Effects of humic acid addition via drinking water on the performance of broilers fed diets containing fermented and non-fermented palm kernel cake

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SUMMARY

An experiment was conducted to examine the effect of humic acid addition via drinking water on the performance of broiler fed diets containing fermented (FPKC) and non-fermented palm kernel cake (PKC) in a completely randomized design experiment involving treatments with 4 replicate. The treatments were arranged as follows: 1) 0% basic ration (0% PKC/FPKC), 2) 0% basic ration + humic acid, 3) 15% PKC, 4) 15% PKC + humic acid, 5) 15% FPKC, 6) 15% FPKC + humic acid. The rations were formulated to contain 22% crude protein and and 3000 kcal/kg metabolizable energy. Feed consumption, body weight gain, feed conversion, and carcass percentage were response variables. The result showed that the parameters were highly significant affected (P<0.01) by any treatment. In conclusion the PKC fermented (15% FPKC) and the addition of humic acid of 100 ppm in water can improve broilers performance as observed from feed consumption (1748.89 g/head), body weight gain (1074.70 g/head), feed conversion (1.63) and carcass percentage (73.15%).

Keywords: humic acid, palm kernel cake, fed diet, fermented, broiler

INTRODUCTION

Palm kernel cake (PKC) is a by-product of palm oil industry that could be used as a feed ingredient for livestock. Palm oil production continues to increase every year. Until now Indonesia is still at the top position as the biggest producer of palm oil in the world with total production up to 26.5 million tons per year (Prayogo, 2012). The aforementioned total production will produces waste in the form of PKC around 10.35 million tons because PKC is 45-46% of palm oil production.

Mirnawati *et al. (*2010) obtained the following results of PKC: 87.30% dry matter, crude protein16.07%, 21.30% crude fiber, crude fat 8.23%, 0.27% Ca and P 0.94% and Cu 48.04 ppm.

Although the PKC crude protein content is high but its use in poultry rations is still low at only 10% in broiler rations (Rizal, 2000). The low quality of PKC is caused by high crude fiber content and the presence of Cu mineral that may be toxic to livestock. The high crude fiber reduces energy usage and protects the protein molecules as described by a protease enzyme of animal. The high Cu amount in PKC binds protein compounds that causes low PKC protein digestibility rate (Babjee, 1989). The low quality of PKC is also due to the low amino acid balance that is a limiting factor (Onwudike, 1986).

A fermentation method using cellulolytic microorganisms like *Neurosphora sitophila, Trichoderma harzianum, Aspergillus niger and Penicillium* sp had been conducted to increase the usage value of PKC. Furthermore, Mirnawati *et al.* (2010) obtained a result that PKC that is fermented with *Aspergillus niger* is able to increase crude protein by 44.37% from 16.07% to 23.20% and decrease crude fiber by 50.28% from 21.30% to 10.42%. It is can be used 100% a substitute of soybean meal protein or at 17.5% in dietary level broiler ration (Mirnawati *et al.,* 2011).

Therefore in this study, humic acid was introduced in the processing of PKC in order to obtain optimal conditions for improving the quality of PKC. This is due to the two substances are not able to bind Cu minerals from the PKC. It is necessary to look for substances / compounds that can reduce the Cu metal in the PKC, one of which is to take advantage of humic acid. Humic acid is also effective in binding micro-nutrient, such as Cu, Zn and Mn (Tan, 1998). Humic acid fraction can interact with metal through the formation of chelate compounds (Tate and Theng, 1980). Mirnawati *et al*. (2010) reported from his research that the administration of humic acid up to 400 ppm dose can be decrease levels Cu of PKC until 100% because humic acid can be bind of Cu - from PKC.

Humic acid can also provide elements such as N, P and S in the soil as well as energy for the activities of microorganisms (Stevenson, 1994). Added by Enviromate T.M (2002) humic acid is also used as a source of mineral and organic substances that plays an important role in the life of microorganisms. On the other side, there are a lot of microbes in digestive tract helping the digestive process, so the addition of humic acid on ration could microbe's activity on the digestive tract.

If humic acid is added to animal feed, heavy metals, nitrates and insecticides can be absorbed and excreted. Several researchers had conducted research in the use of humic acid to stimulate growth of broiler rations (Parks *et al.,* 1996; Eren *et al*., 2000). The addition of humic acid via drinking water was found able to reduce death rate of 3-5%, increasing body weight gain and provide efficiency in broiler rations (Kompiang, 2006). This is due to the ability of humic acid to stimulate the growth of microbes in the gut (Huck *et al*., 1991; Eren *et al*., 2000; Yoruk et al., 2004).

This objective of this study was to determine the effect of humic acid addition via drink water on ration that contains PKC and fermented- PKC to the performance of - broiler.

MATERIAL AND METHODS

The materials were as follows: 1) 100 broilers Arbor Acress strain, 2) The battery cage size of 75 x 70 x 75 cm provided with a place to put feeds and drinks, 3) 60 watt lamps, 4) OHause scale 2610 gram, 5) This research was conducted by using 6 treatments of ration. The treatments are arranged based on equal amount of energy and protein which are 3000 kcal/kg and 22%, respectively. The feed treatment was the replacement of soybean meal protein with PKC fermentation on the following rations:

A: Ration Control (0%PKC and 0%FPKC)
B: Ration Control + Humic Acid
C: Ration PKC 15%
D: Ration PKC 15% + Humic Acid
E: Ration FPKC15%
F: Ration FPKC 15% + Humic Acid

Table 1: Chemical composition and metabolic energy of ration treatments (%)

Ingredient	Treatment (%)					
	A	B	C	D	E	F
Corn	51	51	43.7	43.7	46.5	46.5
Rice brand	12.3	12.3	2	2	1	1
Soybean meal	17	17	8.3	8.3	14	14
Coconut meal	0	0	11	11	3.5	3.5
Fish meal	17	17	17	17	17	17
PKC	0	0	15	15	0	0
PKCF	0	0	0	0	15	15
Oil	2.2	2.2	2.5	2.5	2.5	2.5
Top mix	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100

A: control ration (0%PKC and 0%FPKC), B: control ration + humic acid, C: ration PKC 15%, D: ration PKC 15% + humic acid, E: ration FPKC15%, F: ration FPKC 15% + humic acid

The Measurement of the parameters was: 1) Feed consumption, 2) Body weight gain, 3) Feed conversion, 4) Carcass percentage. The Ration composition and ingredient content and metabolic energy of treatments are presented in Tables 1 and 2.

The research was conducted with experiment methodology. It used a Completely Randomized Design (CRD) with 6 treatments and 4 replications. Each treatment consisted of 5 chickens. The experiment lasted for 4 weeks.

Table 2: Ingredient contents and metabolic energy of ration treatments (%)

Nutrient	Treatment (%)					
	A	B	C	D	E	F
Protein	22.00	22.18	22.18	22.18	21.95	21.95
Fat	4.57	4.63	4.63	4.63	5.22	5.22
Fiber	3.29	4.97	4.97	4.97	4.34	4.34
Calcium (Ca)	1.24	1.17	1.17	1.17	1.10	1.10
Phosphorus (P)	0.26	0.38	0.38	0.38	0.45	0.45
Metionine	0.43	0.42	0.42	0.42	0.40	0.40
Lysin	1.32	1.21	1.21	1.21	1.11	1.11
Tryptophane	0.30	0.30	0.30	0.30	0.46	0.46
Energy (kcal/kg)	3013	3013	3011	3011	2986	2986

A: control ration (0%PKC and 0%FPKC), B: control ration + humic acid, C: ration PKC 15%, D: ration PKC 15% + humic acid, E: ration FPKC15%, F: ration FPKC 15% + humic acid

The data were analyzed by using variance analysis. The differences in treatments are determined by Duncan's multiple range tests (Steel and Torrie, 1991).

RESULTS AND DISCUSSION

Feed Consumption of Broiler

The average of feed consumption on each treatment is shown in Table 3.

Table 3: The Average of Feed Consumption in this Research (g/bird) for 30 Days of Age

Treatment	Feed consumption
A Control(0%PKC and 0%FPKC)	1773.68[b]
B (Control+ Humic Acid)	1778.24[b]
C (PKC 15 %)	1691.52[d]
D (PKC 15 % + Humic Acid)	1782.30[b]
E (FPKC 15 %)	1820.14[a]
F (FPKC 15 % + Humic Acid)	1748.89[c]
SE	7.61

Note: different superscript shows significant difference (P<0.01)

The influence of different treatments is highly significant (P<0.01) on feed consumption. Moreover, the result of DMRT test on the feed consumption showed that treatment A, B and D were not significantly (P>0.05) affected, but did difference significantly compared to treatment C, E and F, whereas treatment C, E, and F did showed significantly ($P<0.01$) to feed consumption.

The high feed consumption on treatment E compared to other treatments were caused by the usage of fermented product or fermented PKC (FPKC) where a fermented material has aroma and flavour that are favoured by livestock. Karmini (1996) fermented materials are more palatable compared to the original materials as fermentation may produce favourable flavours that are commonly produced by vitamin B which are B1, B2, and B12 and also minerals (Kuhad, 1997). Treatment D (PKC 15% + Humic Acid) did not difference significantly compared to treatment A (Control) and B (Control + Humic Acid). Despite the utilization of PKC 15% without fermentation in treatment D, feed consumption can match control feed consumption due to the addition of humic acid. As humic acid can increase microorganisms' activity in the digestive system, thus increase digestion's rate and eventually resulting in increased consumption. Besides, humic acid can bind Cu which is also a constraint in PKC utilization by broiler. This is in accordance with Kucukersan *et al.* (2005) that when humic acid is added to rations, heavy metals, nitrates and insecticides may be absorbed and excreted so that Cu does not interference with digestion and can match the control rations treatment A and treatment B. In treatment B, the control rations + Humic Acid exhibit the same feed consumption with ration A (Control) as humic acid may improve the usability of forage nutrients without increasing feed consumption. In accordance with Humin Tech (2004), humic acid can stabilize flora and improve the usability of forage nutrients without increasing feed consumption.

The feed consumption of treatment C (PKC 15%) is lower than other treatments as unfermented PKC are less preferred by livestock. According to Rizal (2000), PKC can only be used up to 10% in broiler's rations because it has high crude fiber content thus resulting in low palatability.

Treatment F (FPKC 15% + humic acid) demonstrated lower feed consumption than treatment E (PKCF 15% without humic acid). Although both treatments used fermented PKC with enhanced quality, but feed consumption in treatment F can be reduced due to the addition of humic acid to increase the efficiency of rations' usage. In line with the opinion Humin Tech, (2004) that humic acid can stabilize flora and improve nutrient's usability in forage without increasing feed consumption. Furthermore, based on the research conducted by Yoruk *et al.* (2004) feed consumption does not present significant difference with the addition of humic acid.

Body weight gain of broilers chicken

The average body weight gain of broiler in each treatment is shown in Table 4.

Table 4: Average broiler body weight gain in this research (g/bird) for 30 days of age

Treatment	Body weight gain
A Control(0%PKC and 0%FPKC)	1011.90[c]
B (Control+ Humic Acid)	1041.00[b]
C (PKC 15 %)	897.43[d]
D (PKC 15 % + Humic Acid)	1017.70[c]
E (FPKC 15 %)	1039.60[b]
F (FPKC 15 % + Humic Acid)	1074.70[a]
SE	4.94

Note: different superscript shows significant difference (P<0.01)

The influence of rations' treatment is highly significant (P<0.01) on the broilers' body weight gain. According to DMRT test towards body weight gains, treatment A were not significant (P>0.05) compared to treatment D but highly significant (P<0.01) with treatment B, C, E and F. Furthermore, treatment B were significant with treatment E but did show significant with treatment C, D and F. Whereas treatment C, D, E and F showed highly significant difference (P<0.01) towards broilers' body weight gains during the research.

The body weight gain in treatment F (FPKC 15% + Humic Acid) is higher than other treatments. This is due to treatment F is a product of fermentation, where fermented materials have better qualities, higher digestion rate and eliminate toxic compounds. Thus, treatments that use fermented products can be easily absorbed by livestock which are shown by higher body weight gains (Bakker *et al.,* 1981)

Additionally, the high body weight gains in treatment F is due to the amount of Amino Acid contained in fermented PKC is higher than in unfermented PKC thus resulted in better quality and can be easily used by livestock. Furthermore, this treatment added Humic Acid that has beneficial activity of increasing micro flora activities in livestock digestive system that results in increased digestion rate for livestock. According to Shermer *et al (*1998) Humic Acid can stabilize micro flora in the intestine and increase the usability of forage nutrients that will eventually increase the live weight of livestock. Moreover, Kompiang (2006) stated that Humic Acid can increase the population of microbes in the digestive system. The population increment of microbes will improve the performance of livestock including weight gain.

Body weight gain in treatment E (FPKC 15%) was not significantly with treatment B (Control + Humic Acid). Likewise, treatment D (15% PKC + Humic Acid) was not significantly with treatment A (Control). This is due to the fact that treatment E used fermented products which have better quality (Bakker *et. al*., 1981; Pasaribu *et. al*., 1998) thus can match the body weight gains rations in treatment B which contains ration control and humic acid.

Despite the use of unfermented PKC in treatment D, but with the addition of Humic Acid body weight gains rations can match control rations. Although PKC contains a high amount of heavy metals (Cu), but the addition of Humic Acid makes it equal with control rations. In accordance with (Kucukersan, 2005), when Humic Acid is added into rations then heavy metals, nitrate, fluoride, organic phosphate, carbaryl and insecticides can be absorbed and excreted which can be concluded that the addition of Humic Acid can increase the rate of weight gain (Eren *et al.,* 2000; Bailey *et al*., 1996; Kocabagli *et al.,* 2002; Karaoglu *et al.,* 2004)

The low rate of body weight gain in treatment C (PKC 15%) compared to other treatments is caused by the low quality of PKC (Peres *et al.,* 2000; Odunsei *et al.,* 2002 dan Ezieshi and Olomu, 2004) due to the high content of crude fiber. On the other hand, broilers have limited ability to digest crude fiber. This result is supported by the opinion of Rizal *et al*. (2000) that PKC can only be used up to 10% in ducks' rations. While Garcia *et al*. (1999) reported that PKC can only be used up to 6% in broilers' rations.

Feed conversion of broilers chicken

The average feed conversion of broilers' rations in each treatment is depicted in Table 5.

Table 5: Average broiler feed conversions in this research (g/bird) for 30 days of age

Treatment	Ration conversion
A Control(0%PKC and 0%FPKC)	1.75^{b}
B (Control+ Humic Acid)	1.71^{c}
C (PKC 15 %)	1.89^{a}
D (PKC 15 % + Humic Acid)	1.75^{b}
E (FPKC 15 %)	1.75^{b}
F (FPKC 15 % + Humic Acid)	1.63^{d}
SE	7.61

Note: different superscript shows significant difference (P<0.01)

Treatments affected feed conversion (P<0.01). While treatment A, C and F were significantly (P<0.01) affected. Treatment B, C and F provides a highly significant (P<0.01) while treatment B and D were significantly (P<0.05). Treatment C, D, E and F were highly significant (P<0.01). Treatment D and E were non-significant difference (P>0.05) but treatment D and F were highly significant difference (P<0.01). Treatment E and F were highly significantly (P<0.01) affected to the feed conversion of broilers' rations during the research.

The treatment F (FPKC 15% + Humic Acid) has the lowest feed conversion rate. The low feed conversion rate in treatment F is caused by the high rate of body weight gain and low rate of feed consumption. This is in accordance with the opinion of Scott *et al*. (1982) that stated feed conversion rate is determined by the amount of rations consumed and the amount of body weight gain produced. The low rate of rations' conversion in treatment F is due to the addition of humic acid. In accordance with the research conducted by Kompiang (2006) that resulted on the fact that broiler FCR that receives lower humic acid than ration control. This is due to the nature of humic acid that can increase the permeability of the cells so that to smoothen nutrients' transfer.

Another factor that causes the low rate of feed conversion is the possibility of the increasing beneficial microbes population in the intestines. Huck *et al.* (1991) reported that humic acid stimulates microbes' growth in the intestines. Kocabagli *et al. (*2002) stated that the administration of humic acid over growth period provides benefit to the performance of broilers as reflected in growth and feed conversion rate. In addition, Yoruk *et al*. (2004) stated that the addition of humic acid and probiotics during the last period of eggs production are able to increase the number of eggs produced, decrease death rate and increase rations' conversion rate but are not able to increase eggs' quality.

The significant difference (P<0.05) of feed conversion rate in treatment B, D and F compared to treatment A, C and E is due to the addition of humic acid. The condition occurred due to the ability of humic acid to stabilize flora in the intestines and increase nutrients' usability in rations and also increase livestock's weight gain rate without increasing consumption rate. Additionally, Kocabagli *et al.* (2002), Yoruk *et al.* (2004) dan Kucukersan *et al*.(2005) stated that the provision of humic acid during growth period benefits broilers' performance as observed from growth and feed conversion rate.

Treatment E is able to match the rations' conversion rate in treatment A which is caused by the usage of fermented PKC that naturally has better quality than without fermentation, thus can be easily used by livestock and showed better conversion rate. While treatment D, despite the usage of PKC 15% (without fermentation), but the addition of humic acid enables treatment D to match the feed conversion rate in treatment A (Control).

The high rate of feed conversion in treatment C is caused by the usage of PKC 15% without fermentation which has lower quality due to the high amount of crude fiber contained thus cannot be easily used by livestock as it has limitation in digesting crude fiber (Rizal, 2000). The high amount of crude fiber contained in rations can decrease the easily digestive components and the activities of enzymes that assist the digestion of carbohydrates, protein and fat. This is demonstrated by the low rate of body weight gain in treatment C, which resulted in the high rate of feed conversion.

Feed conversion rate in this study is between 1.62 – 1.89. This is supported by the opinion of Kompiang (2006) obtained rations' conversion rate of 1.64 in rations that was mixed with humic acid 100ppm.

Carcass percentage (%) of broiler chicken

The average of broiler carcass in each treatment is shown in Table 6.

Table 6: Average broiler carcass percentage in this research (g/bird) for 30 days of age

Treatment	Ration conversion
A Control(0%PKC and 0%FPKC)	67,20^{b}
B (Control+ Humic Acid)	66,12^{b}
C (PKC 15 %)	61,75^{c}
D (PKC 15 % + Humic Acid)	67,81^{b}
E (FPKC 15 %)	66,54^{b}
F (FPKC 15 % + Humic Acid)	73,15^{a}
SE	1,30

Note: different superscript shows significant difference (P<0.01)

The carcass percentage was affected by treatments (P<0.01). Broiler carcass percentage for treatment A, B, D and E showed a not significantly (P>0.05), but treatment A and C showed a highly significant (P<0.01) along with treatment A and F that resulted in a highly significant (P<0.01). Treatment B, D and E resulted in a not significant (P>0.05), but treatment B and C resulted in a significant (P<0.05) along with treatment B and F that resulted in a highly significant (P<0.01). Treatment C and F along with treatment C and D resulted in a highly significant (P<0.01) but treatment C and E resulted in a significant (P<0.05). Treatment E and F resulted in a highly significant (P<0.01) affected to the broiler carcass percentage during study.

The highest percentage of carcass is gathered in treatment F (FPKC 15% + Humic Acid). The high percentage of broiler carcasses in treatment F is due to the high body weight gain. While carcass percentage is always associated with body weight gain, this is in line with the opinion of Cherry *et al.* (1998) that stated carcass percentage is affected by body weight gain. It is also influenced by management systems where the management system is the same. The highest carcasses percentage obtained in this study is 73.15%. This result is higher compared to the result obtained by Nurhayati (2008) which is 62.01% in the treatment of palm kernel cake mixed with cassava. According to Cherry *et al.* (1998), this result is within the range of broiler carcasses percentage which is 65-75% of live weight.

Treatment E is able to match the carcass percentage of treatment D and B due to the usage fermented PKC that has better quality compared to without fermentation, thus it can be easily used by livestock and presented better carcasses percentage. Despite the usage of PKC 15% (without fermentation), but with the addition of humic acid, the carcass percentage in treatment D is able to match carcass percentage in treatment B and E. As humic acid is able to stabilize flora in the digestive system and increase nutrients' usability in rations and increase body weight gain of livestock without increasing consumption. Added by Kocabagli *et al.* (2002), Yoruk *et al.* (2004) dan Kucukersan *et al*.(2005), the provision of Humic Acid during growth period benefits broilers' performance as observed from growth and carcasses percentage.

The low percentage of carcasses in treatment C is due to the usage of PKC 15% (without fermentation) which has lower quality as a result of the high content of crude fiber (Rizal, 2000), thus it cannot be easily used by livestock has limitations in digesting crude fiber. High crude fiber ratio in rations can reduce the easily digestible components and lower the activities of enzymes that assist the digestion of carbohydrates, proteins and fats. This is evident by the low body weight gain in treatment B, thus resulted in low carcass percentage. Garcia *et al.* (1999) reported that carcass weight decreased with the increment of PKC in broilers' rations if 10% PKC used in broilers' rations.

The broilers carcasses percentage in this study is ranging between 61.75 and 73.15%, which is higher that the result obtained by Kompiang (2006) which is 66.71% on rations with humic acid.

CONCLUSIONS

The usage of fermented PKC and the addition of humic acid 100 ppm in drinking water are able to provide a better broiler performance from unfermented PKC, as observed from feed consumption (1748.89 g/bird), body weight gain (1074.70 g/bird), feed conversion rate (1.63) and carcass percentage (73.15%).

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