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Utilization of Fermented Soy-Milk Waste with *Aspergillus ficuum* in Broiler Ration

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Abstract. Soy-milk waste (SMW) has the potential to be used as feedstuff, particularly for poultry. SMW must be treated with *Aspergillus ficuum* prior to fermentation. Objective: An experiment was conducted to evaluate the use of fermented SMW (F-SMW) with *Aspergillus ficuum* in broiler ration. Materials and Methods: One hundred and forty-day old broiler chicks (DOCs) were used in this study. Iso-energy (3000 kcal/kg) and iso-protein ration (22 percent) were assigned to this study using a completely randomized design (CRD) with 5 treatments and 4 replications. The treatments were as follows: 1) 0 percent F-SMW (control diet), 2) 15 percent F-SMW, 3) 20 percent F-SMW, 4) 25 percent F-SMW and 5) 30 percent F-SMW in broiler ration. The parameters calculated in this study were feed intake, body weight gain, feed conversion body weight, carcass weight, carcass proportion, abdominal fat ratio, nitrogen retention, and crude fiber broiler digestibility. Result: feed intake, body weight gain, feed conversion body weight, carcass weight, carcass proportion, abdominal fat ratio, nitrogen retention, and crude fiber broiler digestibility significantly decreased ($P<0.01$) for all treatments. Conclusion: Up to 25% of F-SMW can be used for broiler ration.

1. Introduction

In poultry farming is the problem of limited feedstuff availability, and most of it is still imported, such as soybean meal, corn, and fish meal that make high feed cost for poultry. [1] stated that one of the main components is feed, which reaches 70% of the total production cost so that efficient feed can produce optimal livestock production. Efforts to reduce the expense of this ration include the use of waste materials that still have a nutritional value, do not conflict with human needs and are available on a continuous basis. One of the wastes that can be used in poultry rations is soy-milk waste (SMW).

SMW is a waste product from Soy-milk. The availability of SMW is quite a lot in line with the number of Home Industry making soy milk. [2] that soy milk, besides containing high protein, also contains isoflavone compounds that can reduce blood cholesterol levels. Along with the increasing demand for soybean milk, its availability in the form of soybean milk waste also increases so that it needs to be used as a source of poultry feedstuff, especially broilers.

SMW contents quite high crude protein i.e. 24.76%, crude fiber 18.15%, crude fat 2.86%, ash 7.49%, Ca 0.087% and P 0.053% [3]. Although the nutritional content of SMW is quite high, it only can be used 6.2% in broiler rations [4]. However, high crude fiber can cause low palatability and reduce ration quality. Efforts can be made to increase the quality and nutritional value of SMW with fermentation. Fermentation is a processing with the help of microorganisms that can improve the nutritional value of feed, taste, aroma, texture, digestibility, and storability better than the original ingredients [5] [6] [7].

Ciptaan and Mirnawati[8] reported that SMW fermented with *Neurospora sitophila* gave better results compared to SMW fermented with *Neurospora sp* and *Neurospora crassa* seen from crude protein 36.49%, crude fiber 14.04%, crude fat 4, 49%, Ca 0.69%, P 0.65%, metabolic energy 3139 kcal/kg, β carotene content 79.64 mg/g, nitrogen retention 57.54% and digestibility of crude fiber 56.05%. Although it has quite good nutritional content such as high crude protein, it can only be used 23% in broiler rations. Due to the high crude fiber (cellulose) and the inclusion of phytic acid, the restricted use of SMW in this ration is 2.98 per cent [9].

This high phytic acid will suppress protein digestibility, so protein is not available. [10] noted that about 67% of the total P in leguminous crops, cereals, oilseed plants and grain waste was bound to phytate. Besides that, [11] also added that phytic acid besides binding P minerals also binds 2 minerals such as Ca ++, Mg ++, Fe ++ and Zn ++ and binds proteins and amino acids by forming complex compounds so that they are difficult to dissolve and cannot be digested by digestive enzymes, because the digestive tract of poultry does not produce phytate hydrolyzing enzymes.

From the above problems, microorganisms that can hydrolyze cellulose and phytic acid are used, so F-SMW has a good quality that is low in crude fiber and phytic acid and can be utilized more in broiler rations. One of the molds that produce cellulase and phytase is *Aspergillus ficuum*. [12] stated that *Aspergillus ficuum* is a microbe that can produce phytase. The ability of *Aspergillus ficuum* to produce phytase enzymes in rice bran substrate with a solid media fermentation system has been carried out by [13], which shows that *Aspergillus ficuum* grown in rice bran substrate can produce the highest activity that is 2,529 units of activity with 88 hours fermentation time

[14] F-SMW with *Aspergillus ficuum* gave the results of crude protein 34.95%, crude fiber 11.01%, nitrogen retention 62.99%, digestibility of crude fiber 58.92%, cellulase activity 48.55%, protease activity 7.76%, phytase activity 7.49%, and phytic acid 0.11%. From the data above, it can be seen that F-SMW with *Aspergillus ficuum* provides better nutritional content so that it is expected to be used more as feed ingredients in broiler rations. The efficiency of the feed product must be scientifically examined to determine the impact of the use of *Aspergillus ficuum* fermented soybean in the ration on the performance of the broiler.

2. Material and Methods

140 DOC broiler strains of Cobb strain CP 707 of PT Charoen Pokphand Indonesia were used in this study, with no separation between males and females. Cages used in this study were 20 units of box cages made of wood and wire measuring 80 × 80 × 60 cm. 7 chickens occupy each unit, equipped with a place to eat and drink, 60-watt incandescent lamps for heating and lighting. The method used is a complete randomized design experimental method (CRD) with 5 treatment rations each and 4 replications. The level of SMW usage differentiated the treatment of ration. The rations are R1, R2, R3, R4, and R5, respectively, using 0, 15, 20, 25, and 30% F-SMW. The treatment ration was prepared with a protein balance of 22% and a metabolic energy of 3000 kcal/kg, according to [15] and the recommendations of [16]. The content of food substances and energy metabolism can be seen in table 1 F-SMW manufacturing procedure: SMW fermentation is processing by adding bran with a ratio (80:20) as a substrate while the inoculum is *Aspergillus ficuum* as much as 10%. Subsequently, incubated in an incubator for 9 days. Furthermore, F-SMW is harvested and roasted at a temperature of 60^0C to dry. After drying, F - SMW is ground and ready to be given in broiler ration.

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Table 1. Composition of treatment feed ingredients

Feed Ingredients	Ration Treatment				
	R1	R2	R3	R4	R5
Yellow Corn	51.80	48.00	46.30	45.00	43.00
Soybean Meal	20.90	10.30	7.00	3.50	0.50
CP 511	13.00	13.00	13.00	13.00	13.00
Fish meal	13.00	13.00	13.00	13.00	13.00
Coconut oil	0.80	0.20	0.20	0.00	0.00
Top Mix	0.50	0.50	0.50	0.50	0.50
FSMW	0.00	15.00	20.00	25.00	30.00
Total	**100**	**100**	**100**	**100**	**100**

Table 2. Content of food substances (%) and metabolic energy (kcal/kg) of the treatment ration

Feed Ingredients	Ration Treatment				
	R1	R2	R3	R4	R5
Crude Protein	22.07	22.16	22.26	22.30	22.51
Crude Fat	3.35	2.93	2.99	2.85	2.90
Crude Fiber	3.30	4.54	4.95	5.36	5.77
Ca	1.11	1.06	1.04	1.02	1.00
P Available	0.60	0.61	0.62	0.62	0.63
ME	3021.80	3038.05	3051.29	3056.33	3066.18

2.1. Data collection
Feed intake, body weight gain, feed conversion body weight, carcass ratio, broiler abdominal fat, nitrogen retention, and crude fiber digestibility were measured and obtained for data analysis.

2.2. Data Analysis
Data is taken every week to study the effects of treatments. The data that has been collected was processed statistically with diversity analysis [17]. Differences between treatments were examined using the Duncan Multiple Range Test (DMRT) [17].

3. Results and Discussion
The effects of treatments on feed consumption, body weight gain, feed conversion, body weight, carcass weight, carcass percentage, abdominal fat percentage, nitrogen retention, crude fiber digestibility of broiler were shown in Table 3.

Table 3. The Average of feed consumption, body weight gain, feed conversion, body weight, carcass weight, carcass percentage, abdominal fat percentage, nitrogen retention, crude fiber digestibility of broiler.

Parameter	R1 (0% F-SMW)	R2 (15% F-SMW)	R3 (20% F-SMW)	R4 (25% F-SMW)	R5 (30% F-SMW)	SEM
Feed consumption (g/head)	404.02[a]	403.72[a]	401.85[a]	400.79[a]	394.72[b]	1.27
Body weight gain (g/head)	218.79[a]	211.17[a]	209.89[a]	205.49[a]	169.87[b]	4.82
Feed conversion	1.85[b]	1.91[b]	1.93[b]	1.97[b]	2.40[a]	0.06
Body weight (g/head)	1241.57[a]	1230.02[a]	1196.07[a]	1195.75[a]	999.29[b]	22.3
Carcass percentage (%)	73.50[a]	72.89[a]	72.77[a]	72.72[a]	66.46[b]	1.35
Abdomen fat percentage (%)	1.84	1.83	1.76	1.75	1.73	0.04
Nitrogen retention (%)	54.64[a]	54.38[a]	54.24[a]	53.91[a]	50.80[b]	0.51
Crude fiber digestibility (%)	47.93[a]	47.60[a]	47.30[a]	46.97[a]	44.89[b]	0.31

Note: A different superscript in the same line indicates a highly significant different (P<0.01).

3.1. Effect of treatments on feed consumption

Based on the results of the analysis of variance, it was shown that the ration amount had a very significant effect (P<0.01) on the feed intake of broiler. Duncan Multiple Range Test (DMRT) results showed that the feed use of R1, R2, R3, and R4 was not significantly different (P>0.05), but that a highly significant difference (P<0.01) was higher than that of R5 in Table 3, the use of F-SMW was 25 percent in a ration equal to the control ration (R1), but if the usage rose to 30 percent, it would result in a reduction in feed consumption.

The consumption of broiler rations that are not significant in the treatment of R1, R2, R3, and R4 due to the use of F-SMW in rations can increase palatability or preferably livestock because of physical changes such as taste, texture and easy to digest from the original ingredients. This follows the opinion of [18] that fermentation can improve the digestibility of ingredients but also increase the nutritional content, texture, and taste of the ingredients for the better. The same thing was expressed by Mirnawati[6] that fermentation materials will have a better quality.

The decrease in ration consumption in the treatment R5 (F-SMW 30%) is thought due to the use of fermented products in rations in higher amounts so that the use of granular feed ingredients is reduced such as corn and soy-bean meal which causes the ration to be smoother. This is what causes the consumption of rations to be reduced where poultry prefers crumble-shaped rations over the form of

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flour or mash. This is supported by the opinion of [19] that feeding in the form of crumble makes the chicken continue to consume feed until it runs out until the chicken needs are met. They are also added by [20] that broiler chickens prefer crumble-shaped rations and produce a better body weight gain than mash. The decrease in ration consumption is also caused by the color of the ration, where in treatment, R5 is darker in color, so it is less liked by broilers. The opinion of [21] stated that there was a decrease in palatability or taste of darker colored food in chicken rations because chickens liked the bright color.

The decrease in broiler ration consumption after the use of more fermented products (30% F-SMW) is thought to be caused by the increasing number of microbial colonies in fermentation where the colony is a single cell protein that can increase the crude protein substrate. Since this crude protein may not be the amino acids produced by nucleic acid, this protein is difficult for poultry to digest. The availability of protein for growth is reduced, which causes an increase in energy requirements to form uric acid. This is consistent with the view of [22] that the ration intake is affected by the presence of a single cell protein that will affect the nucleic acid content. [23], where the ability of poultry to digest nucleic acids is limited, thereby increasing the energy requirements to form uric acid.

3.2. Effect of Treatments on Weight Gain

Based on the results of analysis of variance, it was confirmed that the use of F-SMW at a ration level of up to 30% had a highly significant effect ($P<0.01$) on broiler weight gain. The DMRT results showed the body weight gain in the R1, R2, R3 and R4 treatments were not significantly different ($P>0.05$), but was significantly different ($P<0.01$) from the R5 treatment ration. This shows that the use of F-SMW up to the level of 25% in the ration towards body weight gain can match the control ration, while the use of F-SMW up to the level of 30% although it does not have a negative impact on broiler performance but shows a decrease in broiler weight gain.

With the exception of the increase in body weight of broilers in R1, R2, R3 and R4 treatments related to fermentation materials, the ration has a good nutritional quality. This increases the digestibility of the diet, enhancing the body weight gain. This is supported by the opinion of [24] the final product of fermentation contains compounds that are easier and easier to digest from their primary ingredients to increase growth. Besides, there was no significant difference in broiler body weight gain in treatments R1, R2, R3, and R4 because the consumption of rations obtained in this study was also not significantly different. This may result in the number of food substances consumed by livestock increase body weight [25].

The body weight decrease in the broiler in the R5 treatment (F-SMW 30%) was due to the consumption of rations obtained in the R5 in this study also decreased. Therefore, the weight gain produced is also low. This is consistent with the opinion of [26] that body weight gain is strongly influenced by ration in terms of quantity and is related to ration consumption, which, if disturbed, will interfere with growth. Furthermore, the lower the nitrogen retention, the lower the weight gain produced. According to [27] and Mirnawati[7] that there is a relationship between the amount of nitrogen that is detected in the body of livestock with body weight gain so that nitrogen retention can be used to predict growth.

3.3. Effect of Treatment on Feed Conversion

Based on the results of analysis of variance, it was shown that the use of F-SMW up to the 30% had a highly significant effect ($P<0.01$) on the conversion of rations. DMRT results showed that the feed conversion of broiler rations in treatments R1, R2, R3, and R4 was not significantly different ($P> 0.05$), but significantly lower in treatment R5 ($P<0.01$). These results showed that the use of F-SMW at a level of up to 25% could be equivalent to the conversion of broiler rations in the control ration (R1).

The differences between the feed conversion of treatment R1, R2, R3 and R4 were not significantly different due to the consumption sampling error resulting in weight gain. The ratio between ration consumption and body weight gain is the same where the conversion of rations is determined by the amount of consumption and weight gain. According to [28], the value of feed conversion is affected by ration consumption to body weight gain. Low feed conversion value indicates the efficiency of good feed use because more efficient chickens consume rations for growth [29].

In the treatment of R5 (30% F-SMW), the conversion of rations produced a highly significant effect (P<0.01) because giving F-SMW to 30% level resulted in lower ration consumption and weight gain. According to [30], which states the high and low ration conversion is strongly affected by the amount of ration consumption and the amount of weight gain. The same amount of ration consumption at a lower body weight gain will result in a high conversion value for rations. The average broiler ration conversion obtained in this study ranged from 1.85 to 1.97.

3.4. Effect of Treatment on Body Weight

Based on the results of analysis of variance , it was shown that F-SMW with *Aspergillus ficuum* in the ration had a highly significant effect (P<0.01) on the bodyweight of broilers. Based on the results of the DMRT test it was found that the treatment of R1 was not significantly different (P>0.05) to treatments R2, R3, and R4, but it was highly significant (P<0.01) higher than the treatment R5 (30% F-SMW) to the bodyweight of broilers. Based on this analysis, the use of F-SMW up to 25% in the ration can match the broiler body weight in the control ration, but if the use of F-SMW is increased up to 30 %, there is a decrease in broiler body weight.

In contrast, the fact that R2, R3, and R4 were not treated with the bodyweight of broiler was due to the F-SMW ration with *A. ficuum,* which had better nutritional quality than the original material. This is consistent with the opinion of [6] that fermented material will be of better quality. Also, F-SMW is easier to digest so that the broiler's body can utilize it. Following the opinion of [31] and [32], fermentation may also change feed ingredients in order to be easily digested, produce flavourings, taste good and remove toxins from the original ingredients. The consumption of rations influences body weight.

The higher the ration consumption, the greater the body weight gain and body weight. In this study, the consumption of rations R2, R3, and R4 were not significantly different, so that the resulting life body weights were the same. Furthermore, the lowest ration consumption at R5 treatment was 349.72 g/head/week and resulted in a lower body weight than other treatments. The low of body weight produced is due to the low palatability of the ration, there by reducing consumption. Following the opinion of [25] states that the factors that influence the body weight was feed, in terms of a quantity related to feed consumption if the consumption of feed is low, it will affect body weight. Besides, F-SMW using *A. ficuum* causes the product to darken, thereby creating a decrease in ration consumption. In addition, broilers prefer rations that are bright and right [33]. Added by [21] also stated that the decrease in palatability of darker colored feed in broiler rations because of broilers like bright colors of feed.

Furthermore, the low consumption of ration in the R5 treatment causes a little nitrogen to be retained, and crude fiber is digested, so that body weight gain is low. If low body weight gain will result in low body weight. Product digestibility, including fiber digestibility and nitrogen retention, are factors that affect body weight. In this study, nitrogen retention and fiber digestibility for treatments R2, R3, and R4 were not significantly different (P>0.05). However, the R5 treatment decreased compared to other treatments with 50.80% nitrogen retention and 44.89% fiber digestibility. Based on Ref [34] and [7] opinion that higher digestibility leads to more easily degraded crude fiber with higher nitrogen retention. Higher nitrogen retention will lead to more weight gain. Such findings confirm the association between nitrogen retention and weight gain [7]. So that the use of F-SMW with *A. ficuum* up to 25% in the ration produces broiler body weights that can match the control ration.

The average body weight of broilers obtained in this study was around 999.29 - 1241.57 g/head. This result is lower than the opinion of Ref. [35] that broiler chickens are generally harvested at 4-5 weeks of age with body weights between 1.2 to 1.9 g/head with the aim as a source of meat. The weight of the carcass is directly related to body weight. Other reasons include, but are not limited to, the same quality ration per treatment, balanced food content in feed ingredients and total consumption. In addition, other factors have an impact, such as genes and age. [36] argues that genetics, sex, physiology, age, body weight, and nutritional ration are the factors that affect carcass weight.

3.5. Effect of Treatment on Carcass Percentage

Based on the results of analysis of variance, it was shown that F-SMW with *Aspergillus ficuum* in the ration had a highly significant effect (P<0.01) on the percentage of broiler carcasses. Based on the results of the DMRT it was found that the treatment of R1 was not significantly different (P>0.05) to treatments R2, R3, and R4, but it was highly significantly different (P<0.01) than treatment R5.

In the treatment of R1, R2, R3, R4, and R4, the different percentage of carcass was not affected by the same ration quality, life body weight, and carcass weight. However, due to the lower body weight and carcass weight of treatment R5, the treatment of R2, R3, and R4 differed significantly from the treatment of R5. According to the opinion of [25], the percentage of a carcass is closely related to body weight followed by carcass weight. Added by [25], the weight of the carcass is influenced by the consistency of the ration in each treatments, the balance of nutritional content in feedstuff, and the amount of feed consumed. The average percentage of carcasses obtained during the study around 66.46-73.50%. This result is higher than [37] survey results, i.e. 58.64-65.68%.

3.6. Effect of Treatment on Abdomen Fat Percentage

Based on the results of analysis of variance shows that the use of F-SMW with *Aspergillus ficuum* up to 30% in the ration has no significant effect (P>0.05) on the percentage of broiler abdominal fat. The percentage of abdominal fat is obtained by comparing the weight of abdominal fat with bodyweight multiplied by 100%. In contrary, the fact that R1, R2, R3, R4, and R5 are measured against the percentage of abdominal fat is caused by an iso-energy ration to form the same body fat as the level of energy accumulation in the body. The formation of body fat in chickens is due to the excess energy consumed. According to the opinions of [38] that the difference in abdominal fat percentage is partly due to the nutritional content of rations, energy levels, and amino acids. Also, at the age of 5-6 weeks, fat tissue begins to form, and then there is accumulation. This is consistent with the opinion of [39]. [40] also added that fat tissue began to form quickly at the age of 6-7 weeksFrom then on, fat accumulation continued to progress faster, particularly abdominal fat, at the age of 8 weeks, resulting in a rapid increase in chicken body weight.

Generally, in the initial growth phase of livestock, the amount of fat stored in the body is small, but in the final phase, the process of fat growth will proceed quickly, and fat will be stored under the skin, around internal organs, including intestines, and muscles. Abdominal fat also affects the quality of the broiler carcass. The higher the percentage, the lower the quality of the carcass. According to the opinion of [41], which stated that the low consumption of ration resulted in low body weight gain so that the carcass weight produced was also low. The average percentage of abdominal fat obtained during the study was 1.73 - 1.84%. This result is lower than [40], which states the average abdominal fat of broilers maintained for 6 weeks ranges from 2.49 - 2.50% of the bodyweight of broilers.

3.7. Effect of Treatment on Nitrogen Retention

Based on the results of analysis of variance, it was found that the use of F-SMW up to 30% had a higly significant effect (P < 0.01) on the nitrogen retention of broiler. DMRT results showed that the nitrogen retention of broiler in R1, R2, R3, and R4 treatments was not significantly different (P> 0.05), but it was higly significantly different (P <0.01) lower in R5 treatment. This shows that the use of F-SMW up to the 25% level can equal the nitrogen broiler retention in the control ration (R1).

The non-significant effects on nitrogen retention in R1, R2, R3 and R4 treatments are due to the use of F-SMW with better nutrients and complete amino acids. Due to the complex components of the fermentation process are degraded into simple ones so that the protein content of the substrate is degraded to amino acids that are easily digested by livestock [42]. This is supported by the opinion of [43], which states that phytase is able to hydrolyze phytic bonds, thereby increasing the availability of easily digestible proteins and amino acids and increasing nitrogen retention.

The decrease in nitrogen retention in R5 treatment (F-SMW 30 percent) is due to the low consumption of nutrients due to the presence of microbial nucleic acids, where the protein is difficult to digest by poultry so that nitrogen remains in the livestock body as well. This is following the opinion of [44], which states that an increase in nucleic acid and a decrease in the digestibility of organic matter causes the availability of nutrients to be reduced, so that tissue protein synthesis is reduced. Furthermore, increasing the amount of consumption of nucleic acids will increase energy requirements to form uric acid.

4. Conclusion

It can be concluded from the results of the study that the use of fermented soybean milk with *Aspergillus ficuum* can only be used up to 25% in broiler rations. This can be seen from feed intake 400.79 g/head/week, body weight gain 205.49 g/head/week and feed conversion 1.97, body weight 1195.75 g/head, carcass proportion 72.72 percent, abdominal fat content 1.75 percent, nitrogen retention 53.91 and crude fiber digestibility 46.97 which can meet the control ratio.

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