Buletin Peternakan 42 (2): 103-108, May 2018

ISSTAP
Indonesian Society for Sustainable Tropical Animal Production

Bulletin of Animal Science

ISSN-0126-4400/E-ISSN-2407-876X Acredited: 36a/E/KPT/2016
http://buletinpeternakan.fapet.ugm.ac.id/

Doi: 10.21059/buletinpeternak.v42i2.30977

The Effect of Corn Substitution with Palm Kernel Meal Treated by Enzyme on Production Performance and Carcass Quality of Broiler

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Article history
Submitted: 3 December 2017
Accepted: 21 February 2018

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ABSTRACT

The research was aimed to evaluate the effects of substitution level of corn with palm kernel meal (PKM) untreated and palm kernel meal (PKM) treated by enzyme on production performance and carcass quality of broilers. The method used in this research was experiment using nested of completely randomized design with 2 factors, the main factor was type of palm kernel meal factors consisting of PKM without enzyme (B_1) and PKM by mannanase enzyme (B_2), and substitution corn level L_0 (without substitution), L_1 (12.5%), L_2 (25%), L_3 (37.5%) and L_4 (50%). The different among the treatments were tested by Duncan's multiple range test. The results showed that corn substitution with PKM untreated and PKM treated by enzymes was significantly effect ($P<0.01$) on *feed conversion* ratio (FCR), tenderness, meat cholesterol of broilers and *income over feed cost* (IOFC) and significant effect ($P<0.05$) on feed intake, but there is no significant difference on body weight, percentages of abdominal fat and *water holding capacity* (WHC). Furthermore, effect of level corn substitition with PKM nested to PKM untreated and PKM treated by enzyme was significantly effect ($P<0.01$) on feed intake, body weight, FCR, and tenderness and significant effect ($P<0.05$) on IOFC, but there is no effect on percentages of abdominal fat, WHC and meat cholesterol. It can be concluded that the corn substitution with PKM treated by enzymes was better than the PKM untreated on production performance and carcass quality of broilers. The optimal level of PKM untreated as corn substitution was 12.5%. While replacement with PKM treated by enzyme can be used up to 25%.

Keywords: Broiler, Corn, Mannanase enzyme, Palm kernel meal

Introduction

Feeding is the important factors influence broiler performance, and almost 70% of total cost of feeding. The feed should be containing all the nutrients need by the broiler. Low feed cost will be deliver high income. Then, it's crucial for us during choices the feedstuff used as broiler feed.

Usually, broiler feed used corn almost 50% of total feed. Corn was the most important energy sources for broiler containing metabolic energy 3,350 kcal/kg, and still imported due to limited local production. This condition caused price and the availability fluctuated in different month season. Many researcher concerning to poultry feed, try to found a corn alternative, which is cheap, available, no cause negative effect on performances and palatable for poultry. But, there is no satisfied result on poultry performance. Joseph and Abolaji (1997) reported that cooked Nigerian mango-seed kernels (*Mangifera indica*) can be used corn substitution with level of 20% on the performance, carcass yield and meat quality of broiler chickens. Tirajoh *et al.* (2014) reported that utilization of Papua foxtail Millet (*Setaria italica* sp) can be used 10% as substitute of corn and Widodo *et al*. (2010) stated that noodle waste as corn substitute in broiler diet is up to 20% (33.33% replacing corn).

Palm kernel meal (PKM) is the byproduct of palm oil industry, have a quite high energy and protein, even have limiting factor highly crude fiber which decrease poultry digestibility (Sinurat *et al.*, 2012). PKM contain 15-17% crude protein but higher fiber (Loh *et al.*, 2002). The fiber of PKM consists of Cellulose, β-mannan and lignin. The β-mannan on PKM until 40-50% (Hatta *et al*., 2010; Ribeiro *et al.*, 2011), caused PKM cannot digest by poultry because lack of these enzyme.

Some treatments that can apply to improve PKM quality by physical, enzymatic and fermentation by some microbes. The Enzyme treatment was the practical technique for PKM by application of mannanase to degrade β-mannan content of PKM. Mannanase was extra cellular

enzymes that can be hydrolyzing polysaccharide molecule mannan to mono oligosachiaride, and then mono oligosacharide hydrolyze by monosidase enzyme to manosa (Sumardi, 2007). The degraded polysaccharide to monosaccharide on the PKM will be improve nutrient quality and will be effect to production performance and carcass quality. This research will be evaluating the effects of corn substitution with palm kernel meal (PKM) untreated and palm kernel meal (PKM) treated by enzyme on production performance and carcass quality of broilers.

Materials and Methods

Material research used were 240 day old chick (DOC) CP707 with average body weight 39.66±1.30 g and variance coefficient 3.27% reared and distributed on 30 slot pen 1 m square equipped by feeder and drinker, with 8 DOC each. The basal feed consists of corn, commercial concentrate, PKM and PKM treated by enzyme. The feed and drinking water were given *ad libitum*. The feedstuffs composition and its nutrient content for starter and finisher periods were shown in Table 1, 2 and 3.

The research method was used the feeding trial on nested pattern with completely randomized design with 2 factors: PKM untreated (B_1) and PKM treated by enzyme (B_2) and level of corn substitution: without substitution (L_0), 12.5% (L_1), 25% (L_2), 37.5% (L_3) and 50% (L_4). Each treatment replicated 3 times and 8 DOC each. The treatment combination were : control feed without PKM B_1 (B_1L_0), 12.5% corn substitution with B_1 (B_1L_1), 25% corn substitution with B_1 (B_1L_2), 37.5% corn substitution with B_1 (B_1L_3), 50% corn substitution with B_1 (B_1L_4), control feed without PKM B_2 (B_2L_0), 12.5% corn substitution with B_2 (B_2L_1), 25% corn substitution with B_2 (B_2L_2), 37.5% corn substitution with B2 (B_2L_3), and 50% corn substitution with B_2 (B_2L_4).

The variables were measured production performance (feed intake, body weight, FCR, and IOFC) and carcass quality (percentages of abdominal fat, WHC, tenderness and meat cholesterol content). The collected data were analyzed as a 2 x 5 nested arrangement of treatments on completely randomized design using ANOVA involving PKM (untreated and treated by enzyme) and level (0%, 12.5%, 25%, 37.5% and 50%). Significant differences between treatments were separated using Duncan's multiple range test (Steel and Torrie, 1995).

Table 1. Nutrient content of research feedstuff

Nutrient	Yellow corn	PKM	Treated PKM	Consentrate***	Rice bran
ME (kcal/kg)*	3437.1*	2690.29	2821.2	2300	2140
Crude protein (%)*	9.56	13.83	14.22	41	10.60
Crude llipid (%)*	3.72	9.92	9.71	5	7.41
Crude fiber (%)*	0.58	20.68	17.63	6	27.38
Calsium (%) **	0.01	0.41	0.41	2.50	0.05
Phospor (%)**	0.26	0.49	0.49	1.40	1.48
Methionin (%)**	0.18	0.14	0.14	1	0.27
Lysin (%)**	0.20	0.56	0.56	2.60	0.71
Tryptopan (%)**	0.10	0.17	0.17	0.33	0.09

Sources : * Proximate analysis, ** NRC (1994), *** Label tag of broiler consentrat.

Table 2. The composition and nutrient content of starter treatment feed (%)

Feedstuffs	B_1					B_2				
	L_0	L_1	L_2	L_3	L_4	L_0	L_1	L_2	L_3	L_4
Yellow corn	60	52.5	45	37.5	30	60	52.5	45	37.5	30
PKM Untreated	0	7.5	15	22.5	30	0	0	0	0	0
PKM Treated	0	0	0	0	0	0	7.5	15	22.5	30
Consentrate	40	40	40	40	40	40	40	40	40	40
ME (kcal/kg)	2982	2926	2870	2814	2758	2982	2936	2890	2844	2798
Crude protein (%)	22.14	22.46	22.78	23.10	23.42	22.14	22.49	22.84	23.19	23.53
Crude llipid (%)	4.22	4.70	5.16	5.63	6.09	4.23	4.68	5.13	5.58	6.03
Crude fiber (%)	2.75	4.26	5.76	7.27	8.78	2.75	4.03	5.31	6.58	7.86
Phospor (%)	0.62	0.65	0.68	0.71	0.74	0.62	0.65	0.68	0.71	0.74
Calsium (%)	1.01	1.10	1.07	1.10	1.13	1.01	1.10	1.07	1.10	1.13
Lysin (%)	1.12	1.14	1.17	1.20	0.80	1.12	1.14	1.17	1.20	0.80
Methionin (%)	0.50	0.50	0.50	0.50	0.49	0.50	0.50	0.50	050	0.49
Tryptopan (%)	0.18	0.19	0.19	0.20	0.21	0.19	0.19	0.19	0.20	0.21

Table 3. The composition and nutrient content of finisher treatment feed (%)

Feedstuffs	B_1					B_2				
	L_0	L_1	L_2	L_3	L_4	L_0	L_1	L_2	L_3	L_4
Yellow corn	60	52.5	45	37.5	30	60	52.5	45	37.5	30
PKM Untreated	0	7.5	15	22.5	30	0	0	0	0	0
PKM Treated	0	0	0	0	0	0	7.5	15	22.5	30
Consentrate	30	30	30	30	30	30	30	30	30	30
Rice bran	10	10	10	10	10	10	10	10	10	10
ME (Kcal/kg)	2966	2910	2854	2798	2742	2966	2920	2874	2828	2782
Crude Protein (%)	19.10	19.42	19.74	20.06	20.38	19.10	19.45	19.80	20.15	20.49
Llipid (%)	4.45	4.94	5.40	5.87	6.33	4.47	4.92	5.37	5.82	6.27
Crude fiber (%)	4.89	6.39	7.90	9.41	10.92	4.89	6.17	7.44	8.72	10
Phospor (%)	0.50	0.65	0.68	0.71	0.74	0.50	0.53	0.55	0.58	0.61
Calsium (%)	0.77	1.10	1.07	1.10	1.13	0.77	0.80	0.82	0.90	0.88
Lysin (%)	0.94	1.14	1.17	1.20	0.80	0.94	0.96	0.99	1.02	1.04
Methionin (%)	0.43	0.50	0.50	0.50	0.49	0.43	0.43	0.42	0.42	0.42
Tryptopan (%)	0.16	0.19	0.19	0.20	0.21	0.16	0.17	0.17	0.18	0.18

Result and Discussion

Effect of corn substitution with PKM untreated and PKM treated by enzyme

The effect of corn substitution with palm kernel meal untreated and palm kernel meal treated by enzyme on the production performances and carcass quality of broiler was shown in Table 4.

Production performance. According to Table 4, Feed intake the untreated PKM higher than PKM treated by enzyme (3242.34 vs. 3097.91 g/bird). There was any significant effect of enzyme treatment to the feed intake ($P<0.05$). It could be caused by mannan content. Which mannan content cannot digest by poultry (Sundu *et al.*, 2008). Besides, the metabolizable energy content of PKM untreated was lower compared to PKM treated by enzyme (2690.29 vs. 2821.20 kcal/kg). The broilers will be consuming more feed to fulfill their energy requirement. Onuh *et al.* (2010) reported that the feed intake can be increase due to sensitivity broilers to energy intake in the feed. The PKM treated by enzyme will be easier to digest and absorb by animal (Oluwafemi, 2008).

The body weight of broilers with PKM untreated was lower than the PKM treated by enzyme (1624.54 vs. 1650.76 g/bird). Even though, there is no effect significant of enzyme treatment to the body weight. The higher protein digestibility of PKM treated by enzyme compared to untreated PKM (60.45 vs. 73.48%). The protein digestibility and high metabolizable energy of PKM treated produced higher body weight. The other factors could be lower fiber and higher feed digestibility, then nutrient absorption will be better (Ojewola *et al.*, 2003; Hatta *et al*., 2010). Based on the feed intake and body weight, the feed conversion ratio of PKM treated by enzyme have better compared to untreated PKM (2.04 vs. 1.89). The enzyme treatment significantly effect ($P<0.01$) on FCR. Aya *et al.* (2013) found that PKM treated by enzyme increased the nutrients digestibility and finally will be effect to body weight and lower FCR.

The average IOFC of PKM treated by enzyme better than IOFC of PKM untreated (17218.74 vs. 16092.22 IDR/chick). The higher IOFC value of PKM treated by enzyme due to lower feed intake and higher body weight, and FCR was lower.

Carcass quality. There is no significant effect of PKM treated by enzyme to the abdominal fat and WHC of chicken meat. But, based on numeric, the value of treated PKM was better compared to PKM untreated. The WHC value was

Table 4. The effect of corn substitution with PKM untreated and PKM treated by enzyme on the production performances and carcass quality of broiler

Variables	treatments	
	PKM Untreated (B_1)	PKM treated by enzyme (B_2)
Feed intake (g/bird)	3242.34 ± 221.87^{b}	3097.91 ± 193.84^{a}
Body weight (g/bird)	1624.54±137.16	1650.76±118.76
Feed conversion ratio	2.04 ± 0.32^{B}	$1.89\pm0,23^{A}$
IOFC (IDR/bird)	16092.22 ± 2639.38^{A}	17218.74 ± 280.04^{B}
Abdominal fat (%)	2.20±0.20	1.81±0.54
WHC (%)	73.08±3.34	73.06±2.60
Tenderness (mm/g)	7.78 ± 0.76^{B}	6.26 ± 1.48^{A}
Meat Cholesterol (mg/100 g)	76.51 ± 0.81^{A}	77.64 ± 2.40^{B}

^{a,b} Different superscripts small and large superscript on similar row means significant difference ($P<0.05$) and highly significant different ($P<0.01$).

almost similar to the study done by Tirajoh *et al*. (2014), which substitute corn with 10% Papua foxtail millet (*Setaria italica* sp) about 73.74%.

The tenderness value of chicken meat fed by treated PKM was highly significantly better compared to PKM untreated (P<0.01). Lower fiber in PKM treated by enzyme caused higher feed digestibility and absorption, improve the meat tenderness. The content of mannan can be degraded by the enzyme of mannanase. Soeparno (2005) explained that better quality feed produced better meat tenderness.

PKM treated by enzyme was significantly effect (P<0.01) on meat cholesterol content. It could be cause by fiber content in PKM. Furthermore it can be decrease lipid absorption and bile acid synthesis. Mc Donald *et al.* (2002) reported that the blood cholesterol content affected by feed fiber content, the fiber feed would be bundle the bile acid and secreted via feces. This will be decrease lipid absorption and bile acid synthesis of cholesterol and total cholesterol of the body will be low.

Effects of substitition level of corn with PKM in diet nested to PKM untreated and PKM treated by enzyme on production performance

The level corn substitution with PKM untreated and PKM treated by enzyme on production performance and carcass quality can be seen on Table 5. Effect of level corn substitution with PKM nested to PKM untreated and PKM treated by enzyme was significantly effect (P<0.01) on feed intake, body weight, FCR, and tenderness and significant effect (P<0.05) on IOFC, but there is no effect on abdominal fat, WHC and meat cholesterol.

PKM untreated can be use until 25% as substitution corn in the feed. Furthermore PKM treated by enzyme can be use until 37.5%. This could be caused by metabolizable energy of corn was higher compared to PKM (3437.1 vs. 2690.29 kcal/kg). The poultry consumed feed based on energy requirement. They will be stop to consume if the energy requirement was enough.

The increase of feed intake on higher level of corn substitution caused by different energy in the feed. The utilization of manannase on PKM will be degrade mannan to manosa (Oluwafemi, 2008), and this manosa have limited absorption on poultry (Saenphoom *et al.*, 2013).

The level corn substitution by PKM untreated was significantly effect (P<0.01) on body weight. Substitution until 12.5% does no significant effect on body weight. The PKM treated by enzyme can be used as corn substitution until 25%. According to Hatta *et al*. (2010) PKM treated by enzyme can be increase biological nutrient content, lower fiber, and easier digest and absorption mannan content in broiler.

PKM untreated can be used until 12.5% as substitution corn in feed. Protein digestibility of PKM untreated was lower to corn (60.45 vs. 78.02%). Lower protein digestibility caused lower body weight and higher FCR. Beside on the PKM treated by enzyme can be used as substitution corn until 37.5%. It means quality of PKM treated by enzyme was similar with corn on FCR (1.77±0.09 vs. 1.72±0.03) in feed.

The fiber content of PKM affects the FCR. According to Sundu and Dingle (2003) that a high FCR value could be caused by galactomannan and mannan content which cannot digest by poultry and increase digest viscosity on digestive tract. Substitution of corn by PKM in higher proportion will be caused negative impact to broiler growth, because limited digestion of mannose as product of mannan hydrolysis by the broiler digestion (Saenphoom *et al.,* 2013).

The IOFC value increase significantly with the corn substitution with PKM treated by enzyme. The effect of level PKM treated by enzyme used as corn substitution have similar trend to the FCR variables. The highest IOFC showed by B_2L_2 (18887.80±1707 IDR/bird). But corn substitution until 25% of PKM treated by enzyme has similar IOFC value with corn. The utilization more than 25% caused feed intake tends to increase and body weight decreased.

Effects of substitition level of corn with PKM in diet nested to PKM untreated and PKM treated by enzyme on carcass quality

The effect of PKM level nested to PKM untreated and PKM treated by enzyme on carcass quality was shown on Table 5. Abdominal fat of PKM treated by enzyme was lower compared to PKM untreated. Larger amount of both PKM (PKM untreated and PKM treated by enzyme tends to decrease an abdominal fat. The 25 and 37.5% corn substitution by untreated and PKM treated by enzyme will be decrease abdominal fat respectively 2.29% and 1.23% of body weight.

The value of WHC was not affected by corn substitution on different level of PKM (P>0.05), but on 37.5% PKM treated by enzyme decrease WHC of broiler meat. The best WHC was produced on 50% corn substitution with PKM treated by enzyme was 70.92%.

Effects of substitution level of corn with PKM untreated and PKM treated by enzyme was significantly effect (P<0.01) on tenderness of broiler meat. The corn substitution with PKM untreated by 50% (B_1L_4) increase tenderness value and the highest value with PKM treated by enzyme 37.5% substitution (B_2L_3) were 5.67 and 4.00 mm/g. Respectively. Higher PKM used will be produce better tenderness. The substitution of corn with PKM treated by the enzyme produces higher tenderness than untreated PKM, due mannan is broken down by mannanase into simple glucose that can be absorbed by the intestine and produces tender meat.

Effects of substitution level of corn by PKM untreated did not showed significance effect to cholesterol meat content. Cholesterol content tend to decrease at substitution of 37.5% (L_3) was 75.50 mg/100 g. Similar result found at substitution with PKM treated by enzyme; the lowest cholesterol meat content produced

Table 5. The effect of substitution level of corn with PKM in diet nested to PKM untreated and PKM treated by enzyme production performance and carcass quality of broilers

Variables	Level	PKM Untreated (B_1)	PKM Treated (B_2)
Feed intake (g/bird)	L_0	3019.14±40.96^{A}	3024.30±101.28^{AB}
	L_1	3111.78±52.53^{A}	2967.38±152.60^{A}
	L_2	3145.93±252.91^{AB}	3043.70±117.86^{AB}
	L_3	3454.78±43.38^{B}	3110.65±202.06^{AB}
	L_4	3480.08±87.16^{B}	3343.53±214.29^{B}
Body weight (g/bird)	L_0	1763.58±88.65^{B}	1763.58±88.65^{B}
	L_1	1776.85±21.46^{B}	1786.85±21.46^{B}
	L_2	1574.00±93.74^{A}	1722.21±91.57^{B}
	L_3	1501.58±56.84^{A}	1573.38±27.31^{A}
	L_4	1506.69±14.51^{A}	1477.38±25.04^{A}
Feed conversion ratio	L_0	1.72±0.10^{A}	1.72±0.03^{A}
	L_1	1.75±0.02^{AB}	1.73±0.08^{A}
	L_2	2.00±0.20^{B}	1.77±0.09^{A}
	L_3	2.30±0.11^{C}	1.98±0.10^{A}
	L_4	2.31±0.06^{C}	2,26±0.14^{B}
Income over feed cost (IDR/bird)	L_0	18461.12±1853.72^{a}	18417.35±305.59^{b}
	L_1	18975.99±327.64^{a}	18517.18±590.15^{b}
	L_2	15508.12±2278.42^{a}	18887.80±1707.68^{b}
	L_3	13341.62±1244.87^{a}	16281.31±550.92^{ab}
	L_4	14174.26±458.02^{a}	13990.08±898.60^{a}
Abdominal fat (%)	L_0	2.15±0.30	2.07±0.01
	L_1	2.09±0.08	2.12±0.15
	L_2	2.15±0.12	2.29±0.16
	L_3	2.37±0.13	1.32±0.05
	L_4	2.29±0.19	1.23±0.03
WHC (%)	L_0	73.58±6.16	73.04±2.82
	L_1	75.55±2.13	73.08±3.00
	L_2	73.92±2.26	75.79±1.78
	L_3	72.82±0.40	72.47±2.78
	L_4	69.54±4.59	70.92±0.26
Tenderness (mm/g)	L_0	7.67±0.95^{B}	7.40±0.85^{C}
	L_1	10.10±1.35^{C}	7.65±0.40^{C}
	L_2	8.03±0.06^{B}	5.90±0.17^{AB}
	L_3	7.43±1.25^{AB}	4.00±0.55^{A}
	L_4	5.67±0.32^{A}	6.35±0.55^{B}
Meat cholesterol (mg/100 g)	L_0	77.21±1.26	77.64±4.69
	L_1	76.35±0.58	77.42±4.70
	L_2	76.13±0.87	78.46±1.85
	L_3	75.98±0.93	77.46±1.53
	L_4	76.87±0.75	77.24±1.60

B_1: PKM untreated; B_2: PKM treated by enzyme, L_0: without corn substitution; L_1: 12.5% corn substitution ; L_2: 25% corn substitution L_3: 37.5% corn substitution; and L_4: 50% corn substitution.
^{a,b,c}Different superscript on similar column means highly significant different (P<0.01).

at L_3 was 79.05 mg/100 g. These cholesterol content of broiler meat are between 37.41–79.90 mg/100 g (Milićević *et al*., 2014), consist of saturated and unsaturated fatty acids are C16:0, C18:0, and C16:1.

Conclusion

The corn substitution with PKM treated by enzyme was better than the PKM untreated on production performance and carcass quality of broilers. The optimal level of PKM untreated as corn substitution was 12.5%. While replacement with PKM treated by enzyme can be used up to 25% without any negative effect to production performance and carcass quality.

Acknowledgement

Special thanks to PT Willmar Indonesia for funding support of this research and the Dean of Faculty Animal Husbandry, University of Brawijaya for facility and laboratory support.

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