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THE EFFECT OF FERMENTED MIXED COCONUT OIL AND TOFU SOLID WASTE SUPPLEMENT ON MEAT TENDERNESS AND CHOLESTEROL OF BROILER

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Original scientific paper

Abstract: Study of the effect of Fermented Mixed Coconut Oil and Tofu Solid Waste Supplement on Meat Tenderness and Cholesterol of Broiler was aimed to determine the effect of the mixture of solid coconut oil and tofu waste that fermented with *Aspergillus niger* in ration on meat tenderness and meat cholesterol of broiler. Meat quality is one of final point of the consumer. There are some indicators such as meat tenderness and cholesterol contents. Solid coconut oil and solid tofu waste mixture and fermented by *Aspergillus niger* (CAKTAF) can be used as supplement in broiler feed. CAKTAF contained high protein and low fat; will improved the meat quality. 120 Cobb strain day-old chicks were used in this study for 5 weeks. The ration and drinking water was gave *ad-libitum*. This experiment used Completely Randomized Design (CRD) 6 x 4, consisted of six treatments (the usage rate of CAKTAF of 0% (R-0), 5% (R-1), 10% (R-2), 15% (R-3), 20% (R-4) and 25% (R-5) in the ration, and each treatment was repeated four times. Statistical tests performed by analysis of variance and differences between treatments effects were examined using Duncan's multiple range test. Results indicated that usage up to 25% CAKTAF in the ration will increase the meat tenderness and decrease the cholesterol contents in the meat.

Key words: *Aspergillus niger*, broiler, CAKTAF, fermentation, solid coconut oil waste, solid tofu waste.

Introduction

To avoid the competition between food and feed, we must seek the alternatives for feed ingredients because almost of the raw materials or components of feed are also used as human food. Agricultural processing wastes, such as solid

coconut oil dregs and waste tofu processing, can be utilized as raw material for animal feed rations constituent. The problem of using processing waste is the poor nutrition quality. The fermentation process can be applied to improve the quality of the waste; using microbes.

Meat tenderness may be influenced by changes occurring during muscle conversion to meat. These changes may be controlled, to improve meat quality. The influence of diet on meat properties is minor importance if there are no nutritional deficiencies. Any feeding practice which alters the quantity of glycogen stored in muscles can influence the ultimate meat properties. Some of the physical properties of fresh meat are difficult to measure objectively. Many factor within muscles, such as intra muscular fat content, can contribute to these physical properties. Tenderness is one of palatability factor that has received more research study (*Aberle, et al; 2001*). According to the laboratory and consumer studies, have shown that tenderness is the most important sensory attribute of meat. Tenderness and juiciness are closely related, the more tender the meat, the more quickly the juices are released by chewing it. The deposits of fat in muscle, add to the juiciness and flavor of meat, when it was cooked. Small amount of fat in feed have beneficial effects on the physical characteristics of the feed, and tends to influence the meat.

One aspect about feeding of fats to animals is tends to deposit the type of fat consumed in the ration. The saturated fat and cholesterol content of meat and meat products which are able to exert a definite increase in human serum lipid concentrations. Lipid content of meat is generally its most variable component. One of the lipid components of major concern from a nutritional standpoint is cholesterol. Attempts have been made to lower the cholesterol in eggs (*Elkin, 2007*) by feeding different grains to layers, which may reduce egg cholesterol by about 10 percent. Feeding copper at 125 or 250 parts per million (ppm) can reduce cholesterol in eggs by up to 31 percent. Feeding garlic as a paste at up to 8 percent of the diet may reduce egg cholesterol by as much as 24 percent, but there is wide variation. Other natural products have also shown significant but inconsistent responses. According to *Talat, et al (2000),* there are an average 62.20; 49.75; 58.44; and 41.80 mg/dl cholesterol contents in raw muscle of RIR, broiler, Fayoumi and cross birds, respectively.

One of the advantages in fermentations, the controlled action of selected microorganism is used to alter the texture, which increase the quality and value of raw materials. *Aspergillus niger* is a type of mold that is used commercially in improving the quality of agricultural processing wastes, because of the easy handling, its ability to grow quickly and it is not harmful because it does not produce mycotoxins. This fungus can produce enzymes such as a-amylase,

amylase, cellulase, gluco-amylase, catalase, pectinase, lipase, and galactosidase (*Ratledge, 1994*).

Material and Methods

Materials: Preparation of fermentation products:

- Coconut oil solid waste, from the coconut oil processing home industry (VCO) North Minahasa, North Sulawesi, Indonesia.
- Tofu solid waste, obtained from the Industri Pengolahan Tahu Cikuda, Sumedang; West Java, Indonesia
- Fungus *Aspergillus niger*, obtained from the Laboratory of Biological Sciences, Institut Teknologi Bandung; Indonesia
- Rice, fresh sprouts, gelatin, sugar, obtained from Pasar Suci, Bandung, Indonesia.

Experimental animal: 120 Cobb strain day-old chickens broiler from PT. Missouri Bandung, Indonesia.

Table 1. Composition of Rations Research (%)

Feed Contents	Treatments					
	R0	R1	R2	R3	R4	R5
Corn meal	56.44	52.44	48.44	44.44	40.44	36.44
Soybean meal	29	28	27	26	25	24
Fish meal	9	9	9	9	9	9
Coconut oil	2.5	2.5	2.5	2.5	2.5	2.5
Methionine	0.16	0.16	0.16	0.16	0.16	0.16
Top mix	0.5	0.5	0.5	0.5	0.5	0.5
CaCO3	0.9	0.9	0.9	0.9	0.9	0.9
Di-calcium phosphate	1.5	1.5	1.5	1.5	1.5	1.5
CAKTAF	0	5	10	15	20	25
Total	100	100	100	100	100	100

Note: Compiled by standard requirement by Lesson and Summer (2005)

From Table 1, the compositions are differs only in corn meal, soybean meal and CAKTAF.

Table 2. Standard ration and nutritional value of research diet

Feed Contents	Treatments					
	R0	R1	R2	R3	R4	R5
Protein (%)	22.56	22.49	22.43	22.37	22.31	22.25
Metabolizable Energy (Kcal/kg)	3023.97	3025.61	3027.25	3028.89	3030.53	3032.17
Fat (%)	6.45	6.41	6.36	6.31	6.28	6.22
Crude fiber (%)	3.40	4.44	4.32	4.40	4.41	4.41
Lysine (%)	1.33	1.33	1.33	1.33	1.32	1.32
Methionine (%)	0.60	0.59	0.59	0.59	0.59	0.59
Met + Cyst (%)	0.93	0.93	0.92	0.91	0.91	0.90
Ca (%)	1.08	1.09	1.09	1.09	1.09	1.09
P-non-phytate (%)	0.52	0.52	0.52	0.51	0.51	0.51

Rations: Rations used in the experiment consisted of yellow corn meal, fish meal, soybean meal, solid coconut oil dregs, DCP, Top Mix, CaCO3, and CAKTAF (the mixture of coconut pulp/coconut oil solid waste and tofu solid waste) fermented by *Aspergillus niger*. Feed materials were obtained from PT. Missouri Bandung.

Variables studied

Raw muscle samples were then analyzed for meat tenderness and meat cholesterol. The variables studied in the experiments are meat tenderness and meat cholesterol. The data thus collected was subjected to statistical analysis (Steel and Torrie, 1991) to test cholesterol contents in meat with Lieberman-Buchards method. The tenderness has been identified as the most important factor determining consumer eating satisfaction of meat with Universal penetrometer.

Research Design

This research used Completely Randomized Design (Steel and Torrie, 1991), with 6 treatments and each treatment was repeated 4 times, (there are 120 chickens for 24 experimental units, so each unit were 5 chickens).

Treatment rations were given as follows:
R0 = Ration containing 0% fermented products (CAKTAF) as control,
R1 = Ration containing 5% fermented products (CAKTAF),
R2 = Ration containing 10% fermented products (CAKTAF),
R3 = Ration containing 15% fermented products (CAKTAF),

R4 = Ration containing 20% fermented products (CAKTAF),
R5 = Ration containing 25% fermented products (CAKTAF).
Note: CAKTAF is fermented Coconut oil solid waste and Tofu solid waste.

Results and Discussion

The effect of treatment on meat tenderness

In Table 3, there are the results from using of CAKTAF (fermented solid waste of coconut oil and tofu) in ration, to the broiler carcass tenderness. The highest meat tenderness was get from the broiler that fed R-5 (diet + 25% CAKTAF (185.75 mm/g/10sec) and the lowest was get from the broiler that fed basal diet/0% CAKTAF, R-0 (132.75 mm/g/10sec).

From Table 3, the meat tenderness values were between 13.275 mm/g/10 sec to 18.575 mm/g/10 sec. Meat tenderness was significantly better in the groups which consumed CAKTAF. The tenderness will increase when the CAKCAF in the ration level percentage are higher. It means that the meat from broilers that given only ration without CAKTAF has the lowest tenderness. When given CAKTAF, the meat tenderness will increase. The more CAKTAF in the ration, will results the more tenderness of the meat. In R-0 (diet without CAKTAF-control), the tenderness are 13.275 mm/g/10sec, will increase when the level of CAKTAF more higher; in R-1(5% CAKTAF) 14.125 mm/g/10sec; and in R-2 (CAKTAF 10%) the tenderness is 14.925 mm/g/10sec; the R-3 (CAKTAF 15% in ration (15.325 mm/g/10sec); R-4 (20% CAKTAF) the tenderness 16.90 mm/g/sec; and in R-5 (CAKTAF 25%), has the highest tenderness (18.575 mm/g/sec). It means that the CAKTAF will influence the meat tenderness.

Table 3. The effect of treatment in ration on meat carcass tenderness (mm/g/10 sec)

Replication	R-0	R-1	R-2	R-3	R-4	R-5
I	12.60	12.10	12.80	13.20	15.90	19.50
II	12.40	14.50	14.20	13.40	16.80	17.10
III	13.60	15.20	15.50	15.40	16.00	16.60
IV	14.50	14.70	17.20	19.30	18.90	21.10
Average	13.275	14.125	14.925	15.325	16.90	18.575

According to *Aberle et al (2001)* the influence of diet on meat properties is minor importance if there are no nutritional deficiencies. The influence of diet on the physical properties of muscle, as long as no serious nutritional deficiencies, the feeding practice in ante mortem period which alters the quantity of glycogen stored in muscles can influence the ultimate physical properties of meat.

Table 4. Duncan's Multiple Range Test on meat tenderness during research

Treatments	Average Feed Consumption	Significancy (0.05)
R-0	13.275	a
R-1	14.125	b
R-2	14.925	b
R-3	15.325	b
R-4	16.900	bc
R-5	18.575	c

Note : The same letter in the significancy column showed no significancy

The CAKTAF influence the tenderness, because the fermented supplement (CAKTAF) that controlled the action of *Aspergillus niger* altered the texture which increase the quality and value of raw materials (solid oil and tofu waste). This material will alter the quantity of glycogen stored in muscles that will influence the ultimate meat properties (*Aberle et al, 2001*).

By Duncan test, results showed that the usage rates of CAKTAF (5%, 10%, 15%, 20% and 25%) in the rations raised the chicken meat tenderness; which were significantly different ($p< 0.05$), but the using of 25% CAKTAF has significant effect ($p <0.05$), which were higher in comparison to other treatments (without CAKTAF- 0%; 5%, 10%, 15% and 20% CAKTAF). This facts illustrated that the addition of CAKTAF up to 25% level (R-1 till R-5) in ration, on meat tenderness were able to well respond to chewed the meat.

Meat tenderness of broilers was influenced by the supplement of feed ingredients that making up the ration. The 25% CAKTAF (R-5) tenderness was caused by the expandable nature of fermentation products used in the ration. The higher it expands, it will accelerate the tenderness of the meat.

The effect of treatment on meat cholesterol

The fat content of the rations are between 6.22 mg/100 g (R-5) to 6.45 mg/100 g (R-0). And the average of total cholesterol during 5 weeks of study, are between 39.99 mg/100 g to 38.74 mg/100 g. In Table 5, there are the results of total cholesterol content in broiler meat.

Table 5. Cholesterol content in Broiler meat (mg/100g)

Replication	Treatments					
	R-0	R-1	R-2	R-3	R-4	R-5
I	38.32	40.21	38.49	38.93	38.90	38.97
II	41.45	39.98	40.21	39.84	39.73	39.42
III	40.21	39.89	40.32	38.88	39.94	39.23
IV	39.98	38.98	39.90	39.44	38.32	37.32
Total	159.96	159.06	158.92	157.09	156.89	154.94
Average	39.99	39.77	39.73	39.27	39.22	38.74

The results of the average cholesterol content in broiler meat during the study (5 weeks) ranged from 39.99 mg/100g until 38.74 mg/100g, as seen in Table 5. The cholesterol content of raw and cooked meat and poultry products ranges from 40 to 90 mg/100 g (*Dinh, et. al., 2011*). So the cholesterol values in this study were lower than the normal cholesterol content. According to *Skrivan, et al (2002)*, total lipid and cholesterol levels in breast muscle were suppressed by copper significantly in group 3 by 30% and 20%. Their results showed that dietary copper supplementation alters lipid metabolism and changes the fatty acid composition. The cholesterol content in this study will decrease in the meat that feeding CAKTAF in the ration. Then the differences of the treatment on cholesterol content in broiler meat were analyzed. Results show that the ration which contents of fermentation products (CAKTAF) showed significance ($p < 0.05$) on cholesterol content of broiler meat. And then, by Duncan multiple range test to find out the differences between treatments are shown in Table 6.

Table 6. Duncan's Multiple Range Test on meat cholesterol content

Treatments	Average Meat Cholesterol	Significancy (0.05)
R0	39.99	a
R1	39.77	a
R2	39.73	a
R3	39.27	a
R4	39.22	a
R5	38.74	b

Note: The same letter in the significancy column showed no significant difference

By Duncan tests, showed that the cholesterol content of broiler meat, feeding of R-1, R-2, R-3, R-4 and R-5 decreased compared to R-0, but R-1, R-2, R-3, and R-4 has significancy ($p < 0.05$) than R-5. It means that CAKTAF (5%, 10%, 15% and 20%) in the diet has no significancy on cholesterol content of broilers meat ($p < 0.05$) compared to R-0, but 25% CAKTAF in ration (R-5) showed significant difference ($p < 0.05$); that decreased the cholesterol content compared to the ration 0% CAKTAF (control) and rations contain CAKTAF of 5%, 10%, 15%, and 20%. This illustrated that the addition until 20% CAKTAF in the ration, still useful on cholesterol content of broiler meat.

These results are supported to the improvement on nutritional value, especially on coconut and tofu dregs fermented mixture. In accordance with the facts found in the first and second phase of the research; that the protein content increased, but decreased the crude fiber and crude fat, and the metabolizable energy value and protein digestibility increased compared with CAKTAF ration. The fermentation process by *Aspergillus niger* is able to break down the fats into

smaller compounds in the form of fatty acids, was easily absorbed by broiler chickens.

The low cholesterol contents of broiler meat that fed ration content 25% CAKTAF is caused by the reduced of fat in the ration, and influenced the cholesterol metabolism. Also, according to *Nousiainen and Setala (1998),* the intestinal flora contributes to lipid metabolism of the host in two different ways; first, bacteria can digest dietary and endogenous lipids by lipases and hydrogenate the free fatty acids, and second they can de-conjugate bile acids and modify cholesterol metabolism. It means that the *Aspergillus niger* has an effect to the cholesterol content in the meat that feed CAKTAF. These results are also lower than the results of *Talat et al (2000)* on 4 breeds (Rhode Island Red, broiler, Fayoumi and cross birds) that the average of cholesterol contents are 62.20; 49.75; 58.44; and 41.80 mg/dl, respectively.

Conclusion

The broilers that given CAKTAF which consists of fermented solid coconut oil and tofu waste will have more tenderness meat, than the broilers only consumed diets without CAKTAF. It means that the *Aspergillus niger* has an effect to the tenderness in the meat that feed CAKTAF.From the observation and analysis performed, that the cholesterol content also decrease if the broiler was given CAKTAF. This result showed that by using a mixture of coconut pulp (VCO waste) and tofu fermented by *Aspergillus niger* (CAKTAF) up to 25% in broiler rations can decreased the cholesterol content in the meat.

Uticaj dodavanja fermentisane smeše kokosovog ulje i čvrstog otpada tofua na mekoću i holesterol mesa brojlera

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Rezime

Studija uticaja fermentisane smeše kokosovo ulja i tofu otpada na mekoću i holesterol mesa brojlersa imala je za cilj da se utvrdi uticaj mešavine kokosovog ulje i tofu otpada koji fermentisan sa *Aspergillus niger* u obroku na mekoću i holesterol mesa brojlera. Postoje neki pokazatelji, kao što su mekoća i sadržaja holesterola. Mešavina čvrstog kokosovog ulja i čvrstog otpada tofua, fermentisana pomoću *Aspergillus niger* (CAKTAF) može da se koristi kao dodatak u ishrani pilića. CAKTAF ima visok sadržaj proteina i mali procenat masti, što poboljšava kvalitet mesa. U ovoj studiji korišćeno je 120 jednodenvnih Cobb pilića u ogledu

koji je trajao 5 nedelja. Obrok i voda za piće su bili *ad-libitum*. Ovaj eksperiment koristi kompletno slučajan dizajn (CRD) 6 x 4, i sastojao se od šest tretmana (stopa upotrebe CAKTAF od 0% (R-0), 5% (P-1), 10% (P-2), 15% (R-3), 20% (R-4) i 25% (R-5) u obroku, a svaki tretman je ponovljen četiri puta Statistički testovi izvodeni korišćenjem analize varijanse i razlike između tretmana efekata su ispitane korišćenje Duncan-ovog testa višestrukog opsega. Rezultati ukazuju da upotreba do 25% CAKTAF u obroku, povećava mekoću mesa i smanjuje sadržaj holesterola u mesu.

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