Feeding Microparticle Protein Source-Composed Diet Supplemented with Prebiotic on Body Resistance and Growth Performance of Broiler

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Abstract

Evaluation of feeding effect of microparticle protein source-composed diet added with prebiotic on body resistance and growth of broiler chicken was the purpose of the present study. Dietary treatments tested were T1: diet with intact protein source (fish meal and soybean meal), T2: diet with microparticle protein source + 0.1% porang tuber extract (PTE) as glucomannan source, T3: diet with microparticle protein source + 1.2% dahlia tuber extract (DTE) as inulin source. Parameters measured were bursa fabricius, thymus, and spleen weight, heterophil– lymphocyte (H/L) ratio, protein digestibility, meat protein mass (MPM), feed consumption, body weight gain (BWG), and feed conversion ratio (FCR). A completely randomized design with 3 treatments and 8 replications were arranged in the present experiment. Analysis of variance was set for statistical procedure followed by Duncan test at 5% probability. Bursa fabricius weight significantly ($p<0.05$) increased, but spleen weight, H/L ratio, and FCR significantly ($p<0.05$) reduced in either T2 or T3. Protein digestibility, MPM, and BWG significantly ($p<0.05$) increased in T3 only, whilst, their increased values were at medium level when T2 was fed. However, thymus weight and feed consumption were not affected by treatments. In conclusion, body resistance getting better and performance improves indicated by higher MPM and BWG, and lower FCR in broiler fed 1.2% dahlia tuber extract.

Introduction

Fish meal and soybean meal are the common protein sources for poultry, however, due to their high price in average, an effort to improve nutrient or protein efficiency is needed to reduce production costs. Reducing particle size of both fish meal and soybean meal is one possible method to increase their nutrients utilization. Reduction of particle size provides some advantages in term of nutrients utilization and efficiency to support productivity of growing poultry. The increased protein digestibility and Ca retention was previously found in broiler given microparticle protein of fish meal and soybean meal [1]. Particle size of feed was known to have several advantages related to poultry production such as gastrointeatinal tract development and function, nutrients utlization, and production performance [2,3,4]. Particle size reduction was correlated with the increase in the number of particles in one surface area per volume unit, and this condition brought about the greater accessability of digestive enzymes to the substrate [5, 6]. Feeding diet composed of microparticle protein source at lower level is possible to reduce feed cost, and the addition of non-antibiotic additives, especially prebiotics, would be provided greater effect on growth response.

The inclusion of antibiotic growth promoters in poultry diet has been banned worldwide, including Indonesia, due to the special concern on consumer health and on nutritional value of animal product, thus, the problems prompt to the increasing attention to the use of natural feed additive. Feed additive such as inulin and glucomannan function as prebiotics that have natural characteristic without carrying-over the residue to product and consumer's health friendly. Prebiotic is a nondigestible feed compound that can be fermented by selective intestinal bacteria of the host animal, and stimulated growth and activity of beneficial bacteria. On the other hand, harmfull bacteria counts was depressed, thus improved intestinal health and performance of poultry [7]. Prebiotics are commonly derived from plant sources and it can be obtained from dahlia and porang tubers called as inulin and gluconmannan, respectively. Inclusion of prebiotics inulin [8] and glucomannan [9] in poultry feed using intact protein sources can modulate body resistance improvement, and produce healthy meat for consumer. The present study was conducted to evaluate the inclusion effect of inulin dahlia tuber extract compared to that of glucomannan porang tuber extract on body resistance and performance of broiler chicken fed microparticle protein diet.

Materials and Methods

Animal and Diet

Two hundred birds of 2-week old broiler with initial body weight of 474.3 ± 43,1 g were allocated into 3 treatments with 8 replications of 8 birds each, and other 8 birds were used for endogenous correction. The main purpose of the present study was to compare two prebiotic sources added to the diet using microparticle protein derived from fish meal and soybean meal. Porang and dahlia tuber extract as a source of glucomannan and inulin, respectively, was added to the microparticle protein composed diet. Small amount of approximately 25 g feed was mixed with tuber extract according to treatment, and given in the morning until it was completely consumed. Feeds without any prebiotic addition were fed thereafter to fulfill daily feed requirement. Feeding dietary treatments (Table 1) were started on day 15 and completed when the birds were 35-day old. The birds were given free access of drinking water.

Parameter Observed

Experimental parameters were lymphoid organs weight (bursa fabricius, thymus, and spleen) and heterophyl-lymphocyte (H/L) ratio as an indicator of body resistance. Parameter supporting growth performance namely, protein digestibility, meat protein mass, feed consumption, body weight gain, and feed conversion ratio were observed. Heterophil-lymphocyte (H/L) ratio was determined according to previously reported procedure [10] based on the number of granular (heterophile, eosinophil, and basophiles) and nongranular (lymphocytes and monocytes) in one hundred leucocytes [11]. Blood sample were collected form 2 birds of respective replication after procedure of total collection for protein digestibility determination. Meat samples for meat protein mass measurement were obtained from the same birds used for total collection after weighing carcass weight. Meat protein mass was calculated based on the formula prevoiusly reported [12] as follows: [mass of meat protein = % meat protein content x meat weight (g)].

Tabel 1. Composition and Nutrient Content of Experimental Feed

Ingredient	**Intact Protein Diet (T1)**	**Microparticle Protein Diet (T2 dan T3)***
	------------------------ (%)	------------------------
Yellow corn	54.36	56.62
Rice bran	13.86	13.88
Intact soybean meal	21,20	–
Microparticle soybean meal	–	21.20
Intact fish meal	9.95	–
Microparticle fish meal	–	7.67
Premix	0.25	0.25
Lysine	0.13	0.13
Methionine	0.25	0.25
TOTAL	100	100
Nutrient content**(%)		
Metabolizable energy (kcal/kg)	2,904	2,972
Protein	20.41	18.33
Ether extract	4.44	4.29
Crude fiber	6.14	5.72
Calcium	1.02	1.02
Phosphorus	0.83	0.84

* T1: intact protein (20%); T2: microparticle protein (18%) + 0,1% porang tuber extract (PTE); T3: microparticle protein (18%) + 1.2% dahlia tuber extract (DTE), and nutritional values have been adjusted to 100% unit

** Determined values

Design and Statistical Analysis

There were three dietary treatments tested, namely T1: 20% intact protein diet (control), T2: 18% microparticle-protein diet added with 0.1% porang tuber extract (PTE), and T3: microparticle-protein diet added with 1.2% dahlia inulin extract (DTE). A completely randomized design with 3 treatments and 8 replications (8 birds each) was assigned in the present study. Data were statistically analyzed using analysis of variance to test the treatments effect, and continued to Duncan test at 5% probability.

Results and Discussion

Body Resistance

Lymphoid organs weight (bursa fabricius, thymus, and spleen) and heterophile-lymphocyte ratio (H/L ratio) were defined as the indicator of body resistance that must be correlated with the production ability. Weight of lymphoid organs, especially bursa fabricius and spleen, and also H/L ratio were significantly ($p<0.05$) affected by feeding microparticle protein diet with inclusion of PTE as well as DTE. Feeding diet composed of microparticle protein added with either PTE (T2) or DTE (T3) increased bursa fabricius weight, and decreased lymph weight and H/L ratio (Table 2). The increased bursa fabricius weight and lower H/L ratio reflects the improvement of body resistance.

Tabel 2. Body Resistance Indicator of Broiler Given Microparticle Protein Composed-Diet Added with Prebiotic

Parameter	**Dietary treatment**		
	T1	**T2**	**T3**
Lymphoid organs weight, g/bird			
Bursa fabricius	0.26^{b}	0.35^{a}	0.40^{a}
Thymus	0.30	0.28	0.27
Spleen	0.32^{a}	0.29^{ab}	0.24^{b}
Heterophile-lymphocyte ratio	0.88^{a}	0.73^{b}	0.66^{b}

T1 = intact protein diet (21%); T2 = microprotein protein diet (18%) + 0.1% porang tuber extract (PTE); T3 = microprotein protein diet (18%) + 1.2% dahlia tuber extract (DTE)
$^{a\text{-}b}$ Values within the same row followed by different superscript differ significantly ($p<0.05$)

It is well documented that prebiotic inulin as well as glucomannan can be selectively fermented by beneficial bacteria in the intestine, such as lactic acid bacteria (LAB) in general, to produce short chain fatty acids (SCFA). The decreased pathogenic bacteria growth can be assumed due to the reduced intestinal pH [13,14], although organic acids didn't determine in the present study. Modulation of body resistance is started from the improvement of intestinal health condition in relation to nutrition digestibility and utilization. This is closely related to the higher protein supply due to feeding microparticle protein diet under the contributing effect of prebiotics. Protein in particular is needed and important for antibody formation to response against antigen. It has been previously reported that reduction of dietary protein level tended to decrease primary and secondary immune responses [15]. However, reducing dietary protein level didn't interfere with body resistance found in the present experiment since the feed was composed of microparticle protein source with the contributing effect of prebiotics. It can be defined that prebiotic supplementation could improve health of host animal that provides a beneficial effect on physiological condition [16].

Feeding microparticle protein diet, although at low level (18%), supplemented with either PTE (T2) or DTE (T3) provided the higher availability of protein and possibly amino acids that facilitating the improvement of body resistance. The present study was supported by the previously reported results that broiler fed single microparticle protein source ingredients increased protein and some essential amino acids [1,17]. It is assumable that the adequacy of nutritional supply, especially protein, is the important factor supporting the improvement of lymphoid organ function, such as the increased bursa fabricius and the decreased spleen weights, in relation to body resistance. Recent study was supported by previous results that body resistance improved, as indicated by lower H/L ratio, due to feeding intact protein diet added with dahlia inulin in crossbred local chickens [7], and that with porang glukomannan in broiler [10]. The improvement of body resistance found in the present study can be explained by the decreased H/L ratio by 0.17 and 0.25% in T2 (PTE) and T3 (DTE), respectively, as compared to control (T1).

Growth Performance

Meat protein mass, feed consumption, body weight gain, and feed conversion ratio were the aspect of growth performance that were supported by protein digestibility. Three parameters namely, protein digestibility, meat protein mass, and body weight gain were significantly ($p<0.05$) affected by the treatments (Table 3). The decreased H/L ratio (Table 2) was an indication of higher body resistance due to feeding effects of PTE (T2) and DTE (T3), although with the same feed consumption (Table 3). Feed consumption unchanged in all treatments but BWG was significantly ($p<0.05$) increased in either PTE (T2) or DTE (T3) fed broilers, although in some cases the decreased feed consumption was a principle determinant. Body weight gain increased since protein digestibility is assumed to have overcoming-effect on protein utilization.

Tabel 3. Growth Performance of Broiler Given Microparticle Protein Composed-Diet Added with Prebiotic

Parameter	Dietary treatment		
	T1	T2	T3
Protein digestiility, %	81.9^{b}	84.2^{ab}	86.4^{a}
Meat protein mass, g/bird	101.8^{b}	109.7^{b}	122.1^{a}
Feed consumption, g/bird	2,690	2,647	2,684
Body weight gain, g/bird	1.46^{b}	1.50^{ab}	1.55^{a}
Feed conversion ratio	1.84^{a}	1.76^{b}	1.73^{b}

T1 = intact protein diet (21%); T2 = microprotein protein diet (18%) + 0.1% porang tuber extract (PTE); T3 = microprotein protein diet (18%) + 1.2% dahlia tuber extract (DTE)
$^{a-b}$ Values within the same row followed by different superscript differ significantly ($p<0.05$)

However, meat protein mass was supported by the increased protein digestibility in T2 (PTE), and different from that in T3 (DTE). This phenomenon can be postulated that protein utilization in broilers fed PET was not as efficient as in those given DET. The increase in protein and some essential amino acids digestibilities in broiler fed microparticle of single protein source ingredients [1,17] were the important nutrtitional factor for the improvement of protein deposition in the form of meat protein mass (Table 3). On the other hand, when intact protein (T1) was fed as control without prebiotic resulted meat protein mass and BWG similar to those in T2. In general, growth improvement is usually supported by the increase in protein digestibility, but in case of T2 (PTE) the phenomenon was inconsistent. The difference is possibly due to the level between PTE and DTE that determines the utilization efficiency although both were added to microparticle protein diet. Konjac glucomannan and inulin with the same level at 2% was known to have similar modulating-effect on modulating gut-associated lymphoid tissue immunity in rat [18]. Dietary protein at lower level (18%), added with prebiotic inulin were the important determinant in improving healthy broiler and their meat production. Some previous studies indicated that dietary inclusion of prebiotics improved the performance of broiler chickens [19, 20, 21]. Dietary inclusion of inulin [11,13,14], soybean oligosaccharide [17], and porang glukomanan [10] were the factors attributable to the improved growth performance. Nutrients retention or availability was alleviated by supplementation of prebiotic, and improve its utilization for higher productive performance. The result of previous study shown that the growth performance of broiler given low protein diet was improved by prebiotic supplementation [22].

Conclusion

Body resistance getting better and growth performance improves indicated by higher meat protein mass and body weight gain, and lower fconversion ratio in broiler fed microparticle protein diet added with 1.2% dahlia tuber extract (DTE, T3). The increase in meat production quality is attributable to the healthy improvement of broilers.

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