RESPONSE OF BROILERS TO A FERMENTED PROTEIN SUPPLEMENTARY FEED

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Abstract

This study investigated the effect of fermented protein supplementary feed (FPS; 630 g CP/ kg DM, Integro®) as a protein source in broiler diets on performance and relative weight of carcass and non-carcass components. A total of 600 one-day-old broiler chickens (ROSS308) were randomly divided into six groups of five replicates of 20 chicks each in a completely randomized design. During the experiment (40 days), animals in the control group were fed standard broiler starter and grower diets (C), while the diets of the other groups were supplemented with 20 (FPS20), 40 (FPS40), 60 (FPS60), 80 (FPS80) or 100 (FPS100) g/kg FPS. The FPS20 birds had the highest body weight. Both the C and FPS20 groups had higher feed intake than the other groups. The FCR values of the FPS20 and FPS40 groups were better than those of the FPS60 and C group, followed by the FPS80 and FPS100 groups, respectively. The carcass yield and *pectoralis major* were lower in the FPS80 and FPS100 groups compared to the other groups. The neck weight was higher in FPS60 and FPS100 than in FPS80 birds. The tail weight was higher in FPS40 and FPS80 birds than in the group C. The liver weight was higher in the FPS100 group compared to the group C. The whole gut-weight was higher in the FPS40, FPS80, and FPS100 groups compared to the other groups. These results provide clear evidence of the benefits of adding 40 g/kg FPS to broiler diets without any negative impact on growth performance.

Keywords: *Broiler, Fermented feed, Performance, Supplementary feeding.*

Introduction

The search for alternative protein-rich sources aims to address the protein deficit in animal diets, provide sustainable quality feed ingredients and reduce costs on farms. A balanced protein diet is important for maintaining vital activities, strengthening the immune system and reducing the risk of disease.

Oilseeds and oilseed meals are the main sources of protein (İlkdoğan, 2008). However, the fact that imported meal is generally used in our country due to shortages, as in Europe, makes the compound feed sector dependent on imports and causes an increase in prices by being rapidly affected by economic fluctuations. In addition, the lack of a continuous flow of raw materials causes problems in production (Van der Poel *et al*., 2013). Therefore, the search for cheap and reliable protein-rich feed raw materials that can be used in animal nutrition has gained momentum in order to meet the animal product needs of the growing population globally and in Türkiye. For a resource to be used as a raw material for animal feed, it should have adequate nutritional value, be non-toxic, digestible and palatable to animals (Vasey and Powell, 1984). In this context, unicellular proteins such as blue-green algae, yeasts and edible insects such as house flies and mealworms are used in animal nutrition. Since yeasts are beneficial in terms of performance in poultry nutrition (Shareef and Al-Dabbagh; 2009), the present study determined the effect of complex protein raw material obtained by treating beneficial metabolites, nitrogenous compounds and yeast cell proteins formed during yeast

fermentation with thermal and chemical reactions on the performance of broiler chickens. The yeast industry by-product vinasse, obtained by fermentation of vinasse with certain cereals and milling industry by-products, has a crude protein content of 63%, is heat-treated and does not contain live microorganisms, and its amino acid profile is considered suitable for poultry nutrition. Therefore, our aim was to determine the possibilities and proportions of using the yeast industry by-product in broiler rations by replacing it with soybean meal in certain proportions.

Materials and methods

This study was conducted at the poultry facilities of the Faculty of Agriculture, Eskisehir Osmangazi University, Eskisehir, Türkiye. The experimental protocol and implemented procedures were approved by the local Ethics Committee for Experimental Animals (Protocol code HAYDEK-915/2022).

A total of 600 chicks with similar average body weights were divided into 6 treatment groups in 5 replicates of 20 chicks per replicate according to the randomised experimental design. During the experiment (40 days), animals in the control group were fed standard broiler starter and grower diets (C), while the diets of the other groups were supplemented with 20 (FPS20), 40 (FPS40), 60 (FPS60), 80 (FPS80) or 100 (FPS100) g/kg fermented protein supplementary feed (FPS; 630 g CP/ kg DM, Integro®). FPS was added to the diets to replace soybean meal in the FPS groups. The ingredients of the experimental diets are listed in Table 1.

The chicks were housed in an experimental poultry house with environmentally controlled sawdust litter and fluorescent lighting (starting with 23 h of light and 1 h of darkness and gradually changing to 18 h of light and 6 h of darkness at the end of the period) (Kop-Bozbay et al., 2024). Each pen in the poultry house was 1.25 × 2 m and each pen had a nipple drinker with an equal amount of drip and a hanging broiler feeder (tube type).

Body weight (BW) and feed intake (FI) in replicate pens were determined on day 42. These measurements were then used to calculate daily BW gain (BWG, g day^{-1}), FI (g day^{-1}) and feed conversion ratio (FCR, g feed: g gain).

To determine carcass and non-carcass components on day 42, two birds of each pen (10 birds per treatment) were selected and slaughtered. The non-carcass components were collected and weighed. Carcass yield expressed as dressing percentage, relative weights of non-carcass components were calculated as a percentage of BW just before the slaughter of each bird (g per 100 g BW).

Kolmogorov-Smirnov and Levene's test were employed for normality and homogeneity of variances, respectively. Pen was experimental unit in the present study. IBM SPSS Statistics 25 package programme was used for one way ANOVA. Differences among the means were determined by using Duncan's multiple range test ($P<0.05$).

Results and discussion

As shown in Table 2, FPS addition had a significant effect on the performance of broilers. The FPS20 the broilers had a higher BW and BWG compared to the other groups ($p < 0.05$). The FPS20 broilers had higher BW and BWG than the other groups ($p < 0.05$). BW and BWG of C and FPS60 birds were higher than FPS60 birds, and in FPS60 birds were higher than FPS80 and FPS100 birds ($p < 0.05$). The FI of C and FPS40 birds was higher than the other groups ($p < 0.05$). The FCR of the FPS20 and FPS40 groups was lower than that of the C and FPS60 groups ($p < 0.05$). The FPS80 groups had a lower FCR than the FPS100 birds ($p < 0.05$).

Table 3 shows that the use of FPS in the broiler diet did not affect the relative weight of the femur, tibia and heart of the birds ($p > 0.05$). The FPS80 and FPS100 treatments decreased carcass yield and *pectoralis muscle* weight of broilers compared to the other treatments ($p < 0.05$). The highest wing weights were found in the FPS100 group and the lowest in the FPS20 group ($p < 0.05$). Neck weights of FPS60 and FPS100 birds were higher than those of FPS80 birds ($p < 0.05$). Tail weight was higher in FPS40 and FPS80 groups than in C group ($p < 0.05$). The liver weight of the C group was lower than that of the FPS100 birds ($p < 0.05$). C, FPS20 and FPS60 birds had a lower whole gut weight than the other groups ($p < 0.05$).

Table 1. The ingredients of experimental diets (as fed)

			1-21 d			
Ingredients (g/kg)	**Control**	**FPS20**	**FPS40**	**FPS60**	**FPS80**	**FPS100**
Corn	545.4	556.5	569.9	580.8	592	602.2
Soybean meal	**376**	**347**	**317**	**287.4**	**257.6**	**229**
Fermented protein supplementary feed (FPS)	**0**	**20**	**40**	**60**	**80**	**100**
DCP	20.2	21.0	20.0	20.0	20.0	20.0
Limestone	12.5	11.5	11	10.5	10	9.3
DL-methionine	1.5	1.8	2.2	2.6	2.9	3.3
L-lysine HCI, 78%	1.4	2.2	2.9	3.7	4.5	5.2
Vegetable oil	43	40	37	35	33	31
Salt	10	10	10	10	10	10
Vit-min premix	2.5	2.5	2.5	2.5	2.5	2.5
Nutrient levels						
Metabolizable energy (kcal/kg)	3048.25	3043.75	3044.35	3046.68	3049.50	3051.93
Crude protein (%)	21.98	22.01	22.01	22.00	22.00	22.03
			22-42 d			
Corn	598.3	611	625	634.2	645.7	658.7
Soybean meal	**319**	**288**	**257.5**	**230**	**200**	**170**
Fermented protein supplementary feed (FPS)	**0**	**20**	**40**	**60**	**80**	**100**
DCP	18.0	18.0	17.5	17.5	17.0	16.5
Limestone	7.8	7.2	6.8	6	5.8	5.2
DL-methionine	1.5	1.9	2.2	2.6	3	3.3
L-lysine HCI, 78%	1.4	2.2	3.0	3.7	4.5	5.3
Vegetable oil	54	51.7	48	46	44	41
Salt	8	8	8	8	8	8
Vit-min premix	2.5	2.5	2.5	2.5	2.5	2.5
Nutrient levels						
Metabolizable energy (kcal/kg)*	3182.70	3184.88	3180.01	3181.80	3185.13	3184.43
Crude protein (%)	19.80	19.75	19.73	19.81	19.79	19.79

*Calculated values

Table 2. Performance of broilers fed on fermented protein supplementary feed (FPS)

Item†	Control	FPS20	FPS40	FPS60	FPS80	FPS100	SEM	P
Body weight, g								
	2259.19^{b}	2565.84^{a}	2180.66^{b}	1905.96^{c}	1407.69^{d}	1241.99^{d}	91.440	<0.001
Daily body weight gain, g								
	55.48^{b}	63.14^{a}	53.52^{b}	46.65^{c}	34.20^{d}	30.05^{d}	2.285	<0.001
Feed intake, g								
	10.49^{a}	108.93^{a}	93.23^{b}	92.07^{b}	91.19^{b}	97.31^{b}	1.858	<0.001
Feed conversion ratio, g FI/g BWG								
	1.99^{c}	1.72^{d}	1.74^{d}	1.97^{c}	2.67^{b}	3.24^{a}	0.104	<0.001

SEM: Standard error of mean. Means with different lowercase letters in the same row are statistically different at P<0.05.
†Values are the means of six pens.

Table 3. Relative weights of carcass and non-carcass components of broilers fed on fermented protein supplementary feed (FPS)

Item†, %	Control	FPS20	FPS40	FPS60	FPS80	FPS100	SEM	P
Carcass yield	70.17^{a}	71.73^{a}	70.05^{a}	69.79^{a}	67.58^{b}	67.77^{b}	0.335	<0.001
Pectoralis muscle	9.96^{a}	10.59^{a}	10.06^{a}	9.76^{a}	8.60^{b}	7.83^{b}	0.190	<0.001
Thigh special	10.05	10.16	10.03	9.81	10.26	10.13	0.097	0.848
Femur								
Boned	5.11	5.62	5.28	5.16	5.42	5.58	0.087	0.430
Deboned	3.85	4.10	3.93	3.85	3.88	3.74	0.049	0.443
Tibia								
Boned	4.80	4.46	4.50	4.47	4.52	4.47	0.065	0.678
Deboned	3.01	2.91	2.93	2.77	2.87	2.84	0.040	0.653
Wing	3.33^{bc}	3.21^{c}	3.41^{bc}	3.50^{b}	3.60^{ab}	3.86^{a}	0.045	<0.001
Neck	2.54^{ab}	2.54^{ab}	2.64^{ab}	2.93^{a}	2.49^{b}	2.93^{a}	0.057	0.034
Tail	0.68^{b}	0.73^{ab}	0.85^{a}	0.81^{ab}	0.87^{a}	0.74^{ab}	0.020	0.048
Heart	0.52	0.46	0.45	0.48	0.49	0.52	0.008	0.140
Liver	1.88^{b}	1.94^{ab}	2.09^{ab}	2.04^{ab}	2.00^{ab}	2.15^{a}	0.029	0.041
Whole gut	7.55^{b}	7.02^{b}	8.65^{a}	7.70^{b}	8.76^{a}	9.18^{a}	0.145	<0.001

SEM: Standard error of mean. Means with different lowercase letters in the same row are statistically different at P<0.05.
† Values are the means of six pens.

The dynamic structure of the broiler sector, which is open to development, allows for the use of a variety of feedstuffs that can be employed to enhance the yield characteristics. Yeasts, which are commonly utilized in the production of bread, cakes, and other food items, can also be utilized in animal nutrition to support growth and development. It has been demonstrated that yeast, when added to feeds as a growth factor, inhibits the ability of pathogenic microorganisms to persist in the intestinal microbial flora. Consequently, yeast enhances the live weight of broiler chickens and can be employed as a growth factor instead of antibiotics. In the present study, it was observed that the addition of 40 g/kg FPS to the diets had no detrimental effect on broiler performance. Even at the 60 g/kg level, FCR, carcass yield and pectoralis major muscle ratio were the same as in the Control animals. The observed outcomes may be attributed to the beneficial effects of metabolites produced during yeast fermentation and the subsequent formation of FPS in poultry diets, which have been shown to influence intestinal morphology by enhancing the humoral immune response while maintaining intestinal microbial balance (He *et al.*, 2021). This resulted in improved performance. It can be concluded that the use of FPS will be economically advantageous,

given that 30, 60.25 and 88.8 g/kg less soybean meal was used in the FPS20, FPS40 and FPS60 groups, respectively, compared to the Control group. It is crucial to note that FPS lacks essential amino acids in comparison to soybean. In the experimental groups, essential amino acids were provided in an external supplement. It is therefore recommended that these factors be taken into account when economic analyses are not desired. However, it was unexpected that the live weight and FCR in the FPS20 group were superior to those of the Control. In fact, an additional 13.4% live weight gain and a reduction of 0.27 units in the FCR ratio were observed. This may be attributed to the antimicrobial effect of FPS. The objective was to achieve the same performance by replacing soybean with FPS as that observed in the Contol group. The performance of the 20 kg FPS group, which subtracts 30 kg of soybean meal from 1 tonne of feed from the control group, is promising in that it is higher than the control.

One of the most significant findings of the study was that the incidence of diarrhoea cases decreased as the use of FPS increased, despite the absence of anticoccidial agents in the rations. Consequently, the quality of breast meat will be preserved to a greater extent than in the control group. This may be attributed to the effect of beneficial metabolites formed during yeast fermentation in the present study. A number of studies have demonstrated the potential of probiotics and prebiotics as substitutes for antibiotics in improving immune dysfunction, intestinal morphology impairment, and growth performance in broilers (Ahiwe *et al*., 2021). Probiotics comprising live yeast contain a plethora of biologically valuable proteins, functional nucleic acids, vitamin B complex, immune enhancers such as mannan oligosaccharide, β-glucan and growth-promoting factors (Berto *et al*., 2020; Ahiwe *et al*., 2021). Consequently, live yeast (Saccharomyces cerevisiae) has been demonstrated to confer a number of beneficial effects on poultry, including an improved gut microbial balance, an enhanced humoral immune response and gut morphology, and favourable growth performance outcomes (He *et al*., 2021). Furthermore, the absence of mortality or health issues during the trial indicates that FPS can be employed in broiler diets at a dosage of 40 g/kg without negatively impacting animal performance.

Conclusion

It is important to meet the animals' essential amino acid requirements, improve digestibility and maintain overall nutrient balance when changing the content of protein ingredients in the ration. These strategies can help maintain chicken health and production performance while reducing costs. Indeed, the study provides clear evidence of the benefits of adding up to 40 g/kg FPS to the broiler diet without negatively affecting performance.

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