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Original article

The effect of dietary commercial enzyme preparations on performance of broilers

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Summary — The effects on broiler performance of 2 commercial enzyme mixtures as supplements to barley- based diets were investigated in 3 experiments. The results of these studies indicate that some improvements in growth rate and feed utilization were obtained but were not always consistent and significant when broilers were fed the test diets from 2 to 8 weeks of age. The enzyme preparation SP 343 had a more consistent influence on diet utilization of broilers fed from 1 day of age to 8 weeks. No significant differences were observed by doubling the dose of SP 343.

barley / broiler / enzyme

Résumé — Les effets de deux préparations enzymatiques commerciales sur les performances de poulets de chair. *Trois essais ont été conduits dans le but de tester les effets de deux préparations enzymatiques commerciales sur les performances de poulets de chair recevant des aliments à base d'orge. Quelques améliorations relatives au croît et à l'efficacité alimentaire ont été enregistrées chez des poulets recevant les régimes expérimentaux de 2 à 8 semaines d'âge; elles n'étaient cependant pas toujours significatives et répétables. La préparation enzymatique SP 343 a eu une influence plus constante sur l'indice de consommation des animaux recevant les régimes du premier jour jusqu'à 8 semaines d'âge. Le doublement de la dose de SP 343 n'a pas eu d'effet significatif additionnel.*

poulet de chair / orge / enzyme

INTRODUCTION

The inclusion of barley in broiler feed has been rather limited due to its inconsistent nutritional value and frequent contribution to the production of sticky droppings and wet litter (Hesselman *et al*, 1981, 1982; Mannion, 1981).

Commercially produced enzyme mixtures have long been known to improve the growth of broilers fed barley-based diets (Fry *et al*, 1958; Arscott and Rose, 1960; Willingham *et al*, 1960; Delpech and Ezzat, 1979), but their resulting effects were not always consistent. Extensive summaries of experiments dealing with enzyme supplementation of barley diets and bird response have been provided in the review of Hesselman (1989). In recent years, renewed interest in the use of enzymes in broiler feed to improve the nutritional value of barley has made new commercial mixtures available mostly

based on β-glucanase cellulase and protease activities.

Growth response to enzyme supplementation cannot, however, be assumed for broilers fed local barleys as any response is influenced by the genetic origin of the grain (Daghir and Rottensten, 1966; Coon *et al,* 1979; Mannion, 1981) the geographical area where the barley is grown (Willingham *et al,* 1960) and the nature and level of enzyme supplements in the diets (Anderson *et al,* 1961; Rose and Arscott, 1962; Herstad and McNab, 1975; Rotter *et al,* 1989).

The objective of the current study was to evaluate the efficacy of 2 commercial enzyme preparations when added to barley based diets fed to broiler chicks of different ages.

MATERIALS AND METHODS

General procedure

In all experiments straight run day-old broilers were obtained from a commercial hatchery and randomly assigned to floor pens. They were Arbor acre strains in experiments 1 and 2 and Indian River in experiment 3.

Locally available barley of unknown genetic origin and geographical area was incorporated into the test diets and no adjustment was made for its metabolizable energy content in these experiments when fed with enzyme supplements. The barley used in experiments 1 and 2 was supplied from a different batch than that utilized in experiment 3 (table I).

The composition of the basal diets used in the experiments is shown in table II. Analyses were performed by AOAC 1980 methods of barley and diets' chemical compositions. Common

Table I. Proximate composition of barley.

(%)	Experiments 1 and 2	3
Dry matter	89.52	89.60
Crude proteins	10.93	10.83
Crude fiber	5.56	9.52
Ash	7.47	7.01

lots of diet were prepared in the studies and sub-quantities were taken for mixing in each of the test diets. The experimental diets were thus mixed a week prior to the beginning of each experiment and were kept in a cool place. All diets were isocaloric (2850 Kcal/Kg) and isonitrogenous (21% proteins 1.11% lysine and 0.83% sulfuro-amino acids) within each experiment and were fed *ad libitum.* The birds also had free access to water. Two commercial enzyme supplements have been tested, namely *: Kemzyme, obtained from Kemin France, and "SP 343", received from NOVO Industries Enzymes SA. Enzyme supplements were blended with approximately 40 kg of the basal diet before being added to the final mixture.

Measurements and analyses

The birds from each floor pen were collectively weighed and pen feed consumption data were taken at intervals throughout each experiment. Mortality was recorded as it occurred and all birds were weighed as soon as possible after death.

The pen effect was taken into consideration regarding the weight of the dead birds in the calculation of body weight gain and feed efficiency. In all trials, the obtained data were subjected to analysis variance and treatment means were compared using Duncan's multiple range test (Duncan, 1955).

* The use of trade names implies neither endorsement of the enzymes mixtures named nor criticism of similar compounds not mentioned.

Table II. Composition of experimental diets.

Ingredients	*Experiments*					
	1 and 2 (%)					*3 (%)*
Barley	–	10.00	20.00	30.00	40.00	40.00
Corn	56.34	49.00	41.69	37.68	31.26	30.40
Peas	10.00	10.00	10.00	0.45	–	–
Molasses	2.00	2.00	2.00	2.00	–	2.00
Cotton seed meal	6.00	6.00	6.00	6.00	6.00	6.00
Sunflower meal	6.00	6.00	6.00	6.00	5.28	5.98
Soybean meal	11.44	6.57	1.70	4.71	4.35	1.01
Fish meal (55% CP)	2.00	2.00	2.00	2.00	2.00	2.00
Fish meal (65% CP)	4.20	6.77	9.32	10.00	10.00	12.00
DL-Methionine	0.13	0.11	0.09	0.07	0.07	0.05
Calcium carbonate	0.33	0.38	0.42	0.44	0.21	–
Bone powder	0.88	0.53	0.18	0.06	0.04	–
Salt	0.18	0.14	0.10	0.09	0.09	0.06
Vitamin-mineral mix[1]	0.50	0.50	0.50	0.50	0.50	0.50
Chemical analysis (%)						
Proteins	22.86	23.10	23.81	23.67	23.23	23.50
Crude fiber	4.52	5.07	5.36	5.68	5.66	6.10
Ash	7.33	7.72	7.45	7.31	7.08	8.81
Dry matter	89.59	89.19	89.00	89.26	88.82	90.30

[1] Vitamin mineral pre-mix supplied per kg of diet vitamin A 1 000 IU; vitamin D_3 3 000 IU; vit E 10 mg; vit B_{12} 8 µg; vit K 1.8 mg; riboblavin 4.0 mg; Ca panthotenate 10 mg; niacin 24 mg; choline 0.35 mg; folic acid 0.6 mg; Co 0.4 mg; Cu 8 mg; Fe 25 mg; I_2 1.1 mg; Mn 80 mg; Se 0.2 mg; Zn 50 mg. [2] In experiment 1: Kemzyme was added at 0.05% to the basal diets containing 0.10 20 and 30% barley (see table III). In experiment 2: Kemzyme and SP 343 were added to the basal diets containing 20 and 30% barley respectively at 0.05% (see table IV). In experiment 3: The 10 and 30% barley based diets used in experiments 1 and 2 were fed. 0.4%, 0.8% SP343 were added to a 30% and a 40% barley based diet as shown in table V.

Experiments 1 and 2

Nine hundred and sixty-d-old broilers were used in each experiment. They were fed a commercial starting diet for 2 weeks and thereafter randomly divided into 16 equal weight groups of 60 birds each. Test diets consisted of a 0, 10, 20 and 30% barley based diet as shown in table II supplemented or not with 0.05% Kenzyme and were fed until 57 days of age in experiment 1.

In experiment 2, the birds were fed a control diet with 10% barley with or without 0.05% SP 343 and a 30% or 40% barley based diet supplemented or not with 0.05% Kenzyme or SP 343 respectively, as shown in table IV. The data were submitted to analysis of variance in a 2 x 4 factorial design (experiment 1) and in a completely randomized design (experiment 2).

Experiment 3

Two levels of the enzyme mixture SP 343 were used in this experiment: 0.04 and 0.08%, respectively supplemented a 30 and 40% barley-based diet. These were fed with a control diet (10% barley) to 960-day-old broilers until 52 days of age. Three pens of 64 chicks (randomly

allocated to the pens) having equal group weights were used for each of the 5 dietary treatments.

RESULTS

Broilers' body weights, feed consumption, feed efficiency and litter moisture data are summarized in tables III, IV and V. Mortality was low in all experiments and dietary treatments had no overall significant effect on this parameter. Similarly, the number of males and females counted per pen at the end of each experiment did not vary significantly between the groups fed the test diets. Broilers fed 0% barley gained more weight than those fed barley diets regardless of Kemzyme addition but this effect was not significant (table III).

The non-supplemented barley diets resulted in a slightly lower gain for the period 14 to 57 days. Kemzyme supplementation improved broilers' weight gains in the 10 and 20% barley diets to approach that of the control diet (0% barley) in experiment 1 (table III). Feed intake decreased as dietary barley levels increased. The addition of SP 343 to a 10% barley diet resulted in significant improvement in feed consumption and weight gains at 56 days of age. These effects were not, however, observed at higher levels of barley inclusion regardless of the enzyme mixture supplement. No significant effects were observed on feed to weight gain ratios (table IV). In experiment 3, no major improvement in broiler performance was registered when the dose of SP 343 was doubled from 0.04 to 0.08% in a 30% or 40% barley diet (table V).

Table III. Effects of dietary "Kemzyme" addition on broilers' performance from experiment 1 (14 to 57 days of age)[1].

Kemzyme (%)	*Barley (%)*								
	0		*10*		*20*		*30*		*PSEM*[2]
	0.00	*0.05*	*0.00*	*0.05*	*0.00*	*0.05*	*0.00*	*0.05*	
Body weight (g)	202	209	201	194	196	200	205	205	11.412 7
At 14 d									
At 57 d									
Males	2 430	2 370	2 220	2 320	2 250	2 320	2 190	2 200	295.384 5
Females	1 890	1 990	1 850	1 970	1 880	2 010	1 840	1 860	135.742 4
Body weight gain (g)									
14–57 d	1 995	1 989	1 774	1 973	1 861	1 981	1 830	1 842	170.593 1
Mortality (%)									
14–57 d	6.50	5.50	5.50	6.50	7.00	7.00	7.50	5.00	0.062 6
Feed consumption g/bird									
14–57 d	4 982	4 939	4 723	5 073	4 960	5 020	4 840	4 780	270.022 2
Feed to grain ratio									
14–57 d	2.498	2.485	2.667	2.573	2.652	2.519	2.646	2.598	0.120 5

[1] No significant differences were observed between the measured parameters means in this experiment; [2] Pooled standard error of the means.

Table IV. Comparative effects of 2 enzyme preparations added to high barley diets on broiler performance (14 to 56 days) in experiment 2.

Barley (%)	*10*		*30*			*40*			*PSEM 1*
Enzymes (%)	*0.00*	*0.05% SP343*	*0.00*	*0.05% Kemzyme*	*0.05% SP343*	*0.00*	*0.05% Kemzyme*	*0.05% SP343*	
Body weight (g)									
At 14 days	203	212	208	208	207	211	205	202	11.467
At 56 days									
Males	2 388	2 364	2 235	2 330	2 109	2 197	2 168	2 086	213.7569
Females	1 873	2 046	1 859	1 870	1 909	1 967	1 751	1 814	185.2782
Body weight gain (g)									
14–56 days	1 920^{b}	2 015^{a}	1 816^{c}	1 915^{b}	1 805^{cd}	1 872^{bc}	1 728^{e}	1 736de	60.2661
Mortality (%)									
14–56 days	7.50	6.00	4.00	7.00	5.50	4.00	6.00	6.00	0.0406
Feed consumption (g)									
14–56 days	4 366^{bcd}	4 705^{a}	4 390^{bc}	4 441^{b}	4 271^{cde}	4 497^{b}	4 217de	4 185^{e}	139.0252
Feed to gain ratio									
14–56 days	2.274	2.336	2.418	2.319	2.367	2.403	2.441	2.441	0.0564

1 Pooled standard error of the means; $^{a, b, c, d, e}$ Means along a line having different superscripts are significantly different ($P < 0.05$).

Table V. Effect of SP 343 dose on broiler performance experiment 3 (0–52 d).

Barley (%)	*10*	*30*		*40*		*PSE M*[1]
SP 343 (%)	–	*0.04*	*0.08*	*0.04*	*0.08*	
Body weight gain (g)	2106	2157	2125	2079	2102	41.1987
Feed consumption (g)	4864	4841	4743	4717	4763	97.1597
Feed to gain ratio	2.310^{a}	2.244^{bc}	2.232^{c}	2.269^{bc}	2.266^{bc}	0.0254

[1] Polled standard error of the means; $^{a, b, c}$ Means along each line having different superscripts are significantly different ($P < 0.05$).

DISCUSSION

At the time these experiments were conducted, it was common local practice that commercial broilers feed contained about 10% barley, as in our control treatments (tables III, IV, V). The inclusion of high levels of home-grown barley was considered to be a useful means of utilizing the large surplus harvested. One of the primary ob-

jectives of the experiments was the testing of a high barley level in broiler diets and it has successfully been demonstrated that a level of up to 40% can sustain comparable performances to that of the commercial control diet containing 10% barley (experiments 1 and 2). These results confirm those previously published by Piton *et al* (1979) and others, but appear to be in conflict with those of Coon *et al* (1979), Blum *et al* (1980), and Hesselmen *et al* (1981). The disagreement could be attributed to a lower β-glucane content in local barleys (table I) when compared to some European varieties and to the feeding periods considered in experiments 1 and 2.

The nutritional value of barley appears to be more critical when fed to day-old birds but improves as the bird ages (Petersen, 1969). The addition of the commercial enzyme preparations sustained similar growth performances to the control diet containing 10% barley when the birds were fed the diets starting from 2 weeks of age. When SP 343 was included in the diet of broilers fed to market age in experiment 3, higher weight gains were observed for the 30% barley diet at both levels of the enzymes, concomitant with a significantly lower feed to gain ratio. These results tend to support previous findings of Mannion (1981) where the response to enzyme supplementation of birds fed barley diets was found to be more significant in younger birds. This addition does not seem to be warranted throughout the life of the broiler as the magnitude of the growth response might narrow with age, as in experiment 3.

Numerous studies have confirmed that enzyme addition to barley-based diets increases their ME content and improves feed consumption and growth performance when fed to broilers (Leong *et al,* 1962; Potter *et al,* 1965; Broz and Frigg, 1986a, b; Hesselman and Amman 1986; Rotter *et al,* 1990). This effect has been attributed to a a higher digestibility value for fat, starch and nitrogen. Although feed consumption did not consistently increase following enzyme addition, bird performance and diet analysis tend to indicate that improved ME might account for the results of the experiments.

On the other hand, the broilers fed the enzyme preparations maintained numerically improved body weight gains and feed to gain ratios compared with the control diet at 42 and 57 days of age; these differences were not statistically significant (exp 1).

The present studies have shown that barley can be used up to 30% (from 14 days of age) and up to 40% (to market age) in a low energy diet for broilers when supplemented with commercial enzyme preparation. The lack of response to the enzymatic treatment may be attributed to an inappropriate enzyme mixture (a high β-glucanase activity with a low β-glucane content barley) and reemphasizes the need for evaluating the chemical composition of the substrate prior to the preparation of the enzyme mixture. The mechanisms by which the multi-enzyme mixtures exert their effects on some performances remains to be investigated. However, further studies involving more animals per dietary treatment utilizing enzymatic preparation of known activities may be warranted to determine the effects of these dietary additives on bird performance.

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