Fermented Cocoa Beans Supplementation as a Substitution for Corn in Broiler Feed Rations

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ABSTRACT

This study aimed to enhance the cocoa bean waste flour quality by applying cellulolytic fermentation technology and to identify the optimal level of cacao bean waste fermented flour to replace the corn in local feed rations. The broiler meat cholesterol was analyzed by Liebermann-Burchard method. The phytochemical content and proximate content were tested. The treatments in this study encompassed: P0: control, P1: 5% cocoa bean waste flour, P2: 10% cocoa bean waste flour, P3: 15% cocoa beans waste flour, P4: 20% cocoa bean waste flour. The results suggested that the P4 treatment was able to improve broiler body weight gain, feed conversion ratio (FCR) and production index. Treatment with P4 can replace corn in the ration, which reduce levels of meat fat and cholesterol without causing side-effect on the broiler's digestive tract.

Keywords: Cocoa beans, Fermentation, Feed rations.

Introduction

Broilers are high-quality meat-producing chickens that have a number of superiorities, such as rapid growth and the production of good quality fibrous meat. This type of poultry contains high protein that is needed by humans; therefore, the development of broiler farming is important (Mujnisa et al., 2018). However, a major difficulty among chicken breeders during the maintenance process is the feed factor: feed costs represent 60–70% of the total production costs (Abed et al., 2018; Gaffurd et al., 2018). In general, broiler chicken breeders are very dependent on the needs of commercial feed at a price that is quite expensive.

Meanwhile, there are many local resources and agricultural-plantation wastes that can serve as substitution for commercial chicken feed. Utilization of non-conventional local feedstuffs can be a good solution to the problem of high feed costs. Waste from cocoa beans contains 68.5% dry matter, consisting of 13.2–20.1% crude protein, 25.1% crude fiber, 6.0–10.8% ash, 40.2–52.5% nitrogen extract and 8.8% fat (Nasrullah and Ela, 1993).

The waste byproducts of cocoa cultivation can potentially be used as affordable livestock feed, and based on its nutritional content and abundance, it could particularly supplemented as a substitution for corn in feed rations (Ogunlade et al., 2010; Hamzat and Adeola, 2011; Adamafio, 2013). However, the supplementation of cocoa bean waste for feed is inhibited due to certain factors such as high crude fiber content and theobromine antinutrient compound in the cocoa beans. This compound can continuously reduce the animal's growth (Tarka et al., 1998: Pustuti and Susana, 2014: Olubamiwa et al., 2002).

Negative responses to cocoa bean waste appear when livestock consume more than 300 mg/kg, with an indication of decreased food consumption and daily body weight decrease (Alexander et al., 2008). However, the theobromine content can be reduced through grinding and drying (Gohl, 1981; Tarka et al., 1998). Therefore, in order to maximize the use and cocoa rind for livestock, the fermentation process can be applied.

Fermentation has the potential to improve the nutritional quality of cocoa beans. Fermented cocoa waste may serve as a feedstuff capable of substituting corn. Through the cellulolytic bacterial fermentation, the bacteria break down complex bond into a much simpler bond resulting in an easily digested feed for poultry, increasing the nutritional contents, reducing crude fiber (Mahfudz et al., 1996).

This study focused on determining the optimal level of fermented cocoa bean waste in substituting corn as local feedstuff and improving the productivity of broiler. The supplementation of Indian Camphorweed (Pluchea indica) leaf flour to the feed ration as an eco-friendly feed additive was also tested. According to Collington et al., (1990), additives for feed are extensively used in the poultry farming to improve
the poultry productivity in terms of growth and feed efficiency (Collington et al., 1990).

In this study, feed additives from Indian Camphorweed leaves were used due to their high content of flavonoid compounds, vitamins A and C as antioxidants that could inhibit free radicals to produce a better quality of protein (Rukmiash, 2011). Increasing the addition of cocoa bean waste as a substitute for corn in broiler chicken feed rations through cellulolytic bacterial fermentation was expected to produce affordable alternative feed.

**Materials and Methods**

This research was performed in Manuruki, Tamalate, Makassar for 5 months, from July to November 2018. Approximate analysis and content of tannin, theobromine, cholesterol meat and fat of broiler was identified at Pangkep Politeknik Laboratory of Biochemistry. This study consisted of 5 treatments and 4 replications, so that there were 20 experimental units consisting of 5 broilers for each unit. The chickens were divided randomly into 20 cage units without sex segregation (unsex), and 2% Indian Camphorweed leaf flour was added to every treatment. At the age of 35 days, 1 chicken was randomly taken from each treatment group. Tgh treatments in this study are listed below:

- P0: Ration without cocoa bean waste (control)
- P1: Ration with 5% cocoa bean waste
- P2: Ration with 10% cocoa bean waste
- P3: Ration with 15% cocoa bean waste
- P4: Ration with 20% cocoa bean waste

**The production of fermented cocoa bean waste flour**

Cocoa bean waste was obtained from one chocolate industry in South Sulawesi. The production of cocoa bean waste flour began with collecting waste material from cocoa beans consisting of broken rinds, placenta and whole, broken and squashed seeds. The ingredients were mixed and finely ground to produce a waste powder. The bacteria used in this study were BioMC4 cellulolytic bacteria that were activated by mixing 0.1% BioMC4 with 20% water and 1.5% molasses (mL).

**Bacteria activation**

The bacteria used in this study were BioMC4 cellulolytic bacteria that were activated by mixing 0.1% BioMC4 with 20% water and 1.5% molasses (mL).

**Experimental preparation**

The size of the cages were 150 x 150 x 60 cm. The cage bases were provided with sawdust with 10-cm thickness. Each cage unit was labeled with the treatment number and replication number. The cages and cage equipment were cleaned, chalked and disinfected two weeks before the maintenance step. Each cage was equipped with a hanging feeder and drinker and 60-watts of incandescent lighting as artificial lighting (for chickens aged 1–6 days). On the eighth day, the lamps were replaced with 40-watt incandescent lamps. Ration mixing was performed at the day before the chicken were delivered for four days. The ration was prepared twice a week to keep rations in fresh condition.

**Treatment**

The broiler used in this study were one-day-old males from Lohman 202 broiler strain (DOC). One hundred broilers were kept until they were 35 days old (5 weeks). The employed DOC strain has a relative body weight of approximately 50 g. The broilers were kept in 20 cage units that were randomly numbered with treatment and replication. Each cage unit held five chickens, with individual chicken number placed randomly. Soon after the DOC arrived, they provided with sugar solution to drink.

On the 4th day, the broiler were vaccinated with ND vaccine (B1 strain) through eye drop technique and administered with vitastress for 5 consecutive days. Ad libitum ration and drinking water were implemented. The feedstuff used in preparing the ration included yellow corn, bran, fish flour, Soybean cake, and Coconut oil cake.

The nutritional content of the feedstuff used in preparing the rations is presented in Table 1.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Crude Protein %</th>
<th>Crude Fat %</th>
<th>Crude Fiber %</th>
<th>Ca %</th>
<th>P %</th>
<th>Energy metabolism Kcal/kg</th>
</tr>
</thead>
</table>

Table 1: Nutrient content of feedstuff used in this study.
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Parameters
Parameters observed in this study included:

a. Approximate analysis of cocoa bean waste.
b. The phytochemical content of cocoa beans, including tannin and theobromine tests.
c. Feed ration consumption (g/chicken) = feed given – leftover feed (Rasyaf, 2004).
d. Weight gain (PBB) = BB after treatment – BB initial week.
e. Feed conversion = Feed consumption (g/chicken) / PBB (g/chicken).
f. Percentage of Carcass = Final carcass weight x 100% / Life weight.
g. RN = FC x FN – EW x NE
   % RN = (Consumption – Excreta) x 100 / Consumption.

Abbreviations:
RN = Nitrogen Retention (g/chicken per day)
FC = Feed consumption
EW = Excreta Weight (Feces + Urine)
NE = Nitrogen Excreta (Feces + Urine)
NP = Feed Nitrogen

h. Production index = % of live chickens x final body weight average (kg) x 100%

Statistical analysis
The data obtained were analyzed by analysis of variance (ANOVA) using SPSS statistical software (v16.0). If the treatment had a significant effect, analysis was also performed with the Duncan/Duncan multiple range test (Gomez & Gomez, 1995).

Results and Discussion

Phytochemical analysis of Indian Camphorweed leaves and cocoa bean waste flour

Table 2: Phytochemical content of Indian Camphorweed and cocoa waste flour

<table>
<thead>
<tr>
<th>Component</th>
<th>Indian Camphorweed Leaves</th>
<th>Unfermented CBWF</th>
<th>Fermented CBWF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavanoid (%)</td>
<td>30.20</td>
<td>29.71</td>
<td>28.49</td>
</tr>
<tr>
<td>Theobromin (%)</td>
<td>-</td>
<td>10.10</td>
<td>1.84</td>
</tr>
<tr>
<td>Alkaloid (tannin) (%)</td>
<td>5.40</td>
<td>9.05</td>
<td>3.22</td>
</tr>
</tbody>
</table>

Table 2 shows that Indian Camphorweed leaf flavonoid content was 30.2%. The theobromine and tannin content in unfermented cocoa bean waste flour was higher than in fermented cocoa bean waste flour. This indicates that the fermentation process can reduce the theobromine and tannin content in cocoa bean waste, which is one of the limiting factors of using cocoa bean waste as an alternative feed for poultry rations, especially for broilers. This is also supported by Gokulakrishnan et al. (2007). Further, Adamafio et al. (2011) showed that microbial fermentation can degrade theobromine in cocoa bean waste.
Feed consumption, weight gain, feed conversion (FCR), nitrogen retention, and percentage of broiler carcasses

Broiler performance data obtained in this study included data on ration consumption, weight gain, feed conversion, nitrogen retention and percentage of broiler chicken carcass, which is presented in Table 3 and discussed below.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>P0</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumption (g/chicken)</td>
<td>3175.00 ±</td>
<td>3187.50 ±</td>
<td>3162.50 ±</td>
<td>3155.00 ±</td>
<td>2950.00 ±</td>
</tr>
<tr>
<td></td>
<td>50.00</td>
<td>62.92</td>
<td>25.00</td>
<td>52.60</td>
<td>121.80</td>
</tr>
<tr>
<td>Body weight gain (g/chicken/day)</td>
<td>50.86 ±</td>
<td>53.64 ±</td>
<td>55.29 ±</td>
<td>56.21 ±</td>
<td>49.93 ±</td>
</tr>
<tr>
<td></td>
<td>0.62a</td>
<td>0.59b</td>
<td>0.17c</td>
<td>0.43c</td>
<td>1.05a</td>
</tr>
<tr>
<td>FCR (%)</td>
<td>1.79 ± 0.04a</td>
<td>1.69 ± 0.02b</td>
<td>1.64 ± 0.07bc</td>
<td>1.61 ± 0.04c</td>
<td>1.69 ± 0.05b</td>
</tr>
<tr>
<td>RN</td>
<td>72.17</td>
<td>75.00</td>
<td>74.73</td>
<td>73.36</td>
<td>70.20</td>
</tr>
<tr>
<td>Carcass (%)</td>
<td>66.26 ±</td>
<td>67.88 ±</td>
<td>68.60 ±</td>
<td>69.20 ±</td>
<td>65.65 ±</td>
</tr>
<tr>
<td></td>
<td>0.98a</td>
<td>0.29b</td>
<td>0.57b</td>
<td>0.77b</td>
<td>1.61a</td>
</tr>
</tbody>
</table>

a, b, c Different superscripts on the same line show results that are significantly different \((p < 0.05)\)

Feed consumption

The results of the ANOVA showed that the utilization of fermented cocoa bean waste flour as a substitute for corn in the ration did not have a significant effect on feed consumption \((p > 0.05)\). Average feed consumption ranged from 2950.0 g/chicken to 3187.5 g/chicken. This is because the ration for each treatment group was the same in both the feed composition and its nutritional content, especially protein and metabolic energy content, which ranged from 21–22% and 2900 Kcal/g, respectively. The most important factor influencing ration consumption was the metabolic energy content because the chicken will stop eating if the need for energy is met.

Weight gain

The treatment had a significant effect on body weight gain \((p < 0.05)\). The average broiler weight gain in this study ranged from 49.93–56.21 g/chicken/day. This result is higher than that seen by Adiwinarto (2005), who stated that broiler weight gain ranged from 21.75 g/chicken/day. Daily weight gain in the P0 treatment group was significantly lower than in treatments P1, P2, and P3, but did not differ from that of the P4 treatment group. This shows that cocoa bean waste flour can be utilized at levels up to 20%, with the addition of 2% Indian Camphorweed leaves, as a substitute for corn in preparing poultry rations. The presence of Indian Camphorweed phytochemical compounds work in synergy with the feed to also inhibit the growth of pathogenic bacteria and therefore, the digestive tract worked in an optimal function. Broiler feeds with plant extracts gives a better performance, and the addition of Indian Camphorweed leaf extract in the ration resulted in higher body weight gain. The addition of Indian Camphorweed leaf extract can reduce pH in the digestive tract, thereby increasing the nutrient intake, followed by increased body weight (Hernandez et al., 2004; Syafitri et al., 2015). Suprijatna et al. (2005) stated that factors which influence body weight include both the quality and quantity of feed consumption. Higher consumption of rations means a greater amount of nutrients absorbed, leading to a higher weight gain.

The average broiler body weight gain in treatment P1, P2, P3, and P4 compared to P0 treatment indicated that substitution of fermented cocoa bean waste for corn in the ration formulation at a level up to 20% with addition of Indian Camphorweed leaf flour improved broiler body weight and improved the absorption of nutrients by increasing the efficiency of the digestive process or increasing the digestibility of compounds that were initially indigestable, eventually increasing body weight.

FCR

Feed conversion is one indicator that can provide an illustration of the efficiency of ration use. A higher feed conversion value indicates more ration needed to increase body weight per unit, so the efficiency of ration use will be lower. Conversely, the lower feed conversion value will provide a higher efficiency of ration use. The results of Analysis of Variance (ANOVA) showed that the treatment had a significant effect \((p < 0.05)\) on broiler chicken feed conversion rate. The generated feed conversion on the average in this study ranged from 1.61 to 1.78. Similarly, Kartasudjana and Suprijatna (2006) stated that broiler chicken
conversion at 5 weeks was 1.98–2.08. The highest feed conversion was in treatment group P0 (1.79) and the lowest was in treatment group P3 (1.61), but neither were significantly different from treatment group P2 (1.64). The trend of decreasing ration conversion with the percentage of fermented cocoa bean waste flour in rations is explained by a smaller increase in feed consumption than the body weight gain increase generating a lower feed conversion rate. The results showed that using fermented cocoa bean waste as a substitute for corn with the addition of Indian Camphorweed leaf flour in the ration increased the efficiency of ration use.

This is presumably due to the effect of adding Indian Camphorweed leaf flour, which has phenols and flavonoids that act as antimicrobials and suppress pathogenic bacteria, providing a better conversion compared to other treatments. The high ration conversion rate in P2 and P3 is thought to be the presence of antinutrient compounds in the form of tannins in high concentrations, which inhibits the work of digestive enzymes, so that the digestibility of the feed becomes low. This is consistent with the study by Lacy and Vest (2000), in which the main factors that influenced feed conversion were genetics, ration quality, disease, temperature, cage sanitation, cage management, rationing factors, a rate of digestion in the digestive tract, and physical form of the ration. According to Munt et al. (1995), the feed ration factor affecting ration conversion was the ration form, and crumble and pellet forms tended to reduce the amount of ration lost in the litter compared to the mash ration form. Pellet form rations had a better conversion compared to the mash ration form, with values from 1.8–1.9%. The ration used in the study was in mash form.

**Nitrogen Retention**

Treatment also had no significant effect on nitrogen retention of broiler chickens \( (p > 0.05) \). The average nitrogen retention in this study ranged from 70.20–75.00%. The increase in average nitrogen retention was caused by the digestion and absorption of better food substances, which accelerated the rate of passage through the digestive tract. The amount of ration consumed by livestock greatly affects nitrogen retention. Greater consumption of rations will in turn provide higher consumption of protein, which affects nitrogen retention. Nitrogen retention is influenced by several factors, such as feed consumption, protein consumption and protein quality (Dady et al., 2016).

**Percentage of carcass**

The P3 treatment had the highest carcass percentage value of 69.20%. This high percentage was influenced by the final body weight in treatment group P3 compared to other treatments, which was 2017.50 g/chicken (Table 4). The high final body weight produced a high percentage of carcass. This indicates that the P3 treatment with 15% cocoa bean waste flour and 2% Indian Camphorweed flour can increase the percentage of the carcass to the maximum. This percentage is in line with the previous study by Bell and Weaver (2002), who stated that generally, the percentage of broiler carcasses varies, measuring between 65–75% of body weight. However, according to Brake et al. (1993), the percentage of carcass is also related to gender and age, in addition to body weight.

**Production index**

According to Arifien (1997), the success level of livestock businesses is not only affected by the low conversion value of the ration, but also index of production. To determine the production index, the calculations of the final body weight, the percentage of live chickens, the length of maintenance and conversion of rations was needed.

Table 4: Broiler production index over 35 days in various treatments.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of live chickens</td>
<td>P0</td>
</tr>
<tr>
<td></td>
<td>P1</td>
</tr>
<tr>
<td></td>
<td>P2</td>
</tr>
<tr>
<td></td>
<td>P3</td>
</tr>
<tr>
<td></td>
<td>P4</td>
</tr>
<tr>
<td>The final body weight average (g/chicken)</td>
<td>1820.0</td>
</tr>
<tr>
<td>Maintenance time (days)</td>
<td>35</td>
</tr>
<tr>
<td>Performance index</td>
<td>excellent</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
<tr>
<td></td>
<td>excellent</td>
</tr>
</tbody>
</table>

As shown in Table 4, the production index in this study ranged from 2923 to 3580, and the performance outcome was excellent for all treatments. The P3 treatment had a higher production index of 3580, compared to other treatments. This is supported by a low feed conversion rate of around 1.61 (FCR value in Table 3) and an average final body weight that was higher than in other treatments. A higher production index gave a better broiler chickens performance. This gives an indication that the P3 treatment, with 15% cocoa bean waste flour as a substitute for corn and 2% Indian Camphorweed flour, is more efficient to achieve
maximum growth and profits, compared to other treatments.

### Meat fat and cholesterol levels

Table 5: Average broiler meat fat and cholesterol in various treatments.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
</tr>
<tr>
<td>Meant fat (%)</td>
<td>3.44 ± 0.20&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Meant cholesterol (mg/100 g)</td>
<td>152.50 ± 5.97&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup> Different superscripts on the same line show significantly different results (<i>p</i> < 0.05)

Table 5 shows that the treatments had significant effects on the fat content of broiler meat (<i>p</i> < 0.05), ranging from 2.37–3.44% which still in the normal range. According to Mountney (1995), broiler meat contains fat between 1.3–7.3%. Meat fat is not completely formed in broilers aged five weeks because food substances absorbed by the body are still used for pure growth, and there is no excess energy. Excess energy in feed can be converted into body fat.

The treatment did have a significant effect on cholesterol levels of broiler chicken meat (<i>p</i> < 0.05). Treatments that used 5, 10, or 15% fermented cocoa bean waste flour (P1, P2, and P3, respectively) plus 2% Indian Camphorweed leaf flour to replace corn in the feed ration produced a lower meat cholesterol content compared to control treatment (P0). The lowest cholesterol content was found in the P2 treatment group and the highest in the P0 treatment group. Broiler chicken cholesterol content in this study ranged from 127.75–152.50 mg/100 g of meat, which was lower than those reported by Sutrihadi et al. (2013), ranging from 251–258 mg/100 g of meat.

Decreased cholesterol in meat is thought to be influenced by the bioactive compounds found in Indian Camphorweed leaves flour, such as flavonoids and tannins. Indian Camphorweed leaves also contain phenol compounds that can inhibit the formation of intestinal micelles, where these compounds function to absorb bile acids in order to dissolve and pass cholesterol through the bile ducts into the intestine; they also reduce body fat, stimulate secretion of bile salts and remove cholesterol through feces (Hudha and Widyansingsih, 2014; Rosydi, 2014). Tannins have the ability to bind bile acids in the intestine and remove them through the feces, reducing meat cholesterol. Dhesti and Widyansingsih (2014) stated that tannins can inhibit the action of HMG-CoA reduction and acyl-coenzyme A cholesterol acyltransferase (ACAT) as an enzyme contributing to the cholesterol synthesis absorption process. In addition, the reduction of cholesterol in the treatment group fed rations with fermented cocoa bean waste flour was also influenced by the crude fiber content in the ration. Setyaningsih (2012) stated that crude fiber in the diet suppresses cholesterol formation by increasing intestinal peristalsis so that food is not absorbed maximally, and increases the loss of bile salts in the duodenum so that the liver needs more cholesterol to produce bile salts by taking cholesterol reserves in the tissues.

### The Length of Digestive tract

The length of the digestive tract organs, including the duodenum, jejunum, ileum, cecum and colon were measured in cm after 35 days of treatment.

Table 6: Lengths (cm) of broiler chicken digestive tract organs with various treatments.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Treatments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
</tr>
<tr>
<td>Duodenum</td>
<td>26.60 ±</td>
</tr>
<tr>
<td>Jejunum</td>
<td>61.60 ±</td>
</tr>
<tr>
<td></td>
<td>66.55 ±</td>
</tr>
<tr>
<td>Ileum</td>
<td>0.57</td>
</tr>
<tr>
<td>Colon</td>
<td>16.83 ±</td>
</tr>
<tr>
<td>Cecum</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Different superscripts on the same line show results that are significantly different (<i>p</i> < 0.05)
As can be seen from the Table 6, the treatment had no significant effect on the length of the duodenum, ileum, colon, and cecum of broiler chickens \( (p > 0.05) \); however, it did cause a significantly difference in the length of jejunum \( (p < 0.05) \). The average length of duodenum ranged from 26.60–27.58 cm. Similarly, in a study by Hamsah (2013), broiler chickens at 35 days had duodenum lengths that ranged from 26.94–27.70 cm. The average jejunum length ranged from 61.60–63.00 cm, which is in accordance with that reported by Hamzah (2013), with jejunum lengths ranging from 61.60–63.69 cm. The average length of the ileum ranged from 66.55–68.25 cm. This is consistent with the study by Widianingsih (2008), where the length of the ileum was 63.95–82.85 cm; however, Hamsah (2013) reported lengths ranging from 65.66–68.65 cm. The average length of the cecum ranged from 16.60–17.18 cm, and the average length of the colon was 6.63–7.00 cm. This result is in line with what was reported by Mossami (2011), where the addition of chaff in the ration affected the length of the colon, which measured between 6.00–8.00 cm.

Based on the previous study conducted by Widianingsih (2008), the length of chicken cecums ranged from 15.45–17.08 cm. The results of our study indicate that using a 20% concentration of fermented cocoa bean waste flour to replace corn in feed ration has not affected the length of any of the broiler chicken digestive tract organs. This is because the ration used in this study was prepared with the same fiber content found in feed without cocoa bean waste flour (approximately 6%) and was within the limits that can be tolerated by broiler chickens. Rations with high coarse fiber content affects the length of the digestive tract because they require intensive absorption; therefore, the intestine will expand its surface by thickening the intestinal wall, or by prolonging the intestine so that more nutrients can be absorbed. Furthermore, broiler chickens fed rations with high crude fiber consume proteins that difficult to degrade; thus, the length of the small intestine is longer compared to chickens fed rations with low crude fiber (Cahyono et al., 2012). Coarse fiber has a negative effect on digestibility and absorption of nutrients, due to the increased viscosity during digestion, and affects the chickens’ physiological conditions and the digestive tract ecosystem. Food normally lasts approximately 4 hours in the digestive tract of poultry (Prawitasari et al., 2012). However, these factors can accelerate the transit time, causing the rate of digestion to become faster.

**Conclusion and Recommendation**

Based on the results of this study, it can be concluded that the addition of up to 20% of fermented cocoa bean waste flour in the feed ration, combined with the addition of Indian Camphorweed leaf flour, can improve broiler chicken body weight gain, feed conversion (FCR) and the production index. This concentration of fermented cocoa bean waste flour used in place of corn in the feed ration can reduce the meat fat and cholesterol content in broiler chicken meat and has no effect on the length of the digestive tract.

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**Author Contributions**

A. Mujnisa performed and designed the experiments:
Syamsuddin Hasan analysed and designed the experiments
Purnama Isti Khaerani wrote the manuscript.

**Funding Details**

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

**Disclosure Statement**

No potential conflict of interest was reported by the authors.

**References**


