Study on effects of different levels of yeast on growth performance and gut morphology of commercial broilers in Chittagong, Bangladesh

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List of abbreviations

Abbreviation	Elaboration
YCW	Yeast cell wall
gm.	Gram
µm	micrometer
N	Frequency number
DP	Degree of polymerisation
FCR	Feed conversion ratio
Kg	kilogram

ABSTRACT

The study was conducted to investigate the effect of diets formulated with different levels of *Saccharomyces* yeast on growth and gut morphology of broilers. Day-old broiler chicks of either sex (Cobb 500; n= 240) were distributed randomly into 4 (four) dietary treatments, each replicated three times, twenty birds per replicate in a completely randomized block design. Birds were reared in an open-sided housing condition with similar feeding, lighting and environmental management condition up to 35 days. Data were collected for feed intake and body weight and body weight gain and feed conversion ratio were calculated. Dressing percentage, organ weight and gut morphology of birds were measured at the end of the experiment. At 35 days of age, two birds from each replicate were sacrificed after 12 hours of fasting and samples of ileum and jejunum were taken. Result indicated that use of yeast had no significant effect ($P < 0.05$) on feed intake and body weight of broiler. Effect of different treatments on feed conversion ratio (FCR) of broilers differed significantly at 3rd week of age ($P<0.05$). Highest dressing percentage (72.44%) was found in the broilers that received 2 % yeast treated diet but it did not differ significantly. No adverse effect was observed with respect weights of different organs of birds fed yeast. However, significantly highest liver weight (3.92 gm.) was obtained in the birds fed 2.5% yeast. In present study, no significant differences were found in the villus height, crypt depth and muscularis height with increasing level of yeast supplementation where birds fed 2% yeast had the highest mean value. Finally, it was concluded that using of 2% yeast in poultry diet would be advantageous for better growth performance of broilers without any detrimental effects.

Key words: Broiler, Yeast, Gut morphology, Growth performance

CHAPTER I

INTRODUCTION

Bangladesh is an agriculture based country and about 60% of her population is directly or indirectly related to agricultural activities. At present agriculture sector contributes about 22% of GDP of the country (BBS, 2009). Peoples are getting relatively cheaper source of animal protein in the form of broiler meat. So, broiler farming has become one of the major poultry industries in Bangladesh. In terms of cost, feed is the most important input for poultry production, and the availability of low-priced, high-quality feeds is critical for the expansion of the poultry industry. There is a major demand to produce high quality poultry meat at low price without relying on antibiotics and other drugs in poultry feed and water. One of the major challenges faced by poultry industry in the developing world is the issue of improving efficiency of production. In an attempt to address this issue, series of efforts have been made by researchers.

Saccharomyces cerevisiae, is a unicellular yeast that has been developed to use in animal feeds (Rosen, 2007). Broiler production can be improved by maintaining the intestinal integrity with the inclusion of yeast in their diets (Baurhoo *et al.*, 2007). Typically, the yeast cell wall (YCW) is composed of β-glucans, mannoproteins, and chitin with varying degrees of polymerisation, as presented in Table 1. YCW components can vary depending upon growth conditions, time of harvesting (Klis *et al.*, 2006) and most importantly, strains of yeast. In general, baker's yeast is used for producing high quality β-glucans with good therapeutic applications (Kim *et al.*, 2007). It is a probiotic as well as a fermenter could be used to improve feed quality and/or enhance feed nutrient utilization of broilers. Probiotics acting as bioregulators of the intestinal microflora and reinforcing the host’s natural altitude defenses. Mannan-oligosaccharides are thought to block the attachment of pathogenic bacteria to the animal's intestine and colonization that may result in disease, while acting as a nutrient to other beneficial bacteria.

Table 1: YCW components with their molecular weight and degree of polymerisation (DP)

Macromolecules	Cell wall mass (%, dry weight)[a]	Mean molecular weight, kDa (DP)
Mannoproteins	35–40	Highly variable
1,3 β-Glucan	50-55	240(1500)
1,6 β-Glucan	5-10	24(150)
Chitin	2	25(120)

a = Kwiatkowski *et al.*, 2009.

Benefits of YCW β-glucans in poultry production can be partially attributed to enhanced proliferation and phagocytosis by avian macrophages and heterophils (Lowry *et al.*, 2005). Furthermore, YCW β-glucans can enhance broiler performance under unhygienic conditions through increases in villi height, uniformity and integrity, leading to improved intestinal function and gut health (Yang *et al.*, 2007).

Shareef and Al-Dabbagh (2009) showed that body weight gain were significantly ($P<0.05$) increased in the treatments having yeast at a rate of 1, 1.5 and 2%, compared with the control diet. These birds also had a significantly ($P<0.05$) higher feed intake and feed conversion ratio than others.

Adebiyi *et al.* (2012) conducted a experiment on ninety six day-old broiler chicks allotted to four dietary treatments in a completely randomized design. Each treatment had 3 replicates and there were eight birds per replicate. T1 (control), T2 (1g/kg yeast supplementation), T3 (1.25g/kg yeast supplementation), T4 (1.5g/kg yeast supplementation) were fed to the birds on each treatment. No significant differences were observed in the weight gain of the birds in the treatments. However, bird's fed T2 had the least significant feed conversion ratio (2.10kg) when compared with their counterparts on the T1 (2.34kg). The analysis of the ileum and jejunum showed that the villus height, crypt depth, mucosa height and area of crypt gland of birds fed T4 increased significantly ($p<0.05$) compared with birds fed T1. Dietary inclusion of yeast culture at1.5g/kg increased the growth performance and improved intestinal morphology and nutrient absorption.

Feeds containing no chemical additives are increasingly used in poultry nutrition. Since antibiotic growth promoters have been discredited by consumer associations, there has been

an increasing trend in formulating diets without supplementation of synthetic drugs and chemical additives and many scientists are dedicated in finding natural alternatives to replace antibiotics as growth promoters (Langhout, 2000). Some studies have confirmed that the effects of yeast culture could be an alternative to antibiotic-based drugs in feed for broiler chicks (Stanley *et al.*, 2004). *Saccharomyces cerevisiae* also known "baker's yeast" is one of the most widely commercialized species and one of the effective adsorbents which is rich in crude protein (40-45%) and also rich in vitamin B complex, biotin, niacin, pantothenic acid and thiamin and its biological value is high. Whole yeast products or yeast cell wall components have been used to improve growth and affect the physiology, morphology and microbiology of the intestinal tract of turkeys and broiler chicks (Morales-Lopez *et al.*, 2009). Based on this background the main aim of the study was to investigate the effect of yeast on performance and gut condition of broiler chicks.

CHAPTER II

MATERIALS AND METHODS

2.1 Experimental site

The experiment was conducted at a contract broiler farm, Nandir hat, Chittagong, Bangladesh. The experiment was done under the supervision of Department of Dairy and Poultry Science, CVASU.

2.2 Experimental birds

A total of 240 day-old broiler chicks (Cobb 500) of either sex (Source: M. M. Agha Ltd., Chittagong, Bangladesh) was procured from a commercial dealers, and reared up to 35 days in an open-sided housing system to conduct the experiment.

2.3 Layout of the experiment

Day-old broiler chicks (n=240) were randomly distributed into four dietary treatments, each treatment was replicated three times. 20 birds per replicate were used in a completely randomized block design. The layout of the experiment is given in **Table 2**.

Table 2 : Layout of the experiment

Dietary treatments	Replications			Total no. of birds
	R1	R2	R3	
T1	20	20	20	60
T_2	20	20	20	60
T_3	20	20	20	60
T_4	20	20	20	60
Total Number	80	80	80	Grand Total=240

T1= Control (no yeast), T_2= 2 % yeast, T_3 = 2.5 % yeast and T_4= 3 % yeast

2.4 Experimental diet

Three experimental diets (Diet 1, Diet 2, Diet 3 and Diet 4) were formulated with maize, full fat soya, rice polish, soybean oil as energy sources; soybean meal, meat and bone meal as protein sources along with micro-nutrients to meet or exceed the NRC recommendations. Diet 1 has considered as control, Diet 2 contained 2 %, Diet 3 contained 2.5 % and Diet 4 contained 3 % yeast. These diets were fed to the birds as mash form at *adlibitum* from day1 to 35 days. Starter diets were offered to the birds from 1st to 15th days, and then finisher diets were used for rest of the trial period. All diets were made iso-caloric and iso-nitrogenous.

2.5 Experimental design

The experiment was performed by a Completely Randomized Design (CRD) consisting of four dietary treatments. The chicks were randomly divided into 4 groups consisting 3 replications in each group and were assigned to different treatments as shown in table 3.1. Twenty birds were allotted to each replication.

2.6 Performance data

Live weight, body weight gain, feed intake and feed conversion ratio were weekly determined. Carcass weight, organs weight and dressing percentage etc. were recorded at 35 days.

2.7 Dressing percentage and relative organs weight

The dressing percentage of broilers was calculated as follows:

Dressing percentage % = {(Dressed weight ÷ Body weight) x 100}

Chicks in all treatments were killed at the end of the experiment for blood collection and liver, gizzard, heart, spleen and proventriculus were collected, weighed, and calculated as a percentage of live body weight. Shank length and width were also recorded.

2.8 Gut morphology of broiler

At 35 days of age, two birds from each replicate were sacrificed after 12 hours of fasting and samples of ileum and jejunum 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 5mm cuts that were mounted on glass slides and stained following the H and E (Haematoxyline and Eosin) method. Five readings each of villus height and crypt depth were taken per specimen. This was done with a light microscope (Olympus). Villus height was measured from the apical to the basal region which corresponded to the superior portion of the crypts. Crypts were measured from the basis until the region of transition between the crypt and the villus.

2.9 Statistical analysis

Data were incorporated in Microsoft excel sheet (2007). Data were analyzed using one-way ANOVA of SPSS v.16 for windows and least square means were compared by Duncan's Multiple Range Test. All statements of differences were based on probability <0.5 or better.

CHAPTER III

RESULTS

Table 3 shows live performance of experimental birds. The results showed that use of yeast had no significant effect ($P < 0.05$) on feed intake of broiler. No significant differences were observed in weight gain of the birds fed on different dietary treatments. Highest body weight gain (440.63 gm.) was found in dietary treatment 2 at marketing stage which was not significant. Effect of four treatments on feed conversion ratio (FCR) of broilers significantly differed at 3rd week of age ($P<0.05$). Improved FCR (1.62) were obtained in dietary treatment 2 at 5 weeks of age.

Table 3: Feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) of broiler fed diets formulated with yeast from (1-35 days)

Parameters	Age	Dietary Treatments (Mean ± SE)				P value
		Diet 1	Diet 2	Diet 3	Diet 4	
Feed intake (gm/day)	1-7	147±7.57	140±6.78	154±8.46	148±10.14	0.72
	8-14	294±14.65	282±4.59	289±0.67	304±8.83	0.42
	15-21	527±51.57	517±4.50	539±18.24	484±81.93	0.87
	22-28	590±11.59	522±13.24	644±33.7	604±60.85	0.19
	29-35	781±32.31	708±12.24	684±16.94	766±39.86	0.10
Body weight gain (gm / day)	1-7	88±7.00	92±3.64	93±2.06	91±1.55	0.89
	8-14	152±12.15	142±2.66	170±9.49	157±6.58	0.19
	15-21	328±17.33	339±12.63	296±14.55	283±9.88	0.06
	22-28	374±12.74	325±20.32	343±19.68	246±37.46	0.58
	29-35	425±18.79	440±26.38	380±14.99	420±36.06	0.43
FCR(Feed Gain)	1-7	1.66±0.06	1.51±0.05	1.67±0.12	1.63±0.09	0.58
	8-14	1.94±0.09	1.77±0.06	1.71±0.09	1.93±0.03	0.15
	15-21	1.69±0.07[b]	1.53±0.05[b]	1.81±0.09[b,c]	1.88±0.04[c]	0.03
	22-28	1.76±0.08	1.62±0.12	1.90±0.05	1.82±0.09	0.23
	29-35	1.84±0.04	1.62±0.08	1.80±0.05	1.83±0.06	0.09

[Data represent means± SE of 9 birds per replicate group at day 35; D_1= Control (no yeast), D_2= 2 % yeast, D_3 = 2.5 % yeast and D_4= 3 % yeast, [a,b]Means bearing alphabet not in common within a row differed significantly at $P<0.05$].

Dressing percentage did not significantly differ (P<0.05) in the group of birds fed different levels of yeast. But, highest dressing percentage (72.44%) was shown in the birds having 2 % yeast treated diet. No adverse effects on various organs relative weights were noted in birds of all treatments (Table 4). In this study, significantly higher liver weight (3.92%) was obtained in the birds fed 2.5% yeast. On the other hand, relative weight of all internal organs was increased due to supplementation of 2.5 % yeast in diet.

Table 4: Effect of yeast on dressing and relative weights of different internal organs in birds at 5 weeks of age

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	P value
Dressing Percentage	68.57±0.62	72.44±3.81	69.57±0.69	70.30±0.60	0.59
Liver	3.56±0.05^{a,b}	3.72±0.07^{b}	3.92±0.12^{b}	3.29±0.16^{a}	0.02
Spleen	0.25±0.02	0.17±0.03	0.27±0.05	0.21±0.03	0.22
Heart	0.84±0.06	0.90±0.01	1.09±0.08	0.89±0.05	0.07
Gizzard	3.24±0.40	3.06±0.10	3.40±0.44	2.92±0.12	0.72
Proventriculus	0.87±0.09	0.84±0.06	0.97±0.15	0.89±0.08	0.80
Shank length	1.61±0.23	1.81±0.01	1.79±0.06	1.82±0.03	0.50
Shank width	0.53±0.11	0.56±0.02	0.63±0.05	0.47±0.03	0.37

[Data represent means± SE of 9 birds per replicate group at day 35; D_1= Control (no yeast), D_2= 2 % yeast, D_3 = 2.5 % yeast and D_4= 3 % yeast, ^{a,b}Means bearing different superscripts not in common within a row differ significantly at P<0.05].

Table 5 shows the gut morphological indices of broilers fed different levels of yeast. In our findings no significant differences were found in villus height, crypt depth and muscularis height with increasing level of yeast supplementation although birds fed diet 2 had the highest mean value for villus height and crypt depth. However, the result for the muscularis thickness showed that birds fed diet 4 had the highest mean for ileum (37.16 μm). From this result, it may be deduced that increase in the villus height suggests an increased surface area capable of greater absorption of available nutrients (Caspary, 1992).

Table 5: Gut morphology of broilers

	Parameters (µm)	Diet 1	Diet 2	Diet 3	Diet 4	P value
Ileum	Villus height	194.51±10.41	231.71±10.32	180.75±17.27	158.29±9.34	0.09
	Crypt depth	168.65±11.08	194.05±21.38	134.04±22.82	140.21±16.72	0.16
	Muscularis thickness	31.70±8.03	29.23±2.23	32.99±4.56	37.16±2.37	0.72
Jejunum	Villus height	359.36±26.66	377.65±26.38	347.30±38.09	341.03±21.85	0.82
	Crypt depth	266.49±38.76	282.60±15.86	209.20±37.25	243.73±28.56	0.43
	Muscularis thickness	32.40±2.31	31.54±4.16	26.47±2.55	30.73±3.18	0.57

CHAPTER IV
DISCUSSION

The huge potential of good quality food in promoting and maintaining adequate health has set the tone of research in the area of food for health world-wide (Kapila *et al.,* 2006). There are also a few sound data about the impact of probiotics on metabolic functions of the host (Mikelsaar *et al.,* 2009). Probiotics are mainly represented by mannanoligosaccharides and fructo-oligosaccharides present in the cell wall of yeasts, such as *Saccharomyces cerevisiae*. They exert their action by maintaining or reestablishing the conditions of eubiosis in the digestive tract, and thus, maintaining a normal microbial flora and balanced gastrointestinal tract (Santin *et al.,* 2001). Addition of probiotic to broiler feed resulted in significant improvement concerning hematobio-chemical parameters (Agawane *et al.,* 2004).

4.1 Feed intake of broilers

The results showed that feed intake did not significantly ($P<0.05$) differ between dietary treatment of broiler. This is in agreement with the findings of Al-Monsour *et al.* (2011) but contradicted to the findings of Shareef and Al-Dabbagh (2009) who reported that level of yeast significantly affect feed intake during the first three weeks of life. However, feed intake was found higher (781.50 gm) in control group (Diet 1) at 5 weeks of age which was not significant. This is in accordance with the findings of Saied *et al.* (2011) but contradictory with the findings of Adebiyi *et al.* (2012) and Gao *et al.* (2008). Adebiyi *et al.* (2012) and Gao *et al.* (2008) stated that birds supplemented with yeast consumed more and grew faster than broilers given feed without yeast.

4.2 Body weight gain of broilers

Result represents that no significant differences were observed in the values of the weight gain of the birds fed on the different dietary treatments. This is in agreement with the findings of Al-Mansour *et al.* (2011).The authors reported that yeast levels did not significantly affect body weight gain at first three weeks of life. Al-Monsour *et al.* (2011) also reported that body weight gain increased by the addition of yeast which was not statistically different between groups over the 42 day experimental period.

4.3 Feed conversion ratio of broilers

The FCR of broiler chickens for the entire duration of the experiment were determined. Result showed that the effect of four diets on feed conversion ratio (FCR) of broilers significantly differed ($P< 0.05$) at 3rd week of age. A significant improvement in FCR (1.53) was obtained in diet 2 at 3rd week of age. This is in agreement with the findings of Shareef and Al-Dabbagh (2009) who reported that addition of 1 % yeast on broiler ration significantly increased the FCR of broilers at 21 days of age. Author reported that baker yeast (*Saccharomyces cerevisiae)* supplementation of broilers, at the level of 1%, significantly ($P<0.05$), increased feed conversion efficiency, compared with control group and group added to its diet 0.5 % baker's yeast. Aluwong *et al.* (2012) found FCR 1.14 to1.18 for Marshall Broiler chickens at 42 days of age supplemented with 1.5 and 2.0% dietary *Saccharomyces cerevisiae*. Gao *et al.* (2008) reported that dietary supplemental yeast at 2.5g/kg improves feed conversion and average daily gain during grower and overall periods. But, Al-Monsour *et al.* (2011) reported that yeast level did not significantly affect FCR during the first three weeks of life. Probiotics act by reducing the feed conversion, thereby resulting in an increase of the daily live weight gain (Nilson *et al.*, 2004). Improvement in FCR might be due to efficient ileal digestibility of nutrients (Pelicia *et al.*, 2004). Bansal *et al.* (2011) reported significant and better weekly feed conversion efficiency on probiotic supplementation in the diet of commercial broiler chicks.

4.4 Dressing percentage and relative organs weight of broilers

The results showed that use of yeast had no significant effect ($P<0.05$) on dressing percentage of broiler. This finding was not similar to the findings of Gheisari and Kholeghipour (2005). They stated that treatments containing 0.3% powdery yeast had a higher dressing's percentage when compared with control. There was no adverse effect on various organs relative weights in birds of all treatments (Table 4). Highest liver weight was found in the birds fed 2.5% yeast. However, Rezaeipour *et al.* (2012) revealed that dietary yeast had no effect on carcass characteristics. On the other hand, Paryad and Mahmoudi (2008) stated that addition of dietary yeast at all levels improve carcass characteristics of broilers. These different results may be due to dose or kind of yeast used, strain of broilers, basal diet or environmental conditions. The beneficial effect of *Saccharomyces cerevisiae* is

attributed to the fact that it is a naturally rich source of proteins, minerals and B-complex vitamins (Davis *et al.* 1976).

4.5 Gut morphology of broilers

In our study no significant differences were recorded in villus height, crypt depth and thickness of muscularis with increasing level of yeast where birds fed diet 2 had the highest mean value. Greater villus height increases the activity of enzymes secreted from the tip of the villi resulting in improved digestibility (Hampson, 1986). Cell wall components of yeast may provide a protective function to mucosa by preventing pathogens from binding to villi and allowing fewer antigens to be in contact with the villi. Taller villi indicate more mature epithelia and enhance absorptive function due to increased absorptive area of the villus. It may therefore be stated that adding supplemental yeast to the diets of broiler birds at 2% will improve the performance gut integrity and nutrient utilization.

CHAPTER V

CONCLUSION

Although various levels of yeast had no significant effect on growth performance of experimental bird but it can be concluded that 2% yeast can improve the FCR of broilers without detrimental effects on performance indices of broiler chickens. No adverse effects on various organs relative weights were noted in birds of all treatments but significantly higher liver weight (3.92%) was obtained in the broilers fed 2.5% yeast. More research is, however, required in both experimental and field conditions to confirm this conclusion.

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FIGURES

Figure 1: Mixing of feed ingredients

Figure 2: Brooding of chicks

Figure 3: Vaccination of birds

Figure 4: Live weight and carcass weight measurement

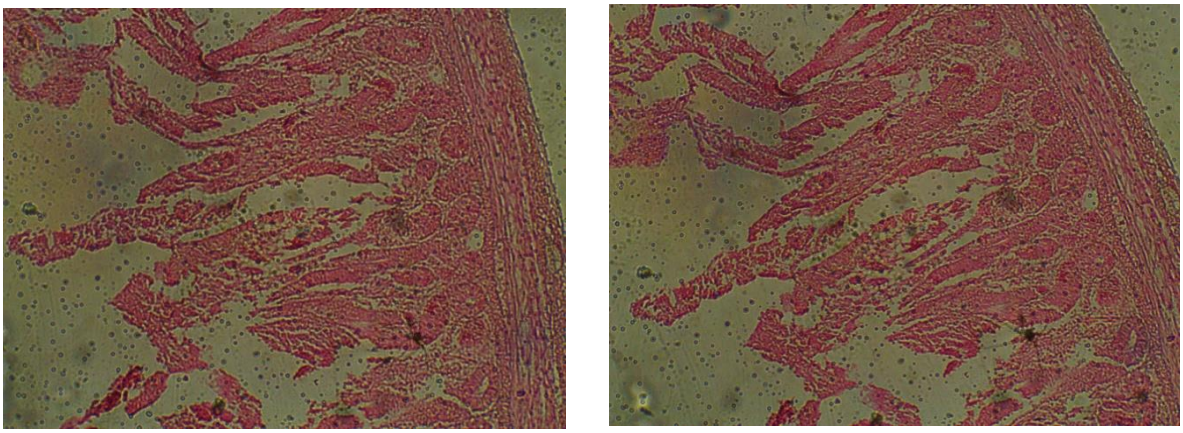

Figure 5: Gut morphology of broilers

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