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Replacement of Soybean Meal with Yeast Single Cell Protein in Broiler Ration: The Effect on Performance Traits

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Abstract.- A study was conducted to evaluate the effect of replacement of soybean meal with yeast single cell protein (YSCP) on broiler performance. A total of 120 chicks were grouped as YSCP-0, YSCP-3.5, YSCP-7.0 and YSCP-10.5 having replacement of YSCP at the level of 0, 3.5, 7.0 and 10.5g/kg feed, respectively. This addition was associated with concurrently removal of same quantity of soybean meal from the respective rations. Each group had 3 replicates of 10 chicks each. The trial was continued for 35 days after a week of adaptation period. In overall, birds' body weight was significantly increased with an increasing replacement levels of YSCP ($P<0.05$). Maximum body weight was recorded in group fed YSCP-10.5. Feed intake was not affected by YSCP, whereas feed conversion ratio was significantly ($P<0.05$) decreased by YSCP in broiler chicks. Dressing percentage and weight of giblets were not affected in all the groups. Lower mortality was recorded in YSCP treated groups as compared to control, although non-significant. The results indicated that the YSCP improved positively the performance of the broilers.

Key words: Soybean meal, yeast, single cell protein, performance

INTRODUCTION

In poultry production feed cost usually ranges between 65-75% of the total production cost and this share is increasing day by day due to increasing cost of the feed ingredients (Khan *et al*., 2010; Chand *et al.*, 2014). A possible way of increasing the supply of poultry products is to reduce the cost of production through the use of cheaper and unconventional feed ingredients in place of costly fish meal and imported soybean meal (Tabinda *et al.*, 2007; Khan and Naz, 2013; *Dhama et al*., 2014a,b).

One of the alternate and unconventional source of protein is the single cell protein (SCP), which is the dried microbial mass or total protein extracted from cultivated microbial biomass (Algae, bacteria, fungi and yeast) on various substrates. Yeast is one of best microorganism for production of single cell protein because of its high nutritional quality and can be put side by side with animal proteins (Adedayo *et al*., 2011). Yeasts have a balance proportion of amino acids, B-complex vitamins (Amata, 2013) and also having probiotic properties therefore more suitable for poultry feed (Adedayo *et al*., 2011). Yeasts are eukaryotic unicellular micro fungi that are widely distributed in the nature. Yeast is rich in protein, vitamins and minerals (Barbara *et al*., 2011) therefore it can be used effectively as an alternate protein source in livestock feeds (Amata, 2013). Yeast has already been used in animals' diet to compensate amino acid and vitamins deficiencies and can be used to replace soya bean meal in poultry ration (Gohl, 1981). Yeasts and soybean have more or less similar essential amino acid composition (Adedayo *et al*., 2011) and can be used for protein supplementation of poultry diet by replacing costly conventional sources like soybean meal and fish meal to lessen the shortage of protein supply. Yeast single cell protein is cheaper dietary protein source, as it can be produced from various substrates (molasses, cellulose, starch etc) on large scale in industry. Previous reports indicated that *Saccharomyces cerevisiae* has improved weight gain, feed conversion ratio and economic efficiency (Ayed and Ghaoui, 2011; Saied *et al*., 2011; Manal and Abou El-Nagha, 2012; Sojoudi *et al*., 2012) in broilers. Therefore, the present study was designed to replace soybean meal with yeast single cell protein in diet to evaluate its effect on growth performance in broiler chicks.

MATERIALS AND METHODS

This research was approved by The

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Department of Poultry Science of the University. A total of 150, day-old broiler chicks (Hubbard) were obtained from the local market. Out of them, 120 chicks were randomly selected and were grouped as YSCP-0, YSCP-3.5, YSCP-7.0 and YSCP-10.5 having replacement of soybean meal with yeast single cell protein (YSCP) at the level of 0, 3.5, 7.0, and 10.5 g/Kg feed, respectively. The yeast was obtained from Angel Co, Ltd, China. The composition of the yeast is shown in Table I. Each group was divided into three replicates of 10 chicks each. Starter and finisher rations were prepared in mash form and formulated to meet the requirement of growing broiler chicks recommended by the National Research Council (1994). The composition and approximate analysis of the feed during starter and finisher phase are shown in Tables II and III. Adaptation period was from 0-7 days of age, while experimental period was from 8-42 days of age.

Table I.- Chemical composition of yeast single cell protein (*Saccharomyces cerevisiae*).

Nutrient	Composition
Dry matter (%)	93
Metabolizable Energy (kcal/kg)	1990
Crude protein (%)	44.4
Crude fat (%)	1
Crude fiber (%)	2.7
Ca (%)	0.12
P (%)	1.4

Body weight of each group was recorded weekly with the help of digital scale (Shimatu Corporation, Japan). Weekly body weight gain was determined by subtracting initial weight from final weight of each week. Overall body weight for each group was calculated by summing up the weekly body weights.

The known quantity of feed was offered daily to all the groups. Feed refused per day was weighted by digital balance. Daily feed intake was determined by subtracting the quantity of feed refused from the feed offered. Daily feed consumed was used to work out weekly feed intake for each group. Overall feed conversion ratio was calculated by dividing total feed consumed with total weight gain. Two birds were slaughtered from each replicate at the end of experiment to work out dressing weight by using the following formula.

$$\text{Dressing percentage} = \frac{\text{Carcass weight}}{\text{Live bird weight}} \times 100$$

Visceral organs *i.e.* liver, heart and gizzard were weighed separately at the end of experiment. Mortality was recorded from the start till the end of the trial.

Data analysis

The analyses of the recorded data were carried out through standard procedure of analysis of variance (ANOVA) in completely randomized design and means were compared by least significant difference (LSD) (Steel and Torrie, 1981). The statistical package SAS (1997) was applied to complete the data analysis.

RESULTS

Data on overall body weight gain, feed intake and feed conversion ratio per chick is given in Table IV. Overall body weight was significantly ($P<0.05$) affected by the replacement of yeast single cell protein (YSCP) in broiler diets. Overall body weight was significantly ($P<0.05$) higher in treated groups as compared to the control. Higher weight gain was recorded for group YSCP-10.5 and lower for the control. The increase in overall body weight was 5.55, 6.14 and 8.38% in groups having 3.5, 7.0 and 10.5g YSCP respectively as compared to the control. Replacement of soybean meal with different levels of YSCP did not affect feed intake significantly ($P>0.05$) at all recorded stages. Numerically the overall feed intake was higher in group YSCP-0 and lower in group YSCP-10.5. Replacement of soybean meal with different levels of yeast single cell protein in broiler ration significantly ($P<0.05$) affected feed conversion ratio (FCR). The best FCR was found for the group YSCP-10.5 followed by YSCP-7.0 and YSCP-3.5. The FCR differ significantly between treated and control group, as well among the treated groups.

Table II.- Ingredients composition (g/kg) of experimental broiler starter and finisher rations (0-22 days) with different Levels of yeast single cell protein (YSCP).

Ingredients (g/kg)	Starter rations				Finisher rations			
	Ration I	Ration II	Ration III	Ration IV	Ration I	Ration II	Ration III	Ration IV
Soybean meal	70.0	66.50	63.00	59.50	70.0	66.50	63.0	59.5
YSCP	0.00	3.50	7.00	10.50	0.0	3.50	7.0	10.50
Maize	317.0	317.0	317.0	317.0	375.0	375.0	375.0	375.0
Wheat	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Broken rice	32.00	32.00	32.00	32.00	50.00	50.00	50.00	50.00
Corn gluten meal	88.00	88.00	88.00	88.00	50.60	50.60	50.60	50.60
Guar meal	24.50	24.50	24.50	24.50	20.00	20.00	20.00	20.00
Canola meal	66.50	66.50	66.50	66.50	50.00	50.00	50.00	50.00
Maize gluten feed	22.00	22.00	22.00	22.00	24.40	24.40	24.40	24.40
Fish meal	90.0	90.0	90.0	90.0	70.0	70.0	70.0	70.0
Rice polishing	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Molasses	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
DCP	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
L-Lysine	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
DL-Metheonine	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Vit. minerals premix	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Total	1000	1000	1000	1000	1000	1000	1000	1000

[1]provides per kg of diet: Mn 80 mg; Zn 60 mg; Fe 60 mg; Cu 5 mg; Co 0.2 mg; I 1 mg; Se 0.15 mg; choline chloride 200 mg; vitamin A 12 000 IU; vitamin D3 2 400 IU; vitamin E 50 mg; vitamin K3 4 mg; vitamin B1 3 mg; vitamin B2 6 mg; niacin 25 mg; calcium-d-pantothenate 10 mg; vitamin B6 5 mg; vitamin B12 0.03 mg; d-biotin 0.05 mg; folic acid 1 mg [2]calculated from NRC values (1994)

Table III.- Proximate composition of the starter and finisher rations.

Ingredients	Starter rations				Finisher rations			
	Ration I	Ration II	Ration III	Ration IV	Ration I	Ration II	Ration III	Ration IV
ME (Kcal/kg)	3115.92	3111.02	3125.60	3125.14	3335.48	3327.32	3324.73	3330.85
Crude protein (%)	23.13	23.24	23.18	23.38	20.57	20.43	20.64	20.52
Crude fiber (%)	3.33	3.19	3.15	3.11	4.54	4.43	4.47	4.33
Ether extracts (%)	3.91	3.70	3.83	3.91	4.27	4.15	4.17	4.12
Ash (%)	6.57	6.83	6.93	6.89	6.77	6.85	7.90	7.88
Dry matter (%)	88.87	88.93	88.78	88.95	89.85	89.67	89.72	89.52

Table IV.- Effect of replacement of soybean meal with yeast single cell protein on total body weight (g), Feed intake (g) and FCR in broiler chicks.

Group	Body weight (g)	Feed intake (g)	FCR
YSCP-0	1588.47±25.82[b]	3586.4±35.2	2.27±0.06[a]
YSCP-3.5	1676.73±28.64[a]	3469.6±23.9	2.06±0.05[b]
YSCP-7.0	1686.12±37.37[a]	3433.5±68.0	2.03±0.03[bc]
YSCP-10.5	1721.74±17.04[a]	3426.0±51.9	1.98±0.01[c]
P- value	0.050	0.734	0.0018

YSCP= yeast single cell protein levels; 0-10.5g replacement of soybean meal per Kg feed; Means with different superscripts within the same column are significantly different at $\alpha \leq 0.05$

Mean dressing percentage, mortality and weight of giblets (liver, gizzard and heart) are given in Table V. Replacement of soybean meal with different levels of yeast single cell protein in broiler ration did not affect dressing percentage significantly (P>0.05). Mortality was not significantly affected in all the groups. Numerically higher mortality was observed in the control group, while the lowest mortality was recorded for the YSCP-10.5. Replacement of soybean meal with different levels of yeast single cell protein had no significant affect on the weight of liver, gizzard and heart.

Table V.- Effect of replacement of soybean meal with yeast single cell protein on mean dressing percentage, mean mortality (%), mean weight of liver, gizzard and heart (g) in broiler chicks

Group	Dressing (%)	Mortality (%)	Liver weight (%)	Gizzard weight (%)	Heart weight (%)
YSCP-0	56.4 ± 0.36	3.3 ± 0.57	56.1 ± 3.84	87.6±2.08	12.7 ± 1.07
YSCP-3.5	58.4 ± 0.93	1.1± 0.33	63.0 ± 1.81	91.6 ± 1.11	12.5 ± 0.89
YSCP-7.0	57.3 ± 0.58	1.1± 0.33	57.2 ± 3.97	84.1 ± 5.27	11.7 ± 1.64
YSCP-10.5	56.3 ± 1.51	0.00	64.8 ± 4.75	92.4 ± 2.35	13.8 ± 1.44
P value	0.428	0.349	0.337	0.284	0.720

YSCP, yeast single cell protein levels; 0-10.5g replacement of soybean meal per Kg feed.

DISCUSSION

Total body weight of broiler chicks significantly improved as the soybean meal was replaced with different levels of YSCP. The beneficial effect of yeast is due to many reasons. Firstly, Yeast cell contain proteins, vitamins and minerals (Amata, 2013) and yeast cell wall contain 1, 1-6,D glucan and mannano-oligosaccharides (MOS), which help in promoting growth and increases growth rate because of its positive effect on mucosa of the intestine. Moreover it increases villus height, increase the number of anaerobic and cellulytic bacteria which enhance lactate utilization and moderates pH of the gut, there by improves the nutrients digestibility and growth performance (Abdel-Azeem, 2002). So these factors might have been responsible for the increase in weight gain in broiler chicks. Our results are in agreement to the findings of Manal and Abou El.Nagha (2012), who reported higher body weight gain in broilers fed dried yeast at the level of 0.3, 0.5 and 0.7%. Shareef and Al- Dabbagh (2009) also reported improved body weight gain using yeast at the level of 2% in broiler ration. Contrary to this study Brummer *et al*. (2010) reported no improvement in body weight with the addition of yeast in broiler ration.

Numerically lower feed consumption was recorded in YSCP-10.5. The improved growth performance is not caused by increased feed intake but could be related to the quality of yeast protein. Yeast cells contain unidentified growth factors along with other nutrients which may be responsible for its beneficial effects (Gao *et al*., 2008). Our results are in line to Gao *et al*. (2008), who reported no affect on feed intake in broilers fed with 0, 2.5, 5 and 7.5g yeast cells per kilogram of feed. Hassanein and Soliman (2010) used live yeast culture in laying hens and found no affect on feed intake. Contrary to these, Sharif *et al*. (2012) and Chen *et al*. (2009), reported higher feed intake in broiler chicks using yeast in the ration. Manal and Abou El Nagha (2012) reported a significant decrease in feed intake, when yeast was fed to broilers at the level of 0.5% in the diets.

Differences amongst groups were significant regarding FCR as weight gain was affected by dietary treatments but the feed intake was not affected in all the groups. Yeast cells contain some unidentified growth factors which act on intestinal villus and increase the absorption of gross energy from the feed, which may be responsible for better FCR (Chen *et al*., 2009) or this might be due to higher biological value of single cell protein (Sharif *et al.*, 2012). Results of this study are in agreement to Chen *et al*. (2009) who reported better feed conversion ratio in broiler chicks fed diets having 3% fermented yeast. Gao *et al*. (2008) also reported similar results that feeding yeast at 2.5g/kg improved FCR in broiler chicks.

Our results are in line with those of Fatufe *et al*. (2010), who observed no effect of using yeast in rabbits on dressing percentage. Contrary to these results Manal and Abou El.Nagha (2012) reported that feeding dry yeast from 0.5 to 6% gave higher dressing percentage. The variations in results may be due to the type of yeast used in the diet or the levels of yeast cells in the diet formulation. Numerically, mortality decreased with increasing level of yeast single cell protein in broiler diet. This may be due to balanced microbial population in the gastrointestinal tract which has positive effect on physical condition and performance in the broiler chicks (Thongsong *et al*., 2008). *In vitro* studies have shown that yeasts have anti-inflammatory effect and it activates natural killer cells and B lymphocytes (Jensen *et al*., 2007). Results of our study confirm findings of some previous researchers. Gao *et al*. (2008) reported numerically reduced mortality in broiler chicks fed diet having 2.5, 5 and 7.5% yeast compared to the control. Yalcin *et al*. (2008) also reported similar results in layers. Contrary to our study, Shareef and Al-Dabbagh (2009), Ozsoy and Yalcin (2011) observed no mortality in the study using yeast at 1 to 3% in the poultry diets. The difference in response may be due to yeast product formulation which may be dried yeast, inactive yeast and fermented yeast culture.

The results of this study are in line to the findings of some previous researchers, Ozsoy and Yalcin (2011) reported no effect of yeast on weight of gizzard, liver and heart in broiler chicks fed diet having 1 to 3% yeast. However, contrary to our results Onifade *et al*. (1998) reported significant increase in weight of liver, gizzard and heart and high carcass weight. The results may vary due to different physiological function of the different organs in different environments and different forms of the feed and yeast single cell protein.

CONCLUSIONS

Replacement of soybean meal with yeast single cell protein at the level of 10.5g/kg feed improved body weight gain and feed conversion ratio. Therefore, investigations on higher level of yeast single cell protein inclusion in poultry diets for replacing other costly protein sources are recommended.

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