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Effects of baker's yeast as a growth promoter supplemented at different levels on growth performance, gut morphology, and carcass characteristics of broiler chickens

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Abstract

A study was performed to determine the effects of varying levels of baker's yeast supplementation on growing performance, nutrient digestibility, gut morphology, and carcass characteristics of broiler chickens. A total of 200 day-old male Cobb 500 broiler chicks were used and divided equally into 5 dietary treatments: T1 (control), T2 (control + 0.1% baker's yeast), T3 (control + 0.2% baker's yeast), T4 (control + 0.4% baker's yeast), and T5 (control + 0.8% baker's yeast) with 4 replicates per treatment and 10 birds per replicate. All birds were given the same management and environmental conditions. Significant differences ($P<0.05$) were observed, with T4 (71.26±0.03 g/d) showed the highest value in weight gain compared to control diet (66.59±0.50 g/d). In FCR, T4 (1.86±0.08) showed the lowest value compared to control diet (2.07±0.08). Also in ileum villus height T4 (1226.1±0.81 µm) showed the highest value compared to control diet (1080.7±0.48 µm). However, no significant difference ($P>0.05$) was observed for cryptal depth, dry matter and metabolizable energy among all treatments. Meat, bone, and fat ratios recorded significant differences ($P<0.05$) between dietary treatments and control group. However no significant difference was observed in the dressing percentage among all dietary treatments. The study indicates that dietary supplementation of 0.4% baker's yeast in the diet increases the growth performance and carcass characteristics, and also improves intestinal morphology and nutrient absorption of broiler chickens.

Keywords: Broiler chickens, baker's yeast, growth performance, carcass characteristics, gut morphology, nutrient absorption.

Introduction

Yeast organisms have already become one of the earliest additives used in the livestock sector. Throughout history, people have used yeast for fermentation and baking. The role of yeast microorganisms is very important for the host and analysing the effect of yeast in animal's intestine is incomplete without emphasizing the importance of the yeast role itself. Supplementation of yeast products in poultry feed as a feed additives has been applied for so many years. Various yeast products such as commercial yeast products, yeast fermented mash produced on farm or yeast by-products from distilleries have been included in animal's diet (Saied *et al.*, 2011). *Saccharomyces cerevisiae* or known as baker's yeast, a unicellular cell, is one of the eukaryotic microorganisms. However, some of the yeasts may become multicellular through the string of connected budding cells known as pseudohyphaes. The size of the yeast may vary depending on the species. It may have a diameter measuring 3-4 µm although some may reach 40 µm (Walker *et al.*, 2002). Mitosis is a way how yeast reproduces asexually and also by others asymmetric division process called budding.

Saccharomyces cerevisiae has been used commercially and also has the excellent adsorbents properties. It rich in crude protein and also has good biological value (Reed and Nagodawithana, 1999). *Saccharomyces cerevisiae* cell wall and its products have been proven to enhance animal's performance, physiology, gut morphology, and also enhance the GIT environment of the animals (Sims *et al.*, 2004; Rosen, 2007; Huff *et al.*, 2010) and broiler chicks (Zhang *et al.*, 2005). Apart from that, it also known to help in the production of vitamin B complex, digestive enzyme, and also enhances the immunity against toxins that could harm the animals (Martinez Amezcua *et al.*, 2004; Silversides *et al.*, 2006).

The effects of baker's yeast on broiler chicks had also demonstrated its ability in replacing antibiotic-based drugs in broiler diets (Hooge *et al.*, 2003; Stanley *et al.*, 2004). Although many studies has been reported on the effect of baker's yeast in poultry, however the information on the suitable level of the baker's yeast inclusion in the broiler feed is still not conclusive. Therefore, the aim of this study was to investigate the effects of baker's yeast supplementation at different levels on the growth performance, nutrient digestibility, carcass characteristics, and gut morphology in broiler chickens.

Materials and Methods

Location

The experiment involved both laboratory analyses and an animal trial. The laboratory analyses were done at Nutrition Analytical Laboratory at Department of Animal Science, Faculty of Agriculture, Universiti Putra Malaysia while the animal trials was done at Poultry Unit, Farm 2, Faculty of Agriculture, Universiti Putra Malaysia.

Management of animals

The experiment was conducted using 200 day-old male broiler chicks of Cobb 500 strain from 1 until 42 d of age. The broiler chicks were obtained from a commercial hatchery and originated from the same breeder flock. Chickens were wing banded and reared in a cage system of approximately same age and weight. The chicks were randomly divided into 5 treatment groups, with 4 replicates and each replicate consisted of 10 chicks and the initial body weight was recorded. The chicks were raised in stainless steel battery cages provided with feeders and water. The water and feed were given *ad libitum*. The treatment diet was given to the chicken at day 21 until day 42. At day 1 until day 20, the chicks were fed with a commercial starter diet. The chicks were vaccinated against Newcastle disease via intraocular route at 7 and 14 d of age.

Diets and treatments

The dietary treatments were iso-nitrogenic and iso-caloric formulated according to NRC (1994) (Table 1) and given starting day 21 until day 42. The baker's yeast was added in the ration of finisher broiler diet as a probiotic. The dietary treatments were T1 (control), T2 (control + 0.1% baker's yeast), T3 (control + 0.2%

baker's yeast), T4 (control + 0.4% baker's yeast), and T5 (control + 0.8% baker's yeast). At the age of 42 d, all birds were slaughtered according to the halal procedure as outlined in MS1500:2009 (Department of Standards, Malaysia 2009).

Table 1: Composition of the experimental diets (finisher)

	Diets[1]				
Ingredients (%)	T1	T2	T3	T4	T5
Baker's yeast	0	0.1	0.2	0.4	0.8
Corn	60.3	60.2	60.1	59.9	59.5
Soybean meal	31	31	31	31	31
Fish meal	3	3	3	3	3
Palm oil	2.45	2.45	2.45	2.45	2.45
Limestone	1.3	1.3	1.3	1.3	1.3
Salt	0.4	0.4	0.4	0.4	0.4
Choline chloride	0.2	0.2	0.2	0.2	0.2
Dicalcium phosphate	0.65	0.65	0.65	0.65	0.65
Lysine	0.1	0.1	0.1	0.1	0.1
DL-Methionine	0.4	0.4	0.4	0.4	0.4
Vitamin premix	0.1	0.1	0.1	0.1	0.1
Mineral premix	0.1	0.1	0.1	0.1	0.1
Total	100	100	100	100	100
CP (%)	20.26	20.26	20.25	20.23	20.23
ME (Kcal/kg)	3031	2887	2904	2885	2885

[1]Diets: T1 (without baker's yeast), T2 (0.1% baker's yeast), T3 (0.2% baker's yeast), T4 (0.4% baker's yeast), T5 (0.8% baker's yeast)

Digestibility trial

The faeces from each cage were collected starting from day 36 until day 41. The samples were collected daily for 6 d and then mixed well in a pail. The faeces were then weighed and put into an aluminium foil cup, labeled and dried in the oven for 72 h under 65^{o}C. The dried faeces were analysed for their nutrient content (Dourado *et al*., 2010).

Chemical analysis

Feed and faecal samples were analyzed for proximate composition according to the methods of Association of Official Analytical Chemist (AOAC, 1997). The analysis was done to determine the dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), and gross energy (GE).

Villus height and crypt depth

At 42 d of age, 3 birds from each replicate were slaughtered and 2-cm segments of ileum between Meckel's diverticulum and ileocaecal junction were taken. The specimens were fixed in 10% formalin after which they were dehydrated in 100% ethanol. The specimens were then cleared with xylene and embedded in paraffin. A microtome was used to make 5-mm cuts that were then mounted on glass slides and stained using the H and E (Haematoxyline and Eosin) method (Houshmand *et al.*, 2012). Three readings each of villus height and crypt depth were taken per specimen. This was done with a light microscope Motic, model BA410, China, Software Motic Images Plus 2.0, camera Moticam Pro 285A. Villus height was measured from the apical to the basal region which corresponded to the superior portion of the crypt. Crypt depth was measured from the basis until the region of transition between the crypt and the villus.

Carcass characteristics

On day 42, 3 chickens from the previous villus height and crypt depth studies were defeathered and eviscerated. The head, legs, and viscera were removed and the carcass was weighed. The dressing percentage was calculated by dividing the carcass weight to live weight of the bird multiplied by 100 as described by Faysal (2015). The meat, fat, and bone were weighed for meat, fat and bone ratios.

Statistical analysis

Data were analyzed using SAS (Statistical Analysis System). Results are presented as mean ± SE using one-way ANOVA to test the effect of baker's yeast on growth performance, nutrient digestibility, carcass characteristics, and gut morphology of broiler chickens. All differences among means were considered significant at $P \leq 0.05$ using Duncan's multiple range test.

Results and Discussion

Growth performance

Significant differences were detected between control and the treatment groups, in terms of FCR and final body weight gain (Table 2). This is in agreement with Tabidi *et al.*, (2013) when yeast product was included in the diet. It was believed to be due to content of amino acid, organic acid, oligosaccharides, aroma, flavour, and also some unknown growth factors in the baker's yeast that provided those effects (Adebiyi *et al*., 2012). In a study conducted by Zhang *et al.*, (2005), supplementation of 0.5% baker's yeast in the basal diet of poultry gave similar effect due to the rich source of B-complex, protein, and minerals in the yeast (Giec and Skupin, 1988). On the contrary, no improvement was observed when yeast product was included in diets of early weaned pigs which could probably be due to the different strain of yeast used which was brewers dried yeast (*Saccharomyces pastorianus*) (White *et al.*, 2002). The response of animals to yeast product in the feed might be different due to the yeast product itself either in the dried or fermented form (Gao *et al.*, 2008), methods of application either in feed or drinking water, breed and age of birds, and level of biosecurity (Perreten, 2003; Stanley *et al.*, 2004; Gao *et al.*, 2008).

Table 2: Growth performance of broiler fed with different levels of baker's yeast (mean ± SE)

Parameters	Treatment groups (Diets)[1]				
	T1	T2	T3	T4	T5
Initial body weight (g) 21 d	851±5.60[a]	848±2.54[a]	847±0.70[a]	844±0.60[a]	843±0.77[a]
Final body weight (g) 42 d	2249±5.18[c]	2330±1.72[b]	2332±0.40[b]	2340±0.26[a]	2342±0.30[a]
Weight gain (g/day) 22 - 42 d	66.59±0.50[c]	70.57±0.07[b]	70.70±0.04[ab]	71.26±0.03[a]	71.36±0.03[a]
FCR 22 - 42 d	2.07±0.08[a]	1.96±0.03[ab]	1.86±0.03[b]	1.86±0.08[b]	1.82±0.07[b]
Feed intake (g/day) 22 - 42 d	139±4.86[a]	138±1.97[a]	131±1.83[a]	132±5.78[a]	130±5.23[a]

[1]Diets: T1 (without baker's yeast), T2 (0.1% baker's yeast), T3 (0.2% baker's yeast), T4 (0.4% baker's yeast), T5 (0.8% baker's yeast)
[a b c] Values within column with different superscripts are significantly different (P<0.05)

Nutrient utilization

In terms of nutrient digestibility, no significant difference (P>0.05) was observed in the values of the DM and ME digestibility (Table 3). Supplementation of baker's yeast as a feed additive in the present study did not affect feed digestibility and the energy used by the birds. Although no significant difference was observed in both DM and ME digestibility, the values of other nutrients such as CF, EE, and OM were significantly different (P<0.05) when compared to the control. This results are in congruency with Abaza *et al*., (2008) who reported probiotic supplementation gave an effect mostly on digestibility coefficient parameters compared to control treatment. As for CP digestibility, no significant difference was observed between T1 and T2. However significant differences were observed as the level of yeast increased, as T5 recorded the higehst value of CP digestibility. This is because the protein is considered as an organic compound used to build the cells, tissues, and organs for the body. Proteins are made up from many amino acids, some of which are essential for growth and production. These statements support the conclusion of Reed *et al*. (1999) who considered yeast as one of the effective adsorbents rich in crude protein (40-45%). For ether extract digestibility, significant differences (P<0.05) were observed between T1 and supplemented treatments. Supplementing baker's yeast in the broiler diet had improved the digestibility of fat. However, the mechanism of action of baker's yeast in improving the nutrient digestibility is not clearly understood. It is speculated that the presence of yeast in the diet has probably enhances the colonization of lactic acid bacteria and finally decreases the population of harmful bacteria over competitive exclusion. On top of that, another possible reason is that it could be due to mannanoligosaccharides of *Saccharomyces cerevisiae* that act as a source of nutrient for other gastrointestinal microbes to establish. Therefore, from this, enhancement of nutrient digestibility might be due to the drop in pathogenic load and an increase in beneficial bacteria in gastrointestinal tract. Afsharmanesh *et al.* (2010) reported that ileal digesta of broiler chickens fed with yeast in both wet and dry diets can also have enhanced absorption of nutrients as acidification can reduce the emptying rate of the stomach and enhanced the digestion process.

Table 3: Nutrient digestibility of broiler fed with different levels of baker's yeast (mean ± SE)

	Treatment groups (Diets)[1]				
Parameters	T1	T2	T3	T4	T5
DM %	61.12±0.30[a]	60.94±0.48[a]	61.40±0.14[a]	61.51±0.24[a]	60.84±0.19[a]
CP %	54.24±0.008[d]	54.25±0.02[d]	54.47±0.01[c]	54.66±0.01[b]	55.45±0.07[a]
EE %	50.49±0.16[b]	53.25±0.16[a]	53.47±0.13[a]	53.45±0.10[a]	53.49±0.17[a]
CF %	44.41±0.11[b]	44.40±0.19[b]	44.52±0.16[b]	45.51±0.09[a]	45.62±0.11[a]
ME (Kcal/kg)	2901±0.04[a]	2887±0.08[a]	2899±0.05[a]	2911±0.02[a]	2908±0.05[a]
OM %	61.36±0.08[a]	61.15±0.31[a]	61.33±0.21[a]	61.58±0.19[a]	60.10±0.42[b]

[1]Diets: T1 (without baker's yeast), T2 (0.1% baker's yeast), T3 (0.2% baker's yeast), T4 (0.4% baker's yeast), T5 (0.8% baker's yeast)
DM-Dry matter; CP-Crude protein; EE-Ether extract; CF-Crude fiber; OM-Organic matter; ME-Metabolizable energy
[a b c d] Values within column with different superscripts are significantly different (P<0.05)

Carcass characteristics

No significant differences (P>0.05) between treatments were observed in the carcass dressing percentage (Table 4). This was consistent with Abaza *et al*., (2008) who reported that the carcass dressing rates were not affected by levels of yeast in the feed. Meat and fat yield demonstrated a significant difference (P<0.05) when comparing between the T1 and the yeast supplemented groups, as T4 recorded the highest values for meat and T1 for fat yield. However, no significant differences (P>0.05) were observed in the bone yield among the treatments. In terms of meat to bone ratio, significant differences (P<0.05) were observed between the treatment groups.

Table 4: Carcass characteristics of broiler fed with different levels of baker's yeast (mean ± SE)

	Treatment groups (Diets)[1]				
Parameters	T1	T2	T3	T4	T5
Dressing percentage (%)	73.32±0.69[a]	74.55±0.20[a]	76.25±1.04[a]	76.84±2.55[a]	76.93±1.88[a]
Meat yield (g)	871±0.48[d]	1002±0.48[c]	1012±0.7[b]	1090±2.5[a]	1087±0.48[a]
Fat yield (g)	64.18±0.09[a]	57.45±0.17[d]	57.60±0.09[d]	63.08±0.08[b]	58.33±0.13[a]
Bone yield (g)	324±0.48[a]	326±0.75[a]	325±0.51[a]	326±0.15[a]	325±0.91[a]
Meat : bone (g)	2.69±0.004[d]	3.07±0.006[c]	3.11±0.003[b]	3.34±0.007[a]	3.35±0.009[a]
Meat : fat (g)	13.57±0.01[b]	17.45±0.05[ab]	17.59±0.02[ab]	17.29±0.04[ab]	18.64±0.05[a]
Bone : fat (g)	5.05±0.009[a]	5.68±0.02[a]	5.65±0.006[a]	5.17±0.007[a]	5.57±0.01[a]

[1]Diets: T1 (without baker's yeast), T2 (0.1% baker's yeast), T3 (0.2% baker's yeast), T4 (0.4% baker's yeast), T5 (0.8% baker's yeast)
[a b c d] Values within column with different superscripts are significantly different (P<0.05)

As for meat to fat and bone to fat ratio, significant differences (P<0.05) were observed between the supplemented baker's yeast and the control group. No significant differences (P>0.05) were observed in dressing percentage among the treatments although the birds fed with baker's yeast showed slightly better dressing percentage compared to control treatment. Dressing percentage is defined as the percentage of the carcass yielded after evisceration, removal of head, feet, and viscera. Inclusion of probiotic manna-oligosaccharides in broiler chickens was shown to increase the mineral retention and enhance the mineralization of bone (Hayat *et al.*, 1993) which was similar to the findings of the present study. According to the result of meat to bone ratio and meat to fat ratio, it showed that the rate of meat conversion from the feed was very efficient with the supplementation of baker's yeast. The enhancement in meat:fat and meat:bone ratio might be due to the action of dry yeast fed to the birds and keeping normal gastrointestinal tract environment by competitive exclusion and antagonism, thus altering metabolism by activating digestive enzyme action and reducing bacterial enzyme activity and ammonia production (Kabir, 2009). Improvement of meat:fat and meat:bone also could be due to improvement of feed digestibility and the improve action of nutrient breakdown, and eventually would have increased growth rate and meat weight (Abdelgader, 2006). Still, the trial was to some extent limited, and not be able to confirm these explanations.

Gut morphology

In terms of gut morphology, the morphology of the intestine can provide some information on GIT health. Shorter villi and deeper crypts are those changes shown when toxin is present in the GIT (Yason *et al.*, 1987). The villus height among T1, T2, and T3, showed no significant difference but showed significant differences (P>0.05) when comparing with T4 and T5. The increase in the villus height suggested that the process of nutrient absorption in the animal's intestine had improved. This also suggested that the increase in villus height could triggers the production of the enzyme from the tip of the villi, thus, enhanced the nutrient digestibility. This current result is in agreement with another researchers who recorded an increase in villus height when yeast were included in diets of rabbit, broiler, and turkey (Sims *et al.*, 2004; Baurhoo *et al.*, 2009). From this result, it also showed that the component of cell wall from yeast products have the ability to protect the mucosa of the villi by preventing the harmful bacteria from attaching to villi and minimize the attachment of antigens to the villi. Moreover, this explained why the birds supplemented with T4 and T5 diet had improved in term of their performances since villus height in these two groups had increased which improved the absorption of available nutrients. On top of that, the increase in villi height would directly activate the epithelial cell turnover and also boost the activation of cell mitosis (Dunham *et al.*, 1993). Development of intestinal morphology could reflect the health status of the gastrointestinal tract of an animal. In contrast with crypt depth, there was no significant difference shown among the treatments.

Table 5: Gut morphology of broiler (mean ± SE)

	Treatment groups (Diets)[1]				
Ileum (µm)	T1	T2	T3	T4	T5
Villus height	1080.7±0.48[b]	1082.4±0.52[b]	1082.5±0.65[b]	1226.1±0.81[a]	1226.9±0.45[a]
Crypt depth	412±1.29[a]	413±0.65[a]	413±1.08[a]	415±1.19[a]	414±1.08[a]

[1]Diets: T1 (without baker's yeast), T2 (0.1% baker's yeast), T3 (0.2% baker's yeast), T4 (0.4% baker's yeast), T5 (0.8% baker's yeast)
[a b] Values within column with different superscripts are significantly different (P<0.05)

Conclusion

The study shows that 0.4% supplementation of baker's yeast in the basal diet of broiler chickens improved body weight gain, feed conversion ratio, meat:bone ratio, meat:fat ratio and the performance of gut integrity. The feeding of yeast at 0.4% and 0.8% levels showed no significant difference between them as 0.8% supplemented group showed slightly heavier body weight gain compared to 0.4% supplemented group.

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