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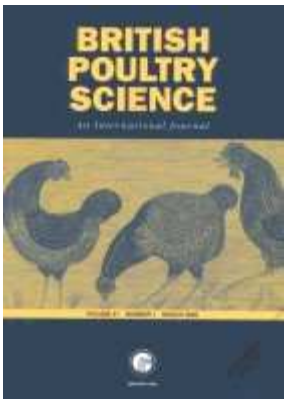

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A comparison of the effects of different yeast products and antibiotic on broiler performance

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Abstract 1. The objectives of this experiment were to compare the effects of different yeast products, with different nucleotide contents and inclusion rates, on broiler performance and to compare the effects to those observed with an antibiotic growth promoter.

2. Two experiments were carried out over two time replicates, one in individual wire cages and one in group pens.

3. Birds were given a diet based on a commercial formulation, which was split into 7 batches. One batch (C) contained no growth promoter and acted as a negative control, another (AV) contained the antibiotic growth promoter Avilomycin (5 g/tonne) and acted as the positive control. The other batches contained yeast extract 2012 at 100 g/tonne (Y21), yeast extract 2012 at 500 g/tonne (Y25), standard yeast 18 at 100 g/tonne (Y81), standard yeast 18 enriched in nucleotides at 100 g/tonne (Y8N1) and standard yeast 18 enriched in nucleotides at 500 g/tonne (Y8N5).

4. In the penned experiment, 280 Cobb broiler chicks (40 birds/treatment) were randomised to diet and pen position on day of hatch. Birds were fed *ad libitum* until slaughter at 28 d. Bird performance was monitored during the experimental period.

5. In the individual cage experiment, 63 Cobb broiler chicks (9 birds/treatment) were taken from the pens at 7 d of age and randomised to diet and cage position. Birds were fed *ad libitum* from d 7 to d 28. A 7-d excreta collection was carried out to determine apparent metabolisable energy (AME) content and nutrient digestibility between d 14 and d 21. Bird intake and weight were monitored weekly during the experimental period. At 28 d the birds were killed and viscosity of jejunal digesta supernatant was determined.

6. In the penned experiment, diet had no significant effect on dry matter intake (DMI), liveweight gain (LWG) or gain:feed values during any individual week of the

experiment or for the entire experimental period. In the caged experiment, DMI was numerically highest for birds fed Y25 diet over the entire experimental period, however this only reached significance in the second week. LWG, gain:feed, viscosity of jejunal contents and gizzard weight were not significantly affected by dietary treatment.

7. Diet AV had a significantly higher AME content than diets Y25, Y81, Y8N1 or Y8N5. Also, oil and NDF digestibility coefficients were significantly affected by diet treatment.

INTRODUCTION

Yeast extracts have been widely reported as successful growth promotants in the poultry industry (Oyofo *et al.*, 1989; Savage *et al.*, 1997; Spring, 2002). These "natural" growth promoters have the potential to replace antibiotics, which have recently been withdrawn from the diet. Consumer acceptability of yeast products is high, since yeast is a natural ingredient used daily in human diets in bread or fermented beverages. It should therefore be accepted by the critical consumer and thus is a concept that deserves further investigation in the poultry industry.

From previous work (Owens, 2004) yeast extracts appeared to have a beneficial effect on food intake and live weight gain of broilers in the first week following introduction to the diet (d 7-14). Clearly the first week post hatch is a very important period in terms of digestive development. The objective of this experiment was to examine if the effects of yeast supplementation could be enhanced by the inclusion of the yeast product from day of hatch. A lack of a microbial challenge will obviously limit the response of the growth promoters (Bedford, 2000). Consequently, in order to test the yeast products fully, the birds require to be challenged in some way. Birds are challenged by the background

microflora present within their normal housing environment. The environment is particularly important in this context because the intestine of the chick is sterile before hatching (Bedford, 2000). It has been reported that an increase in bird challenge should lead to greater positive response from the birds to inclusion of yeast products (Cruickshank, 2002). It has also been suggested that the mode of action of the yeast extract as a growth promoter is brought about by the nucleotide content of the product (Savage and Zakrewska, 1996). The nucleotides act as immunomodulators, which alleviate conditions caused by external stress imposed on the birds' health (Miles, 1993). To date these yeast products have only been used at one rate of inclusion, that is, a dose rate reported to be optimum from trials carried out by the manufacturer. However the effect of addition at higher levels has not been investigated for the onset of toxicity.

Hence, the objectives of this study were to compare the effects of different yeast products, with and without nucleotides, and at different inclusion rates on broiler performance and to compare the effects to those observed with an antibiotic growth promoter. Two experiments were carried out, one in individual cages and the other in group pens. The aim of the penned experiment was to challenge the birds by simulating the environmental conditions that occur in a commercial situation.

MATERIALS AND METHODS

Experimental diets

Birds were given a diet based on a commercial formulation (Table 1). All diets were mixed and pelleted at The School of Agriculture and Food Science (Queen's University, Belfast). Liquid xylanase was included at a rate of 20 g/tonne. The commercial enzyme used was Avizyme 1310 (EC 3.2.1.8), obtained from Danisco Animal Nutrition (Marlborough, UK). A coccidiostat (Elancoban G200- containing

Monensin sodium 100 mg/kg) was also included at a rate of 0.5 kg/tonne. The proximate analysis of the diet is shown in Table 2. The diet was split into 7 batches. The first batch (AV) acted as a positive control, where the antibiotic Avilomycin was added at a rate of 5 g/tonne. To batch two (Y21), the yeast extract 2012 was added at a rate of 100 g/tonne and, to batch three (Y25), it was added at a rate of 500 g/tonne. To batch 4 (Y81) the standard yeast extract 18(Y18) was added at a rate of 100 g/tonne, to batch 5 (Y8N1) the Y18 enriched in nucleotides was added (100 g/tonne) and to batch 6 (Y8N5) the Y18 enriched in nucleotides was added (500 g/tonne). The seventh batch (C) acted as a negative control, with no added growth promoters.

Tables 1 and 2 near here

Yeast products

The standard yeast extract (Y18) contained no nucleotides or long chain peptides, whereas the yeast extract 2012 contained both nucleotides and long chain peptides. The standard yeast was enriched with different amounts of nucleotides found in yeast 2012, to give the other yeast extracts used in the experiment (Y8N1 and Y8N5). The yeast extracts are manufactured from *Saccharomyces cerevisiae* and are obtained from yeast cream specially cultured on a molasses medium. The process for obtaining the yeast extract involves partial or complete autolysis, *i.e.* a transformation of proteins into peptides and amino acids implemented through the proteolytic enzymes present in yeast cells. The cell membranes are discarded; enabling completely soluble yeast extracts to be obtained. The degradation process used to produce these extracts differed in length in order to bring about these different yeast products.

Birds and management

Penned experiment

A total of 300 Cobb broiler chicks were used in two consecutive time replicates. At hatch, birds were weighed and extremely heavy and light birds were removed from the trial. 280 birds were divided into two weight blocks, and within weight blocks, randomised by weight to one of the 7 diets. They were placed in 14 straw litter floor pens (2 pens/diet) and arranged by weight block throughout the room. The initial room temperature was 36°C, which was reduced by 1°C every 24 h in the first week and every 48 hthereafter. The birds were fed *ad libitum* from d 0- d 7. At d 7, 9 birds were taken from each diet and transferred to a caged experiment. The removal of the birds from the pens was balanced in order to achieve a similar mean weight of the birds on each diet (pens and cages). The remaining penned birds were fed *ad libitum* to 21 d. Weekly feed intake and liveweight gains were recorded. The number of birds/pen was reduced weekly, in accordance with recommended stocking densities (Home Office Animal (Scientific procedures) Act 1986), to a minimum of 12 birds in the final week of the experiment.

Caged experiment

At 7 d, the 63 birds taken from the pens were weighed, blocked and randomised to individual wire metabolism cages. The initial room temperature was 33°C, which was reduced by 1^{o}C every 48 h. The humidity was set at 45-50% throughout the experiment and light was provided for 18 h, with the dark cycle being between midnight and 0600 hours. The birds were supplied with water and the experimental diets *ad libitum*. The balance procedure for apparent metabolisable energy and nutrient digestibility determination was carried out from d 14- d 21. Individual bird excreta were collected daily and stored at 4°C. An oxygen bomb calorimeter (Parr, Model 1271), calibrated using benzoic acid, was used to determine gross energy. On

d 28 the birds were killed by dislocation of the spinal cord at the cervical column. A sample of digesta from the jejunum was removed for the purpose of viscosity determination. The digesta was centrifuged (13400 *g* for 8 minutes) and viscosity measured using a Brookfield LVDV II cone and plate viscometer at 20°C.

Nutrient digestibility analysis

Apparent digestibility of nutrients is calculated as the difference between the intake of the nutrient over a specified period and the faecal output over that period divided by the nutrient intake. In the case of poultry it is assumed that all oil and neutral detergent fibre (NDF) in the excreta is of faecal origin. The NDF content of the milled feed and dried faeces samples were determined using the Fibertec system (Tecator Ltd.). The oil content of the milled feed and dried faeces samples were determined by acid hydrolysis to free any bound oil, followed by solvent extraction with petroleum ether (40-60°C) using Soxhlet reflux apparatus. The solvent was then distilled and decanted off and the residual extract dried and weighed.

Statistical analysis

The results were analysed using analysis of variance, with initial bird weight as co-variate for performance measurements.

RESULTS

Penned Experiment

Diet had no significant effect ($P < 0.05$) on dry matter intake (DMI), liveweight gain (LWG) or gain:feed values of the penned birds during any individual week of the experiment or for the entire experimental period (Table 3). Table 3 near here

Caged experiment

DMI was numerically highest for birds receiving the Y25 diet in all individual weeks of the experiment and over the entire experimental period (Table 4). However, the

difference in intake only reached significance ($P < 0.05$) in the second week of the experiment. Intake was significantly higher in this week for birds fed Y25 and Y81 diets when compared with those fed the C and AV diets, the difference between Y25 and AV being 8.6%. Over the entire experimental period the numerical difference between Y25 and AV was 6.5%, but was non-significant. Table 4 near here

Liveweight gain and gain:feed were not significantly affected by diet treatment in any of the individual weeks of the experiment or for the entire experimental period. There was no significant effect of diet on gross energy intake (GEI) or metabolisable energy intake (MEI) (Table 5). However, diet had a significant effect on ME:GE and consequently on the AME content of the diet. Birds receiving the diet containing the antibiotic had significantly ($P < 0.01$) higher ME:GE and AME contents than birds fed on the Y25, Y81, Y8N1 or Y8N5 diets. The ME:gain ratio was also numerically highest for birds fed the AV diet, but this was not statistically significant. Tables 5 and 6 near here

There was no significant effect of diet on the viscosity of the jejunal contents or gizzard weight (Table 6). Oil digestibility was significantly ($P < 0.01$) affected by diet treatment (Table 6). Birds fed on diet Y25 had significantly lower oil digestibility values than birds fed C, AV, Y21 or Y8N1 and birds fed diet Y8N5 had significantly lower values than birds fed C or AV. NDF digestibility was also significantly ($P < 0.001$) affected by diet (Table 6). Birds receiving diet Y21 had significantly higher NDF digestibilities than birds fed all other diets, except Y8N1. Values for birds fed Y8N1 were significantly higher than those for birds fed C and for all diets, except, C, Y81 and AV were significantly higher than those for Y8N5.

DISCUSSION

During this experiment, intake was numerically highest for birds fed the diet supplemented with yeast 2012, at the higher rate of inclusion, although not significantly higher. Taking into consideration previous work (Owens, 2004), where yeast 2012 supplementation also gave higher intakes, it would seem that the addition of this product to poultry feed tends to increase the birds' dry matter intake. One reason for increased intake may be due to improved palatability of the diet containing the yeast extract 2012. This product is used as a flavour enhancer in the food industry and imparts a strong savoury flavour. The flavour enhancing properties of these products is due to the yeast's nucleic acid content. The nucleotides add flavour to human foodstuffs by accentuating the effects of glutamic acid or monosodium glutamate. However, no product has yet been reported to increase poultry feed consumption of a commercial diet on a taste basis. This may be because the chicken does not have an acute sense of taste. Increased intake may also be due to improved bird health. Improved health may be a result of yeast-pathogen binding (Ofek *et al.*, 1977; Mirelman *et al.*, 1980) or the immunoregulating ability of the nucleotides (Savage and Zakrewska, 1996). It is well known that a healthy bird, free from disease, will have increased feed intake and/or feed utilisation (Hayes and Jensen, 2003).

The lack of response of the birds to the yeast supplementation in this study may be due to the nature of the experimental conditions in this study. It has been reported that, in order for the yeast products to be effective, the birds need to be put under stress in some way (Cruickshank, 2002). An attempt was made to challenge the birds in this experiment, by placing birds in litter floor pens. However, this still did not have the desired effect, with the birds fed the yeast-supplemented diets showing no improvements in performance. The pens used in this experiment by no

means compare to the rearing conditions in the poultry industry, where chickens are raised under intensive production systems in densely populated colonies or flocks. Chickens are stressed by various factors such as transportation, overcrowding, vaccination, chilling and/or overheating; and these tend to create an imbalance in the intestinal microflora and a lowering of the body's defence mechanism (Rigby *et al.*, 1980; Ooesterom *et al.*, 1983; Suzuki *et al.*, 1989; Line *et al.*, 1997). It has been claimed that it is under these conditions that the addition of the yeast extract suppresses or eliminates harmful organisms in the intestine and improves growth and feed efficiency (Miles and Bootwalla, 1991). If the experimental conditions had been more challenging, then greater improvements with yeast supplementation may have been obtained. This theory of increasing challenge agrees with conclusions in a recent broiler trial (Cruickshank, 2002). This trial compared 4 well known yeast derived products with an antibiotic and a negative control. Their findings indicated that under real commercial farm conditions, with higher stocking densities and increased disease challenge, a greater positive response to the yeast products was obtained. The enrichment of the standard yeast 18 with nucleotides had no apparent effect on the performance of the penned or caged birds. This could again be due to the insufficient challenge provided for the birds under the conditions of this experiment. It is also possible that the nucleotide content was not a contributing factor. It was found that for diets Y25 and Y8N5, oil digestibility was significantly lower than for diets containing no yeast supplementation. Also NDF digestibility was significantly higher for diets Y21 and Y8N1, than for the control diet. It has been suggested that the oligosaccharides in the yeast have a positive effect on digestive enzyme function. Iji *et al.* (2001) found an increase in specific activities of most brush border membrane enzymes in the jejunum with supplementation with an

oligosaccharide. It is not clear why oil digestibility and energy metabolisability tended to be reduced by the addition of the yeast. The rate of inclusion of the yeast extract 2012 was also investigated in this experiment. Yeast extract 2012 was added at 100 and 500g/T with no apparent difficulties.

To conclude, the addition of the different yeast products to the diet had no significant benefits on performance to the penned birds. In the caged experiment, yeast extract 2012 seemed to have a positive effect on intake in relation to the positive (AV) and negative (C) controls, but this was only statistically significant in the second week. There was no apparent advantage to performance by the enrichment of the standard yeast products with nucleotides. The lack of positive responses to diet supplementation with the yeast products may have been due to the lack of stress on the birds in this experiment. To fully test these products an environment similar to a commercial situation, which provides more bird challenge, should be used.

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Table 1. *Basal diet formulation*

Component	g/kg
Wheat	650
Soya	194.5
Full fat soya	40
Fish meal	40
Vegetable blend	25
Dicalcium phosphate	14
Limestone	8
Minerals/vitamins	7
Binder	6
Methionine	4
Titanium dioxide	3
Sodium bicarbonate	2
Salt	2
Lysine	2
Threonine	2
Choline chloride	0.5

Table 2. *Determined proximate analysis of the diet (values expressed on dry matter basis)*

Analysis	g/kg
Crude protein	230.6
NDF	119.4
Ash	65.0
Ether extract	52.0

Table 3. *Effect of yeast extract and antibiotic supplementation on penned bird performance*

	Age (d)	C	AV	Y21	Y25	Y81	Y8N1	Y8N5	*P*	SEM
DMI (g/d)	0-7	14.1	13.7	14.2	13.2	14.6	12.9	13.5	NS	0.87
DMI (g/d)	7-14	42.8	41.5	40.1	40.6	40.3	40.3	41.5	NS	1.97
DMI (g/d)	14-21	80.8	78.5	78.6	74.7	74.3	76.9	77.6	NS	2.46
DMI (g/d)	0-21	45.9	44.6	44.3	42.9	43.0	43.4	44.2	NS	1.66
LWG (g/d)	0-7	12.0	12.0	11.6	10.7	11.6	10.8	10.9	NS	0.92
LWG (g/d)	7-14	35.7	32.4	32.3	31.4	30.6	32.6	32.1	NS	1.88
LWG (g/d)	14-21	59.7	60.3	59.5	59.1	59.0	59.2	60.3	NS	1.62
LWG (g/d)	0-21	35.8	34.9	34.5	33.7	33.7	34.2	34.1	NS	1.28
Gain:feed	0-7	0.86	0.87	0.81	0.80	0.78	0.83	0.80	NS	0.025
Gain:feed	7-14	0.83	0.78	0.80	0.77	0.75	0.81	0.75	NS	0.022
Gain:feed	14-21	0.74	0.77	0.76	0.79	0.80	0.77	0.78	NS	0.018
Gain:feed	0-21	0.81	0.78	0.78	0.79	0.80	0.78	0.77	0.094	0.007

DMI = dry matter intake, LWG = live weight gain, C = Control diet, AV = Avilomycin added to diet, Y21 = Yeast 2012 (100 g/t), Y25 = Yeast 2012 (500 g/t), Y81 = Standard yeast extract, Y8N1 = Standard yeast (100 g/t), Y8N5 = Standard yeast (500 g/t).

Table 4. *Effect of yeast extract and antibiotic supplementation on caged bird performance.*

	Age (d)	C	AV	Y21	Y25	Y81	Y8N1	Y8N5	*P*	SEM (I)
DMI (g/d)	7-14	40.9	39.8	39.1	41.5	39.1	40.1	40.9	NS	1.02
DMI (g/d)	14-21	80.1[a]	79.5[a]	83.7[ab]	86.4[b]	85.0[b]	83.3[ab]	84.2[ab]	<0.05	1.62
DMI (g/d)	21-28	121.2	117.8	120.8	124.2	123.6	123.5	116.1	NS	2.66
DMI (g/d)	7-28	80.8	78.7	81.4	83.8	82.6	82.7	80.5	NS	1.40
LWG (g/d)	7-14	35.0	33.6	32.8	35.2	33.7	33.3	33.3	NS	1.06
LWG (g/d)	14-21	60.8	62.5	65.3	65.9	66.6	64.1	63.8	NS	1.67
LWG (g/d)	21-28	85.3	83.6	81.6	84.1	86.0	82.9	81.6	NS	2.78
LWG (g/d)	7-28	60.4	59.4	59.9	61.4	62.1	60.3	59.5	NS	1.36
Gain:feed	7-14	0.85	0.87	0.84	0.85	0.87	0.84	0.82	0.099	0.014
Gain:feed	14-21	0.76	0.78	0.78	0.76	0.79	0.77	0.76	NS	0.014
Gain:feed	21-28	0.71	0.71	0.67	0.67	0.69	0.67	0.71	NS	0.016
Gain:feed	7-28	0.75	0.75	0.73	0.73	0.75	0.73	0.74	NS	0.010

DMI = dry matter intake, LWG = live weight gain, C = Control diet, AV = Avilomycin added to diet, Y21 = Yeast 2012 (100 g/t), Y25 = Yeast 2012 (500 g/t), Y81 = Standard yeast extract, Y8N1 = Standard yeast (100 g/t), Y8N5 = Standard yeast (500 g/t).
[a,b] Values within a row not sharing a common superscript are significantly different ($P < 0.05$).

Table 5. *Effect of yeast extract and antibiotic supplementation on metabolisability of diet*

	C	AV	Y21	Y25	Y81	Y8N1	Y8N5	*P*	SEM
GEI (MJ consumed/7 d)	10.23	10.71	10.87	10.91	10.98	10.61	10.50	NS	0.221
MEI (MJ)	7.62	8.18	7.98	7.81	8.01	7.67	7.44	NS	0.215
ME:GE ratio	0.745[a]	0.762[ab]	0.733[ab]	0.716[b]	0.729[b]	0.723[b]	0.709[b]	<0.01	0.0098
AME content (MJ/kg)	14.12[a]	14.43[ab]	13.91[ab]	13.58[b]	13.83[b]	13.63[b]	13.39[b]	<0.01	0.185
ME:gain (MJ/kg)	18.90	19.29	18.91	18.57	18.39	18.72	18.06	NS	0.296

GEI = gross energy intake, MEI = ME intake, C = Control diet, AV = Avilomycin added to diet, Y21 = Yeast 2012 (100 g/t), Y25 = Yeast 2012 (500 g/t), Y81 = Standard yeast extract, Y8N1 = Standard yeast with nucleotides (100 g/t), Y8N5 = Standard yeast with nucleotides (500 g/t).

[a,b] Values within a row not sharing a common superscript are significantly different ($P < 0.05$).

Table 6. *Effect of diet on jejunal viscosity, gizzard weight and nutrient digestibility*

	C	AV	Y21	Y25	Y81	Y8N1	Y8N5	P	SEM
Viscosity (cP)	6.08	6.84	6.53	7.04	6.31	5.88	6.55	NS	0.453
Gizzard weight (g)	23.38	21.91	20.27	21.90	23.01	21.82	22.50	NS	1.588
Oil digestibility	0.69^{c}	0.70^{c}	0.65^{b}	0.56^{a}	0.62^{ab}	0.65^{b}	0.61^{ab}	<0.01	0.025
NDF digestibility	0.37^{ad}	0.38^{acd}	0.44^{b}	0.40^{ac}	0.40^{acd}	0.41^{bc}	0.35^{dc}	<0.001	0.012

C = Control diet, AV = Avilomycin added to diet, Y21 = Yeast 2012 (100 g/t), Y25 = Yeast 2012 (500 g/t), Y81 = Standard yeast extract, Y8N1 = Standard yeast with nucleotides (100 g/t), Y8N5 = Standard yeast with nucleotides (500 g/t).

^{a,b} Values within a row not sharing a common superscript are significantly different ($P < 0.05$).