EVALUATION OF HIGH LEVELS OF RADICEL WITH OR WITHOUT ENZYMES IN BROILER DIETS

By

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Abstract: *The main target of this study was to evaluate the effect of high levels of radicel, as a non-conventional feedstuff, with or without enzymes on broiler performance. In this study, two levels of radicel (15 and 20% of the diet) in addition to the control diet (without radicel) were used. Each level of radicel was fed either without enzyme, with a commercial enzyme mixture E1, Kemzyme (at 1 g/kg diet) or a commercial enzyme mixture E2, Prismazym Veg (at 2 g/kg diet). Accordingly, a total of 7 experimental diets (2 levels of radicel x 3 treatments), in addition to the control (without radicel) were used. A total number of 210 unsexed one day old Ross broiler chicks were distributed randomly and divided equally into seven experimental groups nearly equal in average live weight. Each group was represented by 30 birds in three replicate pens of 10 chicks each and kept under similar management conditions. All diets were formulated to be isocaloric and isonitrogenous in each of the experimental stages according to the strain catalog recommendation. Radicel (malt sprouts) is a by-product of barley germination, left after removing barley malt.*

The results of this study showed that radicel contained moderate amounts of major nutrients, especially CP (20.14%) and NFE (54.24%), but it contained high level of CF (14.21%) and 24.84% ADF (cellulose + lignin). It is rich in (ppm): 7250 Na, 4900 total P, 4125 K, 3000 Fe, 2050 Mg, 425 Cu, 120 Zn and 30 Mn. In comparison to the NRC (1994) requirements of the chicks, arginine and methionine were the first limiting amino acids (0.76), while isoleucine (0.80) and phenylalanine (0.83) were the second and third limiting amino acids, respectively. Radicel at 15% without enzyme supplementation gave better performance than that with enzyme supplementation but still less than the control. Radicel at 15% with or without enzymes did not decrease carcass percentage or digestion coefficient values of the nutrients as compared with the control. While, 20% radicel without enzyme decreased both of them. From economic point of view, 15% radicel without enzyme supplementation gave best economic efficiency and relative economic efficiency, followed by 20% radicel + E1

as compared with the control. However, E2 was not as effective as E1 under the condition of this experiment.

INTRODUCTION

Due to the high price and limiting local production of soybean meal and corn in Egypt, the main components of poultry diets, efforts to find alternative local and cheaper sources of poultry feeds should be continued. Several by-products are produced during the processes of beer production. These by-products reported to have a reasonable nutritive value as a feedstuff for animals and poultry**.** There are several waste products generated from the malting and brewing process. From the malting, the malt culms or malt sprouts or radicel, as commercially called in Egypt, are produced after screening off the shoots and rootlets. From the brewing, the spent grains of barley, spent hops and brewing yeast are generated (**El-Boushy, 1994)**.

El-Ghamry *et al* (1999), Abdel-Malak *et al.* (2001), Hashish and Abd El-Samee (2002) and **Abdel-Azeem and Hamid (2006)** indicated that radicel could be used in feeding rabbits, broilers and laying hens to reduce their feeding cost. **Annison and Choct (1991)** revealed that soluble nonstarch polysaccharides (NSP) present in viscous grains increase digesta viscosity, which interferes with the activity of intestinal enzymes in the gastrointestinal tract. As a consequence, feeding barley increases the incidence of sticky droppings, reduces the extent of digestion and absorption of nutrients, and impairs broiler performance. The importance of adding enzymes to the diets containing barley or barley by-products was supported by **Abdel-Malak *et al.* (2001)** who reported that radicel diets supplemented with kemzyme revealed some improvement in chick performance for each radicel level (10, 14, 18% of the diets). **Gracia *et al.* (2003)** found that broiler performance, apparent retention of nutrients and AMEn of the diet were improved by enzyme supplementation of the diet containing barley throughout the trial. Enzymes reduce viscosity and improve nutrient digestibility and feed intake **(Lazaro *et al*., 2003a, b)**.

The objective of the current work was to evaluate the effect of high levels of radicel, as a non-conventional feedstuff, with or without enzyme supplementation on broiler performance.

MATERIALS AND METHOODS

The present study was performed at El–Kanater El–Khairia poultry research station, Animal Production Research Institute. The chemical analysis was conducted at laboratories of Animal Production Research

Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt. The main target of this study was to evaluate the effect of feeding high levels of radicel, as a non-conventional feedstuff, with or without enzymes on broiler performance. In this study, two levels of radicel (15 and 20% of the diet) in addition to the control diet (without radicel) were used. Each level of radicel was fed either without enzyme, with a commercial enzyme mixture E1, Kemzyme (at 1 g/kg diet) or a commercial enzyme mixture E2, Prismazym Veg (at 2 g/kg diet). Accordingly, a total of 7 experimental diets (2 levels of radicel x 3 treatments), in addition to the control (without radicel) were used. A total number of 210 unsexed one day old Ross broiler chicks were distributed randomly and divided equally into seven experimental groups nearly equal in average live weight. Each group was represented by 30 birds in three replicate pens of 10 chicks each and kept under similar management conditions. Artificial light was used beside the normal day light to provide 24-hour / day photoperiod. Feed and water were provided *ad libitum.*

All diets (Table 1) were formulated to be isocaloric and isonitrogenous in each of the experimental stages. The diet contained 23% CP and 3100 kcal ME /Kg during the first stage (0-10 days of age), 21% CP and 3200 kcal ME /Kg during the second stage (10-28 days of age) and 19% CP and 3270 kcal ME /Kg during the third stage (28-42 days of age). All diets were formulated to at least meet the nutrient requirements according to the strain catalog recommendation (Table 2). Radicel was obtained from Al-Ahram Manufacturing and Filling Beverage Company, Tharwat St., Bin El-Saraiat, Giza, Egypt in air dried form. Radicel (malt sprouts) is a by-product of barley germination, left after removing barley malt.

Kemzyme (E1) and Prismazym Veg (E2) are commercial products, purchased from local market and added at the level recommended by the manufacturer. Each gram of the enzyme mixture (kemzyme) contained 540 units α-amylase, 3000 units beta-glucanase, 450 units protease and 5000 units cellulase. While, each kg of Prismazym Veg contained 375000 FYT phytase and 7500 FBG beta-glucanase.

Feed consumption and body weight of the birds were measured, while, body weight gain, feed conversion ratio (g feed / g gain), and economic efficiency were calculated. European Production Efficiency Index, EPEI (Hubbard broiler management guide, 1999), was calculated as follows:

European Production Efficiency Index =

$$\frac{\text{Live body weight (kg) x Livability (100-\%mortality)}}{\text{Production period (days) x Feed conversion ratio}} \times 100$$

The digestibility coefficients of nutrients of the experimental diets were evaluated using 3 male birds from each treatment at the end of the experimental period (at 6 weeks of age). Faecal nitrogen was determined according to the method outlined by **Jakobsen *et al.* (1960)**, while the urinary organic matter fraction was calculated according to **Abou-Raya and Galal (1971)**. The proximate analyses of radicel, feed and dried excreta samples were carried out according to the official methods **(AOAC, 1990)**. Amino acids were determined in radicel sample according to **(OJEC, 19-9-98)** in the Central Laboratory for Food & Feed (CLFF)**,** Agricultural Research Center, Ministry of Agriculture, Giza, Egypt. Its mineral contents were determined in analytical laboratory of General Organization Agriculture Equalization Fund (GOAEF), where (Mn, Mg, Zn, Cu, Fe, Ca) were determined using Atomic Absorption (GBC 932/933) Operation manual with AAS software for windows 95, (Na and K) were determined using Flame Photometer Jenway (PFP7) and (P) was determined using Spectronic 21D. Three male birds were chosen randomly from each treatment, at the end of the experiment, for slaughter test, and carcass weights were determined and presented as a percentage of live body weight.

Data from all the response variables were subjected to factorial and one way analysis of variance **(SAS, 2000)**. Variables having a significant F-test ($P \leq 0.05$) were compared using Duncan's Multiple Range Test **(Duncan, 1955)**.

Factorial analysis Model:

$X_{ijk} = \mu + T_i + F_j + (TF)_{ij} + e_{ijk}$

Where: X_{ijk} = any observation.

μ = Overall mean.

T_i = Radicel level (i=1and 2).

F_j = Enzyme (j=1, 2 and 3).

$(TF)_{ij}$= Interaction between radicel level and enzyme supplementation

e_{ijk} = Experimental error

One way analysis model:

$X_{ij} = \mu + T_i + e_{ij}$

Where: X_{ij} = any observation.

μ = Overall mean.

T_i = Treatments (i=1, 2,…and 7).

e_{ij} = Experimental error

RESULTS AND DISCUSSION

Chemical Composition of Barley Radicel:

The chemical analysis of radicel (Table 3) revealed that it contains moderate amounts of major nutrients, especially CP and NFE, but it contains high level of CF and ADF (cellulose + lignin). It contained, on air dry basis (as fed), 20.14% CP, 54.24% NFE, 14.21% CF and 24.84% ADF. It is rich in most of the minerals (ppm): 7250 Na, 4900 total P, 4125 K, 3000 Fe, 2050 Mg, 425 Cu, 120 Zn and 30 Mn. Radicel was analysed first for the nutrients shown in Table 2 to be used in feed formulation, the other components were analyzed later for the discussion. The diets sodium content, when radicel sodium was included, ranged between 0.13-0.27% (Table 1), which was within the accepted range (0.07-0.35%) for broilers (documentation of nutrient requirements of starting and growing market broilers) as indicated in the **NRC (1994).**

Table 4 illustrated that radicel, in comparison to the **NRC (1994)** requirements of the chicks was deficient in most essential amino acids, except valine, histidine and leucine. Arginine and methionine were the first limiting amino acids (0.76), while isolucine (0.80) and phenylalanine (0.83) were the second and third limiting amino acids, respectively.

The values of this study were in the range found by **Abdel-Malak *et al.* (2001), Hashish and Abd El-Samee (2002)** and **Osman e*t al.* (2002).** The values were (20.14 vs. 21.98-31.00%), (2.81 vs. 2.10-6.37%), (5.20 vs. 5.72-8.00%), (14.21 vs. 12.91-16.65%) for CP, EE, ash and CF, respectively. While, NFE value was higher (54.24 vs. 33.00-47.90%).

The values of essential amino acids (%) were in the range found by **Abdel-Malak *et al.* (2001) and Hashish and Abd El-Samee (2002)** regarding arginine, leucine, lysine, methionine and valine. The values were (0.95 vs. 0.90-1.07%), (1.21 vs. 1.09-1.25%), (1.07 vs. 1.00-1.12%), (0.38 vs. 0.36-0.37%) and (1.04 vs. 1.00-1.19%), respectively. While, histidine, isoleucine, phenylalanine and threonine values of this study were lower (0.39 vs. 0.42-0.47%), (0.64 vs. 0.78-0.87%), (0.60 vs. 0.80-0.87%) and (0.72 vs. 0.89-0.98%), respectively.

Growth Performance:

Tables 5 and 6 show the effect of the different treatments on body weight (BW), body weight gain (BWG), feed intake (FI), feed conversion (FC) and European Production Efficiency Index (EPEI) during the different stages of the experimental period. Initial body weights (IBW) were almost the same and ranged between 44-45 g. Also the Tables show the effect of the two factors included in this study, the radicel level, irrespective to the enzyme supplementation and the effect of enzyme supplementation, irrespective to the radicel level, when the control diet (without radicel) was excluded.

Table 5 showed that the two factors included, radicel level and enzyme supplementation had no significant ($P \leq 0.05$) effect on both BW and BWG. When the control diet (without radicel) was included in the comparison, both BW and BWG values were decreased significantly ($P \leq 0.05$) due to radicel levels either with or without enzyme supplementation, except during the first 10 days, where the differences were not significant. Feed intake was decreased, in general, with increasing radicel level from 15 to 20% during the total experimental period, while there was no significant difference between the FC values. The EPEI values were close (194.96 and 199.55 for 15 and 20% radicel, respectively). Enzyme mixture E2 decreased feed intake as compared with No E or E1 during the experimental periods, while there was no significant difference between the FC values. EPEI values were decreased due to enzyme supplementation as compared with No E group (210.04 vs. 196.89 and 184.85 for No E, E1 and E2, respectively). When the control diet (without radicel) was included in the comparison FI values were decreased significantly ($P \leq 0.05$) due to radicel levels during the experimental periods either with or without enzyme supplementation. The best FC values, during the total experimental period (0-42 days) were for the 15% radicel without enzyme followed by the control without radicel and 20% radicel + E1 (Table 6). The values were 1.76, 1.78 and 1.80, respectively. The values of feed conversion during 10-28 days for radicel diets were higher than those during either 0-10 or 28-42 days of age. This may be due to increasing the feed intake in relation to the body weight gain during this period as compared to the control (without radicel), while it was decreased during 0-10 and 28-42 days of age. The best EPEI value (276.48) was for the control (without radicel), followed by 15% radicel (228.56) and 20% radicel + E1 (215.61). It could be concluded that the contents of E1 were more suitable than those of E2 when the diet contained radicel especially at 20% and that

15% radicel without enzyme supplementation gave better performance than that with enzyme supplementation but still less than the control.

The negative effect of 20% radicel, without enzymes, on growth performance was associated with higher CF and ADF percentages (Table 1) as compared with the other diets. Also, several cases of unhygienic sticky droppings adhering to chickens and floors of the production cages were observed, especially with 20% radicel without enzymes. **Annison and Choct (1991)** revealed that soluble nonstarch polysaccharides (NSP) present in viscous grains increase digesta viscosity, which interferes with the activity of intestinal enzymes in the gastrointestinal tract. As a consequence, feeding barley increases the incidence of sticky droppings. The results were supported by **Zaczek *et al.* (2003)** who reported that increasing the concentration of fiber had a negative effect on body weight. **Abdel-Azeem (2005)** found that the worst feed conversion ratio for hens was observed when dietary crude fiber was increased. The positive effect of E1 supplementation to 20% radicel diet was supported by **Gracia *et al.* (2003)** who found that broiler performance was improved by enzyme supplementation of the diet containing barley throughout the trial. Enzymes reduce viscosity and improve nutrient digestibility and feed intake **(Lazaro *et al*., 2003a, b)**.

The better effect of 15% radicel than 20% was supported by **Abdel-Malak *et al.* (2001**) who showed that 14% radicel in broiler diets without or with Kemzyme resulted in better performance and economic efficiency than 10 or 18% radicel. **Abdel-Azeem and Hamid (2006)** reported that there were no significant differences in final BW and BWG between groups of broilers fed diet containing 8% or 16% barley radicel as compared with the control, while 24% radicel decreased the performance.

Carcass Characteristics

Table 7 showed that radicel level had no significant effect on the carcass characteristics and immune organs (spleen, bursa and thymus), except gizzard value which was higher for 15% radicel than 20%. Enzyme supplementation had no significant effect, except on carcass%, where E2 gave higher value than No E or E1. When the control diet (without radicel) was included in the comparison, only carcass and liver were affected significantly. The least value of the carcass (68.5%) was for 20% radicel, while the highest value (72.63%) was for 20% radicel + E2. The highest liver value (3.19%) was for 20% radicel + E1, while the least value (2.21%) was for the control (without radicel). It could be concluded that up to 15% radicel did not decrease carcass percentage as compared with the control.

While, 20% radicel without enzyme decreased carcass percentage. The results of carcass characteristics**,** especially the low abdominal fat pad (AFP) and gizzard for 20% radicel as compred with 15% was supported by **Abdel-Azeem and Hamid (2006)** who found no significant differences in carcass %, but abdominal fat and gizzard fat were decreased with increasing radicel level in broiler diets (0, 8, 16, 24%). Also, **Abdel-Malak *et al.* (2001**) found no significant differences in carcass characteristics of the broilers fed diets containing 0, 10, 14 or 18% radicel.

Nutrients Utilization

Radicel level had no significant effect on nutrients utilization**,** however the values were higher for 15% than 20% (Table 8). Enzyme supplementation had significant effect only on CF where the highest value (37.5%) was for E1. In general, E1 resulted in the best digestion coefficient values for all the nutrients followed by E2 when compared with No E. When the control diet (without radicel) was included in the comparison, there was a significant ($P \leq 0.05$) effect on OM, CF and NFE. Up to 15% radicel with or without enzymes did not decrease the digestion coefficient values of OM, CF and NFE. While, 20% radicel without enzyme resulted in the least values in general.

The reduction in digestibility coefficients of most of the nutrients for the birds fed the diets containing 20% radicel without enzymes could be due to the high CF and ADF, as indicated by **Sarmiento and Belmar (1998) and Frombling (2000)** who found that increasing percentage of dietary fiber had a negative effect on the apparent retention of DM and OM. **Hammad and Abd El-Maksoud (2005)** found that increasing dietary crude fiber to the level of 5, 7, 9% significantly ($P<0.05$) decreased OM digestibility by 8.81, 11.6, and 16.70%, respectively. The results showed the efficacy of enzyme supplementation containing α-amylase, beta-glucanase, protease and cellulase than those containing only phytase and beta-glucanase when the diets contained high level of radicel. The importance of enzyme supplementation was supported by **Gracia *et al.* (2003)** who revealed that broiler performance and apparent retention of nutrients of the diet were improved by enzyme supplementation of the diet containing barley throughout the trial. **Abdel-Azeem and Hamid (2006)** fed broilers on diets containing 0, 8, 16 or 24% radicel, they found that the highest digestibility coefficients of most of the nutrients were for the diets containing less than 16% radicel.

Economic Efficiency

Table 9 showed that 20% radicel gave better economic efficiency and relative economic efficiency than 15%. No E gave better economic efficiency and relative economic efficiency as compared with E1 or E2. When the control (without radicel) was included in the comparison, 15% radicel without enzyme supplementation gave best economic efficiency (1.51) and relative economic efficiency (117), followed by 20% radicel + E1 which gave 1.43 and 111, vs. 1.29 and 100% for the control.

The results were in agreement with those of **Abdel-Malak *et al.* (2001**) who fed broilers on diets containing 0, 10, 14 or 18% radicel and recommended 14% for best performance and economic efficiency and **Abdel-Azeem and Hamid (2006)** who fed broilers on diets containing 0, 8, 16 or 24% radicel, and did not recommend 16 or 24% radicel but 8% (the level which was less than 16% in their study) for best performance and economic efficiency.

The previous findings showed that although radicel at both studied levels resulted in less growth performance than the control (without radicel) however, 15% radicel neither decreased carcass percentage nor digestion coefficient values significantly ($P \leq 0.05$) as compared with the control. While, 20% radicel without enzyme decreased both of them.

From economic point of view, 15% radicel without enzyme supplementation gave best economic efficiency and relative economic efficiency, followed by 20% radicel + E1 as compared with the control.

Table (1): Composition and calculated analysis of the control basal diets.

Ingredients (%)	Starter			Grower			Finisher		
	Radicel level			Radicel level			Radicel level		
	0%	**15%**	**20%**	**0%**	**15%**	**20%**	**0%**	**15%**	**20%**
Yellow corn	48.57	36.00	33.80	50.11	40.07	37.00	55.45	44.77	39.79
Soybean meal (38%)	33.99	35.00	32.75	33.75	31.36	30.23	30.23	28.50	30.25
Corn gluten meal (60%)	9.16	5.50	5.50	6.00	4.00	3.50	4.46	1.95	--
Radicel	--	15.00	20.00	--	15.00	20.00	--	15.00	20
Corn oil	4.21	4.68	4.14	6.37	6.00	5.75	6.62	6.68	6.96
Di calcium phosphate	1.66	1.58	1.56	1.67	1.62	1.60	1.18	1.13	1.09
Lime stone	1.42	1.34	1.32	1.20	1.08	1.05	1.18	1.11	1.08
NaCl	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine HCl	0.18	0.07	0.10	0.09	0.05	0.05	0.07	0.03	--
DL-Methionine	0.21	0.23	0.23	0.21	0.22	0.22	0.21	0.23	0.23
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated analysis:									
Crude protein %	23	23	23	21	21	21	19	19	19
Metabolizable energy (Kcal ME /Kg diet)	3100	3100	3100	3200	3200	3200	3270	3270	3270
CF %	3.78	5.62	6.12	3.74	5.42	5.97	3.57	5.28	5.97
ADF %	4.93	8.29	9.26	4.78	7.94	8.98	4.47	7.66	8.87
Available P %	0.45	0.45	0.45	0.45	0.45	0.45	0.35	0.35	0.35
Calcium %	1.00	1.00	1.00	0.90	0.90	0.90	0.80	0.80	0.80
Na %	0.13	0.24	0.27	0.13	0.24	0.27	0.13	0.24	0.27
Lysine %	1.40	1.40	1.40	1.27	1.27	1.27	1.15	1.15	1.15
Methionine %	0.65	0.65	0.65	0.61	0.61	0.61	0.57	0.57	0.57
Methionine + Cystine %	1.08	1.08	1.08	0.997	0.999	0.998	0.93	0.93	0.93

1. Each 3 kg of Vit. & Min. Mixture contains: Vit. A 12000,000 IU, Vit. D_3 2000,000 IU, Vit. E 10,000 mg, Vit. k_3 2000 mg, Vit. B_1 1000 mg, Vit. B_2 5000 mg, Vit. B_6 1500 mg, Vit. B_{12} 10 mg, Pantothenic acid 10,000 mg, Niacin 30,000 mg, Folic acid 1000 mg, Biotin 50 mg, Choline 300,000 mg, Manganese 60,000 mg, Zinc 50,000 mg, Copper 10,000 mg, Iron 30,000, Iodine 1000 mg, Selenium 100 mg, Cobalt 100 mg, Ca CO3 to 3,000 gm.

Table (2): Nutrient requirements of Ross (208)

	Starter	**Grower**	**Finisher**
Crude protein %	23	21	19
Metabolizable energy (Kcal ME /Kg diet)	3100	3200	3270
Available P %			
Calcium %	0.45	0.45	0.35
Lysine %	1.00	0.90	0.80
Methionine %	1.40	1.27	1.15
Methionine + Cystine %	0.65	0.60	0.57
	0.93	0.84	0.76

Table (3): Chemical composition of radicel

Items	On air dry basis (as fed)	On dry matter basis
Moisture, %	3.40	--
Dry matter (DM), %	96.60	100
Organic matter (OM), %	91.4	94.62
Crude protein (CP), %	20.14	20.85
Ether extract (EE), %	2.81	2.91
Crude fiber (CF), %	14.21	14.71
Ash, %	5.20	5.38
Nitrogen free extract (NFE), %	54.24	56.15
Calculated ME (kcal/kg)[1]	3326	3441
Fiber fraction:		
NDF[2] %	60.52 %	62.66
ADF[3] %	24.84 %	25.72
Hemi cellulose[4] %	35.68 %	36.94
Cellulose[5] %	14.99 %	15.52
ADL[6] %	9.85 %	10.2
Na ppm	7250	7505
Total P ppm	4900	5072
K ppm	4125	4270
Fe ppm	3000	3106
Mg ppm	2050	2122
Cu ppm	425	440
Zn ppm	120	124
Ca ppm	50	51.76
Mn ppm	30	31.06

ME[1] = 53 + 38 (% CP + 2.25 x % EE + 1.1 x NFE), **Scott *et al*. (1976)**
NDF[2] (Neutral detergent fiber) = cellulose + hemicellulose + lignin
ADF[3] (Acid detergent fiber) = cellulose + ADL (lignin)
Hemicellulose[4] = NDF-ADF   Cellulose[5] = ADF-ADL[6] (Acid detergent lignin)
2-6 were determined according to **Van Soest (1983).**

Table (4): Amino acids composition of radicel as compared to NRC requirements of broiler chicks (1994)

Amino acid (%)	Radicel (a)	NRC (1994) requirements (b)	(a / b)*
Arginine	0.95	1.25	0.76
Histidine	0.39	0.35	1.11
Isoleucine	0.64	0.80	0.80
Leucine	1.21	1.20	1.01
Lysine	1.07	1.10	0.97
Methionine	0.38	0.50	0.76
Phenylalanine	0.60	0.72	0.83
Threonine	0.72	0.80	0.90
Valine	1.04	0.90	1.16
Asparatic	1.96		
Serine	0.63		
Glutamic	2.58		
Proline	1.45		
Glycine	0.86		
Alanine	1.05		
Cysteine	0.47		

*- Essential amino acids of radicel / NRC requirements (1994).

Table (5): Body weight and body weight gain of broilers as affected by different treatments

Treatments			Body weight (g)				Body weight gain (g)			
No	Radicel level % (RL)	Enzyme supplementation (ES)	IBW	At 10 days	At 28 days	At 42 days	0-10 days	10-28 days	28-42 days	0-42 days
	15	-	44	165	734	1610	120	570	875	1566
	20	-	45	155	661	1587	111	505	927	1543
	-	**No E**	44	168	749	1676	124	581	927	1631
	-	**E1**	44	160	694	1602	116	534	909	1558
	-	**E2**	45	152	651	1518	108	499	867	1473
1	**Control (without radicel)**		44	197	979^{a}	2067^{a}	153	782^{a}	1088	2023^{a}
2	**15% R**		44	169	772^{b}	1740^{b}	125	603^{b}	968	1696^{b}
3	**15% R+E1**		44	163	737^{bc}	1578^{b}	119	574^{b}	841	1534^{b}
4	**15% R+E2**		44	162	694^{bc}	1512^{b}	118	532^{b}	817	1467^{b}
5	**20% R**		44	167	725^{bc}	1611^{b}	122	558^{b}	886	1567^{b}
6	**20% R+E1**		45	157	650^{bc}	1627^{b}	112	493^{b}	977	1583^{b}
7	**20% R+E2**		45	143	607^{c}	1524^{b}	98	465^{b}	917	1480^{b}

a, b ....= Means in the same column within each factor differently superscripted are significantly different ($P \leq 0.05$)

Table (6): Feed intake, feed conversion and EPEI of broilers as affected by different treatments

Treatments			Feed intake (g)				Feed conversion (feed/gain)				EPEI
No	RL (%)	ES	0-10 days	10-28 days	28-42 days	0-42 days	0-10 days	10-28 days	28-42 days	0-42 days	
	15	-	199	1417	1419^{a}	3034^{a}	1.69	2.49^{b}	1.66^{a}	1.96	194.96
	20	-	193	1467	1257^{b}	2917^{b}	1.75	2.99^{a}	1.38^{b}	1.90	199.55
	-	**No E**	196	1465^{a}	1374	3035^{a}	1.62	2.56	1.51	1.88	210.04
	-	**E1**	199	1498^{a}	1329	3026^{a}	1.73	2.85	1.50	1.95	196.89
	-	**E2**	192	1363^{b}	1311	2866^{b}	1.80	2.82	1.54	1.96	184.85
1	**Control (without radicel)**		241	1247^{c}	2110^{a}	3598^{a}	1.58	1.60^{c}	1.94^{a}	1.78	276.48
2	**15% R**		175	1412^{b}	1357^{bc}	2944^{c}	1.47	2.35^{b}	1.42^{bc}	1.76	228.56
3	**15% R+E1**		211	1520^{a}	1484^{b}	3214^{b}	1.79	2.65^{ab}	1.79^{ab}	2.11	178.17
4	**15% R+E2**		210	1319^{c}	1415^{b}	2944^{c}	1.80	2.48^{ab}	1.76^{ab}	2.02	178.16
5	**20% R**		216	1519^{a}	1391^{b}	3126^{b}	1.77	2.76^{ab}	1.60^{abc}	2.01	191.52
6	**20% R+E1**		188	1477^{ab}	1174^{d}	2839^{c}	1.67	3.04^{ab}	1.20^{c}	1.80	215.61
7	**20% R+E2**		174	1406^{b}	1207^{cd}	2788^{c}	1.79	3.17^{a}	1.32^{c}	1.89	191.53

a, b ....= Means in the same column within each factor differently superscripted are significantly different

Table (7): Effect of treatments on carcass characteristics and immune organs

Treatments			Items									
NO	**RL (%)**	**ES**	**Carcass (%)**	**Liver (%)**	**Gizzard (%)**	**Heart (%)**	**AFP (%)**	**Intes. (%)**	**Gall (%)**	**Spleen (%)**	**Bursa (%)**	**Thymus (%)**
	15	-	70.69	2.65	2.82^{a}	0.58	0.74	7.73	0.07	0.18	0.22	0.62
	20	-	70.07	2.79	2.42^{b}	0.54	0.56	8.55	0.09	0.16	0.20	0.54
	-	**No E**	69.35^{b}	2.54	2.55	0.55	0.61	8.15	0.06	0.14	0.23	0.56
	-	**E1**	69.92^{b}	2.90	2.58	0.56	0.71	8.40	0.09	0.17	0.23	0.60
	-	**E2**	71.87^{a}	2.71	2.73	0.59	0.64	7.87	0.10	0.20	0.16	0.58
1	**Control (without radicel)**		72.06^{ab}	2.21^{c}	2.48	0.55	0.98	6.60	0.06	0.16	0.20	0.39
2	**15% R**		70.19^{bcd}	2.62^{bc}	2.74	0.62	0.80	7.93	0.06	0.14	0.27	0.59
3	**15% R+E1**		70.77^{abcd}	2.61^{bc}	2.84	0.57	0.78	7.93	0.06	0.16	0.26	0.70
4	**15% R+E2**		71.11^{abc}	2.71^{b}	2.88	0.55	0.63	7.33	0.08	0.24	0.12	0.57
5	**20% R**		68.5^{d}	2.46^{bc}	2.36	0.48	0.41	8.37	0.05	0.13	0.19	0.54
6	**20% R+E1**		69.06^{cd}	3.19^{a}	2.32	0.54	0.63	8.87	0.12	0.18	0.20	0.50
7	**20% R+E2**		72.63^{a}	2.71^{b}	2.57	0.62	0.65	8.40	0.11	0.16	0.19	0.58

a, b ....= Means in the same column within each factor differently superscripted are significantly different ($P \leq 0.05$)

Table (8): Effect of treatments on nutrients utilization

Treatments			Items					
No	**RL (%)**	**ES**	**DM (%)**	**OM (%)**	**CP (%)**	**EE (%)**	**CF (%)**	**NFE (%)**
	15	**-**	78.9	81.7	93.7	91.1	27.9	81.1
	20	**-**	77.0	78.9	94.2	89.4	23.7	76.1
	-	**No E**	75.5	77.2	93.0	89.1	24.0^{b}	74.5
	-	**E1**	80.8	83.8	94.5	92.0	37.5^{a}	82.1
	-	**E2**	77.5	79.9	94.5	89.6	15.8^{b}	79.2
1	**Control (without radicel)**		81.6	84.0^{a}	94.7	89.6	29.9^{ab}	83.3^{a}
2	**15% R**		79.5	81.8^{a}	93.4	89.1	27.0^{abc}	82.1^{a}
3	**15% R+E1**		79.4	83.1^{a}	93.8	95.4	38.3^{a}	81.0^{a}
4	**15% R+E2**		77.8	80.2^{a}	94.0	88.8	18.3^{bc}	80.1^{a}
5	**20% R**		71.5	72.5^{b}	92.6	89.0	21.1^{bc}	66.8^{b}
6	**20% R+E1**		82.2	84.5^{a}	95.2	88.6	36.8^{a}	83.3^{a}
7	**20% R+E2**		77.3	79.6^{ab}	94.9	90.4	13.2^{c}	78.4^{a}

a, b ....= Means in the same column within each factor differently superscripted are significantly different ($P \leq 0.05$)

Table (9): Input / output analysis and economic efficiency as affected by different treatments

Treatments			BW (kg)	FI/chick (kg)	Feed cost/chick (LE)	Feed cost/kg BW (LE)	Total revenue (LE)[1]	Net revenue (LE)	Economic efficiency (EE)[2]	Relative EE%
No	RL (%)	ES								
	15	-	1.610	3.034	4.38	2.73	9.66	5.29	1.22	100
	20	-	1.587	2.917	4.11	2.59	9.52	5.41	1.32	108
	-	**No E**	1.676	3.035	4.24	2.54	10.06	5.82	1.38	100
	-	**E1**	1.602	3.026	4.35	2.71	9.62	5.28	1.23	89
	-	**E2**	1.518	2.866	4.15	2.74	9.11	4.96	1.20	87
1	**Control (without radicel)**		2.067	3.598	5.39	2.61	12.40	7.01	1.29	100
2	**15% R**		1.740	2.944	4.16	2.39	10.44	6.28	1.51	117
3	**15% R+E1**		1.578	3.214	4.66	2.95	9.47	4.81	1.03	80
4	**15% R+E2**		1.512	2.944	4.31	2.85	9.07	4.77	1.11	86
5	**20% R**		1.611	3.126	4.32	2.68	9.67	5.35	1.24	96
6	**20% R+E1**		1.627	2.839	4.03	2.47	9.76	5.74	1.43	111
7	**20% R+E2**		1.524	2.788	3.99	2.62	9.14	5.15	1.29	100

N.B: Total price for feeds was calculated according to the price of different ingredients available in A.R.E. at experimental time

1- The price was calculated due to the local market which was 6.0 LE/kg live weight.

2- EE = Net revenue / chick (LE)

Total feed cost / chick (LE)

Roilers, Radicel, Non-Conventional Feedstuffs, Enzymes, Performance)

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الملخص العربي

تقييم المستويات المرتفعة من الراديسيل مع أو بدون انزيمات في علائق بداري التسمين

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استهدفت هذه الدراسة تقييم تأثير المستويات المرتفعة من الراديسيل كمصدر غذاء غير تقليدي مع أو بدون الإنزيمات علي الأداء الإنتاجي لبداري التسمين. استخدم في هذه الدراسة مستويان من الراديسيل (15 و20% من العليقة) بالإضافة إلي الكنترول (دون راديسيل). تم التغذية علي كل مستوي من الراديسيل اما دون إضافة إنزيمات أو بإضافة كيم زيم (1 جم/كجم عليقة) أو إضافة بريزمازيم فيج (2 جم/كجم عليقة). و بالتالي تم استخدام 7 علائق تجريبية (2 مستوي راديسيل x 3 معاملات) بالإضافة إلي الكنترول (بدون راديسيل). و استخدم في هذه الدراسة عدد 210 كتكوت روص غير مجنس عمر يوم وزعت عشوائيا إلي 7 مجاميع متساوية في العدد و متوسط وزن الجسم. احتوت كل مجموعة علي 3 مكررات بكل منها 10 كتاكيت ربيت جميعها تحت ظروف متماثلة من الرعاية. كل العلائق كانت متساوية في البروتين و الطاقة تبعا لكتالوج السلالة.

أوضحت نتائج هذه الدراسة احتواء الراديسيل علي كميات معتدلة من العناصر الغذائية خصوصا البروتين الخام (20.14%) و المستخلص الخالي من الازوت (54.24%)، و لكنه يحتوي علي نسبة مرتفعة من الألياف (14.21%) والسليولوز واللجنين (24.84%). كما أظهرت النتائج أن الراديسيل غني في كل من (جزء في المليون) 7250 صوديوم، 4900 فوسفور كلي، 4125 بوتاسيوم، 3000 حديد، 2050 ماغنسيوم، 425 نحاس، 120 زنك، 30 منجنيز. و بمقارنته باحتياجات الكتاكيت NRC (1994) اتضح أن الأحماض الامينية الارجنين و المثيونين كانت هي الأحماض الامينية المحددة الأولي (0.76) والحامض الاميني المحدد الثاني كان الايزوليوسين (0.80) والحمض الاميني المحدد الثالث كان الفينيل الانين (0.83). إضافة الراديسيل بمستوي 15% دون إضافة إنزيمات أعطي أفضل أداء إنتاجي للنمو

عنه في حالة إضافة الإنزيمات ولكنه كان اقل من الكنترول. كما أن 15% راديسيل مع أو بدون إنزيمات لم يؤدي إلي انخفاض نسبة الذبيحة أو قيم معاملات الهضم مقارنة بالكنترول، في حين أن 20% راديسيل دون إضافة الإنزيمات أدي إلي انخفاض كل منها.

ومن وجهة النظر الاقتصادية نجد أن 15% راديسيل دون إضافة إنزيمات أعطي أفضل كفاءة اقتصادية يليه 20% راديسيل + كيم زيم مقارنة بالكنترول. و لم يكن للمخلوط الإنزيمي بريزمازيم فيج نفس كفاءة المخلوط الإنزيمي كيم زيم تحت ظروف هذه التجربة.