after feather picking, their carcasses were eviscerated and traditionally processed. Each carcass was immediately dissected into two parts; breast yield (including neck and wings) and thigh yield (including drumstick), according to the standard procedure. Procedures of cleaning out and cutting up the carcasses, and excising the abdominal fat were performed on a hot carcass basis. Abdominal fat (AF) weight (the adipose tissues surrounding the gizzard and bursa of Fabricius and those adjacent to the cloaca) was determined. Records on the individual weights of eviscerated carcass (EC), breast yield (BY), thigh yield (TY) and giblets (i.e. heart, liver without gall bladder and skinned empty gizzard) were also maintained. Carcass yield (CY) was calculated as EC plus giblets. All carcass traits were expressed as percent of live body weight at slaughter.

Blood constituents

Six blood samples per dietary treatment were taken during slaughtering (at 42 days of age) into heparinized test tubes. Subsequently, individual blood plasma samples were analyzed, using commercial kits, for glucose, total protein, total lipids, cholesterol, calcium and inorganic phosphorus, according to the methods of Trinder (1969), Doumas *et al.* (1981), Frings and Dunn (1970), Allain *et al.* (1974), Moorhead and Biggs (1974) and Goldenberg and Fernandez (1966), respectively.

Statistical analysis

A completely randomized design in a factorial arrangement of treatments, 4 levels of each of CGB (0.0, 15, 20 or 25%) with or without enzyme supplementation, was used. The statistical processing of data was performed using the Statgraphics Program (Statistical Graphics Corporation, 1991) based on a multifactor analysis of variance, with $P \leq 0.05$ considered to be significant. For each parameter, significant differences among means of the dietary treatments were separated by using LSD-multiple range test of Quattro Program (Borland International, Inc., 1990).

RESULTS AND DISCUSSION

It is interesting to note that cereal grain by-products (CGB) by enzyme addition (EA) interactions, observed herein, were not significant for all parameters studied. Therefore, only means of the main factors were tabulated and discussed

Growth performance of broiler chicks

Data on the performance of broiler chicks from 2 to 6 weeks of age in terms of initial LBW, BWG, FI and FC, as influenced by feeding graded levels of RB, WB or RWB with and without enzyme addition, are presented in Table 2.

Table 2: Effects of feeding graded levels of RB, WB or RWB with (+) and without (-) enzyme addition (EA) on growth performance and economic efficiency of feeding (EEF) of broilers, from 2 to 6 weeks of age

Treatments	IBW[1] (g)	BWG[2] (g)	FI[3] (g)	FC[4] (g:g)	EEF (%)
RB level	Rice bran (RB; Exp. 1)				
1 (0.0%)	395	1771	3863[c]	2.181[b]	138.8
2 (15%)	397	1738	4114[ab]	2.371[a]	135.0
3 (20%)	394	1712	4229a	2.471[a]	131.3
4 (25%)	397	1620	3986[bc]	2.465[a]	135.8
SEM[5]	6.08	39.1	79.0	0.037	3.81
Significance	NS	NS	*	**	NS
EA					
1 (-)	397	1697	4038	2.387	141.1[a]
2 (+)	395	1724	4058	2.357	129.4[b]
SEM[5]	4.30	27.6	55.8	0.026	2.69
Significance	NS	NS	NS	NS	**
WB level	Wheat bran (WB; Exp. 2)				
1 (0.0%)	395	1771	3863	2.181	138.8[a]
2 (15%)	395	1802	3967	2.205	126.5[b]
3 (20%)	402	1705	3778	2.216	121.4[b]
4 (25%)	399	1692	3780	2.234	117.2[b]
SEM[5]	6.12	32.8	82.3	0.034	3.40
Significance	NS	NS	NS	NS	**
EA					
1 (-)	396	1733	3859	2.227	130.2[a]
2 (+)	399	1752	3835	2.192	121.7[b]
SEM[5]	4.32	23.2	58.2	0.024	2.40
Significance	NS	NS	NS	NS	*
RWB level	RB+WB (RWB; Exp. 3)				
1 (0.0%)	395	1771	3863	2.181[b]	138.8[a]
2 (15%)	400	1777	3899	2.195[b]	138.8[a]
3 (20%)	399	1681	3901	2.324[a]	126.5[b]
4 (25%)	396	1740	4058	2.334[a]	125.1[b]
SEM[5]	6.59	31.4	74.2	0.030	3.47
Significance	NS	NS	NS	**	*
EA					
1 (-)	399	1737	3949	2.276	136.9[a]
2 (+)	399	1748	3911	2.241	127.7[b]
SEM[5]	4.66	22.2	52.5	0.021	2.45
Significance	NS	NS	NS	NS	*

[1-5]: Refer to initial body weight, body weight gain, feed intake, feed conversion and standard error of the means, respectively.

[a-c]: For each criterion, means in the same column having different superscripts differ significantly (P≤0.05); NS= not significant; *= significant at P≤0.05; **= significant ≤0.01.

EEF= 100 [Net profit/kg gain]/[Feed cost per kg gain].

In comparison with chicks fed the control diet, performance of chicks for FI, BWG and FC was not affected (P>0.05) by feeding diets containing up to 25% WB, with and without enzyme addition. A similar trend of response was observed in FI and BWG for broilers fed up to 25%-RWB diets, irrespective of dietary enzyme supplementation. However, a significant deterioration ($P<0.01$) in FC of broiler chicks was observed when the dietary level of RWB reached 20 or 25%, irrespective of enzyme addition to their diets.

Irrespective of dietary enzyme addition, feeding the broiler chicks on the 15 or 20%-RB diets resulted in significantly higher values of FI ($P<0.05$) and poorer values of FC ($P<0.01$) as compared to those of the control group; yet, BWG was not affected by dietary RB level. Even though, birds fed on the 25%-RB diets had slightly higher FI and slightly less BWG, in comparison with the control group, they achieved a significantly ($P<0.01$) poorer FC value. On the other hand, enzyme addition to the experimental diets (RB-, WB-, or RWB-containing diets) did not affect ($P>0.05$) FI, BWG or FC of chicks, regardless of the dietary type and level of CGB.

The observed increase in FI of broilers given the diets containing 15 or 20% RB was unexpected, mainly because the experimental diets, tested herein, were formulated to be isocaloric and isonitrogenous. Feed conversion is a correlation between growth and feed consumption. Since no significant differences were observed in growth of chicks fed RB-diets, as compared with the control (0.0% RB), thus their higher FI may account for their poorer feed conversion. In partial agreement with the present result, Zombade and Ichhponani (1983) found that broilers fed a 20% defatted rice bran (DRB)-diet consumed significantly more feed than those fed a corn-groundnut cake basal diet; but their diets were not formulated to be isocaloric.

The absence of significant differences in BWG of broilers fed the RB-diets in the present study agrees with the findings of Zombade and Ichhponani (1983), who observed no differences in weight gain between broilers, fed on a 20% DRB-diet, and those fed the control diet. Also, in partial agreement with the present result, Adrizal *et al.* (1996) found that dietary DRB up to 22.5% did not affect body weight and feed to gain ratio of broilers from 4 to 35 days of age. Similarly, Wang *et al.* (1997) demonstrated that dietary RB level up to 50% did not have any deleterious effects on growth and feed conversion efficiency of growing Leghorn chicks; while similar quantities of RB depressed the performance of broiler chicks when incorporated into their diets.

No clear interpretation could be offered for the negative impact of feeding RB-diets on FC of broilers in the present study. The low amino acid digestibility in rice pollard (a synonymous tern to rice bran in Australia) (Ravindran *et al.*, 1998) may have been partly responsible for the current depression in FC. According to the scientific literature, feed conversions are usually poorer with increasing dietary level of RB; however, the point at which FC is depressed varies from one experiment to another. For example, Warren and Farrell (1990b) found no change in FC when dietary inclusion level of RB reached 40% in some experiments while in others a poorer feed conversion was observed upon feeding RB at inclusion rate of 20% of the diet. A variety of factors contained in RB such as its contents of phytic acid, crude fiber, crude protein, ether extract and the degree of rancidity of its lipid fraction, and other factors may account for this effect (Farrell, 1994). He also reported that young chickens can tolerate up to 20% RB in their diets before the performance is affected. However, in the present study, the effect of dietary crude fiber level can be ruled out, since the crude fiber contents of the experimental diets were within the acceptable range and were too low to cause any deleterious effect on the performance of broilers. In general, the inconsistent responses of growing birds fed RB-diets may be attributed to differences in age and genotype of birds (Farrell and Martin, 1993; Wang *et al.*, 1997), and quality of rice bran used, which could be affected by the type of milling machine and the degree of adulteration with rice hulls (Farrell, 1994).

On the other hand, the reasons for the absence of response of broiler chicks to the dietary enzyme supplementation, under the conditions of this study, are unclear. However, phytic acid may be a causative factor for the depressed FC in broilers fed the RB- or RWB-containing diets, particularly if the activity of added phytase (involved in the enzyme preparation used) had been expired. It is possible that the added enzymes might be inactivated in one way or another, or had insufficient activities. In general, the lack of any effect of added enzymes in the present study agrees with the findings reported by Farrell and Martin (1998), using chickens and ducks. These investigators tested the efficacy of two enzymes targeting mainly the non-starch polysaccharides in RB and found that enzyme addition gave no response. Similarly, Aboosadi *et al.* (1996) found that the supplementation of broiler chicken diets, containing 30% RB, with cell wall degrading enzymes failed to elicit any response. In this respect, McNab (1993) stated that microbial feed enzymes may not give a consistent response due to a variety of reasons. These reasons relate to the rate of development of the digestive system of the bird, subtle changes in the composition of feed ingredients and conditions during feed processing, as well as the activity of feed enzyme.

Economic efficiency of feeding (EEF)

Data on EEF, determined as a net profit per kg gain relative to feed cost per the same unit of gain, of broiler chicks fed the experimental diets containing graded levels of RB, WB or RWB with and without EA, from 2 to 6 weeks of age are presented in Table 2. Apart from the dietary EA, EEF for the whole experimental period was significantly depressed ($P<0.01$) with increasing the dietary WB level up to 25%; the poorest EEF value (117.2%) was attained by broiler chicks fed on the 25%-WB diets and the highest one (138.8%) was obtained by the control birds (fed on 0.0%-CGB-diets). Also, there was a significant depression ($P<0.05$) in EEF of broilers fed on the diets containing 20 or 25% RWB compared with their control counterparts (fed on 0.0% CGB-diets); values of EEF were 138.8, 126.5 and 125.1% for broilers fed the 0.0, 20 and 25% of RWB-containing diets, respectively. Whereas, no significant differences ($P>0.05$) were observed in EEF for broilers fed on the RB-diets, regardless of dietary EA. Irrespective of type and level of dietary CGB, the exogenous enzyme supplementation produced significantly inferior values of EEF for broilers fed on RB-, WB- and RWB-containing diets compared with the corresponding values of EEF for birds.

Independently from the effects of dietary EA, the depressed EEF achieved by broilers fed on the WB-diets may be due mainly to higher values of feed costs per kg rather than to slightly poorer values of FC compared with their control counterparts. However, these two reasons may be responsible for the observed declines in the EEF attained by broilers fed the diets containing 20 or 25% RWB. On the other hand, because FI and BWG, and thus FC of broiler chicks were not affected by dietary EA, under the conditions of this study, the observed depressions in the EEF that occurred as a result of the addition of enzyme preparation in the experimental diets are mainly attributed to higher costs per kg diet, regardless of dietary type and level of CGB. In disagreement with the present results, Osei and Oduro (2000) found that addition of enzymes to WB-containing diets for broiler chicks reduced feed intake and improved feed conversion, and significantly decreased the feed cost per kg gain and thus EEF was improved.

Digestibility of nutrients of the experimental diets

The digestibility coefficients of nutrients in 5-week-old broilers as affected by feeding graded dietary levels of RB, WB or RWB with and without enzyme addition (EA) are shown in Table 3. Apart from EA, significant decreases ($P<0.05$) in the digestibility coefficients of DM and OM, and erratic significant differences ($P<0.05$) in NFE digestibility were observed with increasing the dietary inclusion level of RB up to 25%; whereas digestibility of the other nutrients (CP, EE and CF) were not affected. However, broilers fed on diets, containing up to 25% WB, exhibited significantly higher digestibilities for only EE ($P<0.01$) and NFE ($P<0.05$), compared with those obtained by their control counterparts, irrespective of dietary enzyme supplementation. With the exception of attaining a significant increase ($P<0.05$) in NFE digestibility by broilers fed the RWB-containing diets, those of DM, OM, CP, EE and CF were not affected by dietary RWB level. On the other hand, dietary EA had no significant effect ($P>0.05$) on nutrients digestibility of the experimental diets, regardless of dietary type and level of CGB.

It might be extrapolated that antinutritional factors [such as phytic acid, non-starch polysaccharides (NSPs) and trypsin inhibitors] known to be present in RB (Ravindran and Blair, 1991) were partially responsible for the observed decrease in DM and OM digestibilities by broiler chicks fed the highest level of RB. But, this approach may be questioned for two reasons. Firstly, Annison *et al.* (1995) found no effect of feeding RB-NSPs to broiler chicks on their growth, feed conversion or digestibilities of starch and protein; however, Kratzer and Payne (1977) concluded that trypsin inhibitors in RB were not the cause of depressed growth in chickens. Secondly, the enzyme addition, applied herein, failed to elicit any effect on nutrients digestibility and performance of chicks. This lack of effectiveness of supplemental enzymes; used in the present study, could be attributed to a reduced activity of this enzyme mixture, or probably its activity might have been inhibited; to some extent, due to the effect of an improper marketing. On the other hand, Purushothaman *et al.* (1990a) fed broiler chickens on diets containing up to 20% autoclaved deoiled RB, from one to 5 weeks of age, and found that percentages of utilization of nutrients and N, P and Ca balances were not affected by deoiled RB intake.

Table 3: Digestion coefficients of nutrients of the experimental diets for 5-week-old broiler chicks fed graded levels of RB, WB or RWB with (+) and without (-) enzyme addition (EA)

*Treatments	DM[1]	OM[2]	CP[3]	EE[4]	CF[5]	NFE[6]
RB level	Rice bran (RB; Exp. 1)					
1 (0.0%)	76.90[a]	79.91[a]	93.30	74.56	20.75	86.18[b]
2 (15%)	77.17[a]	80.63[a]	94.91	72.90	23.53	88.13[a]
3 (20%)	75.34[ab]	78.84[ab]	94.58	73.11	20.29	86.96[ab]
4 (25%)	73.77[b]	77.03[b]	93.82	72.38	18.98	85.46[b]
SEM[7]	0.77	0.65	0.53	0.61	1.99	0.56
Significance	*	*	NS	NS	NS	*
EA						
1 (-)	76.00	79.52	94.41	73.82	20.87	87.13
2 (+)	75.58	78.68	93.90	72.65	20.91	86.24
SEM[7]	0.54	0.46	0.37	0.75	1.41	0.40
Significance	NS	NS	NS	NS	NS	NS
WB level	Wheat bran (WB; Exp. 2)					
1 (0.0%)	76.90	79.91	93.30	74.56[bc]	20.75	86.18[b]
2 (15%)	78.02	81.48	94.21	74.34[c]	21.54	90.03[a]
3 (20%)	77.38	80.85	92.60	76.86[b]	24.29	89.92[a]
4 (25%)	77.79	81.54	93.96	80.49[a]	22.50	90.32[a]
SEM[7]	0.59	0.57	0.44	0.80	2.54	0.83
Significance	NS	NS	NS	**	NS	*
EA						
1 (-)	77.65	81.23	93.88	76.60	20.62	89.68
2 (+)	77.40	80.66	93.16	76.45	23.92	88.54
SEM[7]	0.42	0.40	0.31	0.56	1.79	0.58
Significance	NS	NS	NS	NS	NS	NS
RWB level	RB+WB (RWB; Exp. 3)					
1 (0.0%)	76.90	79.91	93.30	74.56	20.75	86.18[b]
2 (15%)	76.74	79.81	94.30	74.22	19.55	88.04[a]
3 (20%)	76.45	79.71	94.56	75.69	20.60	87.75[a]
4 (25%)	76.07	79.28	94.74	75.53	17.29	88.19[a]
SEM[7]	0.41	0.40	0.50	0.74	2.50	0.45
Significance	NS	NS	NS	NS	NS	*
EA						
1 (-)	76.62	79.89	94.30	75.32	19.84	87.67
2 (+)	76.46	79.47	94.11	74.68	19.25	87.40
SEM[7]	0.29	0.28	0.35	0.52	1.77	0.31
Significance	NS	NS	NS	NS	NS	NS

[1-7]: Refer to dry matter, organic matter, crude protein, ether extract, crude fiber, nitrogen free extract and standard error of the means, respectively.

[a-c]: For each criterion, means in the same column having different superscripts differ significantly (P≤0.05); NS= not significant; *= significant at P≤0.05; **= significant at P≤0.01.

The improvement in EE digestibility of the present WB-containing diets; in particular at the highest inclusion rate (25% of the diet), may be explained by a decreased rate of feed passage through the gastrointestinal tract of the bird and therefore, improving the digestion and absorption of nutrients. But this explanation may be invalid here mainly because no significant improvements were observed in the digestibilities of non-lipid components of these diets. The fatty acid composition of the dietary fat may also be involved as a contributing factor in that respect. More specifically, the increased ratio of unsaturated to saturated fatty acids, associated with increasing the added level of sunflower oil in these diets, may have been interacted synergistically in favor of fatty acid absorption, and thus enhanced fat digestibility (Dänicke, 2001). However, there was no definite interpretation for the higher digestibility of NFE, achieved by broilers fed on the WB-containing diets, compared with those of their control ones; it might be erroneously overestimated. The same approach may be applied to explain the observed improvement in NFE digestibility of the RWB-containing diets compared with the control ones.

In general, the failure of the enzyme addition to improve the digestibility coefficients of nutrients of the experimental diets may be attributed to a variety of factors, relating to the experimental birds, diets and/or the enzyme preparation used. In contradiction with the present result, ZiRong *et al.* (1999b) fed broilers on a 30% WB-containing diet with or without an enzyme preparation (xylanase, beta-glucanase and cellulase) and found that digestibilities of DM, CF and EE significantly increased in response to enzyme supplementation. They also found significant increases in the activities of trypsin, alpha-amylase and proteolytic enzyme in the duodenal contents of the experimental birds fed the enzyme-supplemented diet. But, the composition and nutrient contents of their experimental diets and type and activities of the added enzymes were different from that used in the present study. Also, Pourreza and Classen (2001) fed broilers during the starter period (0 to 21 days of age) on diets containing 25% WB and fortified with phytase and xylanase and found that crude protein digestibility and phytate P degradability increased significantly by added phytase while supplemental xylanase only improved crude protein digestibility. This response coincides with the viewpoint of Farrell and Martin (1993) that younger rather than older birds are more likely to benefit from the dietary supplementation with exogenous enzymes.

Carcass traits

Data in Table 4 summarize the effects of feeding graded levels of RB, WB or RWB with and without EA on carcass traits of 6-week-old broiler chicks. Apart from dietary EA, it was observed that broilers fed the RB-containing diets achieved significantly higher ($P<0.01$) percentages of giblets compared with those fed on the control diets; however, no significant differences ($P>0.05$) were observed among dietary treatments for all other carcass traits examined. Feeding either WB- or RWB-containing diets had no significant effect ($P>0.05$) on carcass characteristics, regardless of dietary EA. On the other hand, dietary EA had no significant effect ($P>0.05$) on carcass traits of the experimental chicks, regardless of dietary type and level of CGB.

The significant increase in giblets percentage, observed for broilers fed the RB-containing diets in the present study, may have been resulted from some enlargements in its components (*i.e.* liver, gizzard and heart) as a consequence of feeding these diets. In general, the present results agree with those reported by El-Full *et al.* (2000) who found no negative effect on percentages of carcass yield and abdominal fat when 50 to 100% of yellow corn in broiler diets was replaced by RB; but this substitution resulted in significantly higher percentages of liver and total giblets. Similarly, Das and Ghosh (2000) fed broilers on rations containing up to 20% of raw RB and found no adverse effect on carcass traits among dietary treatments. Also, Purushothaman *et al.* (1990a,b) fed the broiler chickens on isonitrogenous and isoenergetic diets that contained up to 20% deoiled RB and found that carcass yield was similar in all dietary groups. On the other hand, Osei and Oduro (2000) fed broiler chicks on 17%-WB-diets, supplemented with an enzyme preparation (composed mainly of xylanase and pentosanase) from 3 to 7 weeks of age, and found that carcass dressing percentage significantly increased in response to dietary enzyme addition.

Table 4: Carcass traits of 6-week-old broiler chicks fed graded levels of RB, WB or RWB with (+) and without (-) enzyme addition (EA)

Treatments	LBW[1] (g)	CY[2] (%)	BY[3] (%)	TY[4] (%)	Giblets (%)	AF[5] (%)
RB level	Rice bran (RB; Exp. 1)					
1 (0.0%)	2224	73.34	38.75	30.05	4.54^{b}	2.05
2 (15%)	2068	73.42	39.38	28.99	5.05^{a}	2.08
3 (20%)	2139	69.62	36.20	28.21	5.21^{a}	1.76
4 (25%)	2103	72.17	38.34	28.56	5.27^{a}	1.60
SEM[6]	50.4	1.65	1.42	0.47	0.14	0.17
Significance	NS	NS	NS	NS	**	NS
EA						
1 (-)	2113	71.00	37.03	28.85	5.11	1.81
2 (+)	2155	73.27	39.30	29.05	4.92	1.93
SEM[6]	35.7	1.17	1.01	0.33	0.10	0.12
Significance	NS	NS	NS	NS	NS	NS
WB level	Wheat bran (WB; Exp. 2)					
1 (0.0%)	2224	73.34	38.75	30.05	4.53	2.05
2 (15%)	2289	74.41	39.65	30.59	4.16	2.59
3 (20%)	2281	71.25	37.03	29.73	4.48	2.52
4 (25%)	2193	73.17	37.38	31.03	4.76	2.68
SEM[6]	48.9	0.70	0.72	0.34	0.24	0.20
Significance	NS	NS	NS	NS	NS	NS
EA						
1 (-)	2227	72.95	38.37	29.94	4.64	2.46
2 (+)	2265	73.14	38.03	30.76	4.33	2.46
SEM[6]	34.5	0.49	0.51	0.24	0.17	0.14
Significance	NS	NS	NS	NS	NS	NS
RWB level	RB+WB (RWB; Exp. 3)					
1 (0.0%)	2224	73.34	38.75	30.05	4.54	2.05
2 (15%)	2205	75.12	40.82	29.40	4.89	1.90
3 (20%)	2056	73.10	37.94	30.35	4.81	2.38
4 (25%)	2142	73.54	38.81	30.07	4.65	2.47
SEM[6]	50.4	0.73	0.84	0.38	0.12	0.20
Significance	NS	NS	NS	NS	NS	NS
EA						
1 (-)	2135	73.76	39.06	30.00	4.70	2.21
2 (+)	2179	73.78	39.10	29.94	4.74	2.20
SEM[6]	35.7	0.52	0.59	0.26	0.08	0.14
Significance	NS	NS	NS	NS	NS	NS

[1-6]: Refer to live body weight at slaughter, carcass yield, breast yield, thigh yield and abdominal fat and standard error of the means, respectively.

[a-b]: For each criterion, means in the same column having different superscripts differ significantly (P≤0.05); NS= not significant; **= significant at P≤0.01.

Blood constituents

Effects of feeding the current experimental diets on blood plasma constituents of 6-week-old broiler chicks are presented in Table 5.

Table 5: Blood plasma constituents of 6-week-old broiler chicks as affected by feeding graded levels of RB, WB or RWB with (+) and without (-) enzyme addition (EA)

Treatments	GL[1] mg/dL	TP[2] g/L	TL[3] g/dL	CH[4] mg/dL	Ca mg/dL	P mg/dL
RB level	Rice bran (RB; Exp. 1)					
1 (0.0%)	195	4.01	8.89	110	19.21	5.90
2 (15%)	206	4.08	7.87	111	17.59	6.15
3 (20%)	221	4.06	7.34	104	20.56	5.92
4 (25%)	198	4.14	7.63	106	16.63	6.07
SEM[5]	15 1	0.07	0.71	2.91	0.93	0.33
Significance	NS	NS	NS	NS	NS	NS
EA						
1 (-)	220	4.04	7.56	108	18.58	6.20
2 (+)	190	4.09	8.31	107	18.41	6.21
SEM[5]	10.8	0.05	0.50	2.38	0.65	0.23
Significance	NS	NS	NS	NS	NS	NS
WB level	Wheat bran (WB; Exp. 2)					
1 (0.0%)	195	4.01	8.89	110	19.21	5.90
2 (15%)	207	4.06	8.35	111	16.87	6.70
3 (20%)	221	4.12	7.96	108	15.89	6.21
4 (25%)	222	4.10	8.71	112	16.12	6.39
SEM[5]	12.9	0.06	0.47	2.18	0.67	0.40
Significance	NS	NS	NS	NS	NS	NS
EA						
1 (-)	212	4.06	8.69	109	17.16	6.52
2 (+)	211	4.06	8.26	112	16.89	6.49
SEM[5]	9.13	0.04	0.33	1.54	0.47	0.28
Significance	NS	NS	NS	NS	NS	NS
RWB level	RB+WB (RWB; Exp. 3)					
1 (0.0%)	195	4.01	8.89	110	19.21	5.90
2 (15%)	163	4.20	8.89	117	19.29	6.26
3 (20%)	183	4.10	9.12	116	17.42	5.99
4 (25%)	198	4.04	8.97	116	17.88	5.83
SEM[5]	12.1	0.06	0.76	0.08	0.78	0.38
Significance	NS	NS	NS	NS	NS	NS
EA						
1 (-)	193	4.10	9.02	114	18.12	5.85
2 (+)	177	4 00	8.90	115	18.79	6.13
SEM[5]	8.61	0.05	0 54	5.61	0.55	0.26
Significance	NS	NS	NS	NS	NS	NS

[1-5]: Refer to plasma glucose, total protein, total lipids, cholesterol and standard error of the means, respectively; NS= not significant.

Concentrations of plasma glucose, total protein, total lipids, total cholesterol, calcium and inorganic phosphorus were not significantly (P>0.05) affected by the dietary treatments. The insignificant differences among the dietary treatments for all blood constituents, measured herein, may reflect normal metabolic processes and functions of organs and tissues. In agreement with the present result, Sherif (2003) observed no changes in the levels of blood

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استخدام رجيع الأرز أو نخالة القمح في علائق كتاكيت اللحم

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أجريت ثلاثة تجارب عاملية (٤×٢) لإعادة تقييم استجابة كتاكيت اللحم (هبرد) للتغذية على علائق متماثلة في محتوياتها من الطاقة الممثلة (حوالي ٣١٠٠كيلوكالوري/كجم) والبروتين الخام (حوالي ١٩%) وذات محتويات مختلفة [صفر(كنترول) أو ١٥او ٢٠او ٢٥%] من رجيع الأرز(تجربة ١) أو نخالة القمح (تجربة ٢) أو مخلوطهما (تجربة ٣) مع عدم إضافة أو بإضافة مستحضر إنزيمي (مكون من إنزيم الفيتيز بمعدل ١٥٠جم/طن+أفيزايم-١٥٠٠بمعدل ١,٥كجم/طن) من عمر ٢الى٦أسابيع. واشتملت معايير الاستجابة للكتاكيت على الزيادة في وزن الجسم واستهلاك العلف ومعامل التحويل الغذائي والكفاءة الاقتصادية للتغذية ومعاملات الهضم للعناصر الغذائية وبعض صفات الذبيحة و بعض مكونات بلازما الدم (الجلوكوز-البروتين الكلي-الدهون الكلية-الكوليستيرول-الكالسيوم-الفسفور غير العضوي).

ويمكن تلخيص النتائج المتحصل عليها للفترة التجريبية الكلية فيما يلي: بصرف النظر عن تأثير الاضافة الإنزيمية للغذاء، نتج عن زيادة مستوي رجيع الأرز في العليقة إلي٢٠او٢٥% زيادة معنوية في استهلاك العلف بينما تدهور معامل التحويل الغذائي ولم تتأثر باقي القياسات. كما نتج عن التغذية على المستوى ٢٥% من نخالة القمح تحسنا معنويا في معاملات هضم المستخلص الإيثيري للغذاء بينما تدهورت الكفاءة الاقتصادية ولم تتأثر باقي القياسات. كما نتج عن زيادة مستوي مزيج رجيع الأرز+نخالة القمح في العليقة إلي ٢٠او٢٥% تدهورا معنويا في كل من معامل التحويل الغذائي والكفاءة الاقتصادية للتغذية ولم تتأثر باقي القياسات. إذا ما صرف النظر عن مستوى ونوع الناتج الثانوي للحبوب النجيلية في الغذاء كان للإضافة الإنزيمية أثرا سلبيا على الكفاءة الاقتصادية للتغذية ولم تتأثر باقي القياسات. كان تأثير التداخل غير معنوي بين مستوى ونوع الناتج الثانوي للحبوب النجيلية في الغذاء وبين الإضافة الإنزيمية بالنسبة إلى كل الصفات المدروسة.

وعموما فانه من الناحية الاقتصادية يمكن استنتاج أن كل من رجيع الأرز أو نخالة القمح أو مخلوطهما يمكن إدخالها في علائق كتاكيت اللحم بمستوى ١٥% دون حدوث تأثيرات ضارة على النمو ومعامل التحويل الغذائي. كما أن إضافة الإنزيمات إلى العلائق -تحت ظروف هذه الدراسة- كان إسرافا غير ضروريا ولم يحدث أي تأثير على المظاهر الإنتاجية للكتاكيت أومعاملات الهضم للعناصر الغذائية. وبناءا عليه يمكن التوصية بان تلك المستحضرات الإنزيمية يجب أن يتم اختبار فعاليتها معمليا قبل تدعيم أعلاف الطيور بها.