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The Effects of Using Clove Meal (*Syzygium aromaticum* L.) as Feed Additive on Nutrient Digestibility and Metabolizable Energy of Broiler Chicken

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ABSTRACT: This study was aimed at determining the effect of clove meal addition in diets on nutrient digestibility and metabolizable energy in broilers and whether it could be an alternative to antibiotics or not. In this experiment, twenty-four 35-day-old broilers of the chicken strain Lohman were used. A total of twenty broiler chickens were selected as representatives for determining the digestibility. The treatment diets were: T0 (basal diet), T1 (basal diet + 0.25% clove meal), T2 (basal diet + 0.5% clove meal), T3 (basal diet + 0.75% clove meal), and T4 (basal diet + 1% clove meal). The variables measured were dry matter digestibility, organic matter digestibility, apparent protein digestibility, true digestible protein (TDP), Apparent Metabolizable Energy (AME), True Metabolizable Energy (TME), Nitrogen Corrected Apparent Metabolizable Energy (AMEn) and Nitrogen Corrected True Metabolizable Energy (TMEn). A completely random design was used, with five treatments and four replications. The data were analyzed using analysis of variance (ANOVA), and differences among treatments were examined using Duncan's multiple range test. The results show that the treatment influences significantly ($P<0.05$) of dry matter, organic matter, apparent protein digestibility, and TDP. In contrast, there were no significant effects ($p>0,05$) of dietary treatment on AME, TME, AMEn, and TMEn. However, the addition of 0.75% clove meal indicated the best result in AME, TME, AMEn, and TMEn. It can be concluded that the experiment indicated that the addition of clove meal (Syzygium aromaticum L.) in 0.75% on the diet of broiler chickens was effective in increasing the digestibility of dry matter, organic matter, crude protein, TDP, and metabolizable energy.

Keywords: Clove meal; Feed additive; Broiler; Nutrient digestibility; Metabolizable energy

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INTRODUCTION

Recently, utilization of growth promoters (AGPs) in Indonesia has been banned and restricted since 2018, with some reasons as follows: 1) the possibility of antibiotic residues in the animal product will be toxic for consumers; and, 2) microorganisms that exist in humans or animals (especially pathogenic bacteria such as *Salmonella*, *Escherichia coli*, and *Clostridium perfringens*) will become resistant to certain antibiotics (Nhung, et al, 2017). For the natural and safety aspects, it is important to explore the potential of natural feed additives to replace the chemical ones.

Clove essential oil has a yield of about 14–21%, where 95% is the main component of eugenol. Eugenol is a strong-smelling chemical compound that can be found in large amounts in clove grain. It is slightly soluble in water and soluble in organic solvents (Sulliman, et al. 2021). Cloves contain bioactive compounds such as eugenol, whose high levels can serve as an antiseptic, antifungal, antibacterial, anti-carcinogenic, and antioxidant (Prianto et al., 2013). Feed additives can be obtained from clove meal (*Syzygium aromaticum*), which is shown to increase appetite and feed intake in broilers; therefore, clove meal can be used as a substitute for antibiotics (Sulliman, et al. 2021).

Research by Salman and Ibrahim (2012) states that the addition of clove meal at levels of 0.4% and 0.8% in the feed gives the best effect on the value of the FCR (1.80 and 1.85), as well as on the growth rate (23 and 21.918). A clove extract supplementation of 400 ppm was able to reduce the number of coliform bacteria present in the intestines on observation days 21 and 42 by 4.51 cfu/g and 3.08 cfu/g. The use of 400 ppm clove extract as an alternative to natural growth promoters could replace the role of antibiotics in controlling and limiting the growth of pathogenic bacteria in the digestive tract (Dalkilic, 2009). This study was aimed at determining the effect of clove meal addition in diets on nutrient digestibility and metabolizable energy in broiler chickens.

MATERIALS AND METHODS

Animals

A total of twenty four broiler chickens were selected as representatives for determining the digestibility. The birds were randomly chosen from a total of 200 broiler chickens reared on DOC until the age of 5 weeks, with an average body weight of 1.89 ± 0.13 kg.

Clove Meal Used

The clove meal used was obtained from UPT Materia Medica Batu, Malang, and it is already in the form of meal.

Treatments

The basal diets used in this study consisted of concentrates, yellow maize, and rice bran and were arranged based on the broiler chicken finisher's nutritional needs. The composition and nutrient analysis for the basal diets are shown in Table 1.

This study uses a completely randomized design, which consists of five treatments and four replications. The treatment is the addition of flour clove (*Syzygium aromaticum* L) in the feed at different concentrations, which consisted of:

T0 = Basal diet (control)
T1 = Basal diet + clove meal 0,25%
T2 = Basal diet + clove meal 0,50%
T3 = Basal diet + clove meal 0,75%
T4 = Basal diet + clove meal 1,00%

Variables were observed in this study are :

1. Dry Matter Digestibility

Dry matter digestibility was calculated by the following formula :

$$DM\ digestibility = \frac{DMi - DMe}{DMi} \times 100\%$$

Where:
DMi : total dry matter intake
DMe : total dry matter excreta

2. Organic Matter Digestibility

$$OM\ digestibility = \frac{OMi - OMe}{OMi} \times 100\%$$

Where:
OMi : total organic matter intake
OMe : total organic matter excreta

3. Apparent protein digestibility
Digestibility of protein can be calculated by the following formula (McDonald et al., 1977):

$$App.prot.digest\ (\%) = \frac{prot.intake - prot.\ excreta}{Prot.\ intake} \times 100\%$$

Where:
Protein intake : (feed consumptionx %DM diet) x %CP on diet
Protein excreta : (total excreta x %DM excreta) x %CP on excreta

4. True Digestible Potein (TDP)
True protein digestibility can be calculated using the equation according to Fenton and Fenton (1979), which is cited by Aghakhanian et al. (2009):

$$TDP\ (\%) = \frac{prot.intake.-(prot.excreta - prot.endogen)}{prot.intake} \times 100\%$$

Where :
Prot.intake : (feed consumpt. x %DM diet) x %CP on diet
Prot.excreta : (total excreta x %DM excreta) x %CP on excreta
Prot.endogen: (total excreta endogen x %DM excreta endogen) x % CP on excreta endogen

5. Metabolizable Energy
According to Kadim et al (2002) metabolizable energy is given by:

a) *Apparent Metabolizable Energy* (AME)

$$AME\ (kcal/kg) = \frac{GE\ intake - GE\ ekskreta}{intake}$$

b) *True Metabolizable Energy* (TME)

$$TME\ (kcal/kg) = \frac{GE\ intake - (GE\ ekskreta - GE\ Endogenous)}{intake}$$

c) *Nitrogen Corrected Apparent Metabolizable Energy* (AMEn)

$$AMEn\ (kcal/kg) = \frac{GE\ intake - (GE\ ekskreta + (8{,}73\ x\ RN))}{intake}$$

d) *Nitrogen Corrected True Metabolizable Energy* (TMEn)

$$TMEn\ (kcal/kg) = \frac{GE\ intake - (GE\ ekskreta - GE\ Endogenous + (8{,}73\ x\ RN))}{intake}$$

where:
GE intake = consumption (g/DM) x GE feed (kcal/kg)
GE ekskreta = Total excreta (g/BK) x GE excreta (kcal/kg)
GE endogenous =Total excreta endogenous (g/DM) x GE excreta endogenous (kcal/kg)
RN = Nitrogen Retention (g)
Intake = Feed Consumption (g/DM

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Table 1. Composition and Nutrient Analysis of Basal Diet Variables

Composition	Unit (%)
Yellow Maize	55
Rice bran	5
Concentrates	40
Total	100
Nutrient Analysis	Basal Diet
Dry Matter (%)*	89,31
Crude Protein (%)*	21,26
Crude Fiber (%)*	4,97
Crude Lipid (%)*	4,73
An-organic Matter (%)*	7,85
Gross Energy (Kkal/kg)*	3879,69
Metabolizable Energy (Kkal/kg)**	2715,78

* Based on calculations using Microsoft Excel 2013
** Based on the conversion of 70% GE

Statistical Analysis

Data were analyzed with ANOVA (Steel and Torrie, 1992). The research design used a completely randomized design. The differences among treatments were tested using Duncan's multiple comparison test, and statistical significance was declared at P<0.05 and P<0.01.

RESULTS AND DISCUSSION

The digestibility of nutrients is calculated by the difference between the consumption of food substances and the nutrients contained in the excreta. Average data for dry matter, organic matter, and the apparent protein feed TDP treatment are presented in Table 2.

Dry Matter Digestibility

Table 2 shows that the feed treatment results are the highest dry matter digestibility of feed with the addition of flour clove 0.75% (P3), with a dry matter digestibility value of 70.52 3.36%, and then successively followed by P4 (68.42 ± 3.81%), P2 (67.92 ± 1.96%), P1 (65.34 2.31%), and the lowest is P0 (59.50 ± 3.79%). Based on the results of statistical analysis, it is known that the addition of 0.5–1% flour cloves can significantly (P <0.01) improve the digestibility of dry matter compared with the control treatment.

Phytobiotics in clove flower extract act as an antibiotic that is capable to controlling and limiting the growth of pathogenic bacteria in the gastrointestinal tract (Dalkilic, 2009). Accordingly, Krauze (2022) reported that the use of phytobiotics in feed provided positive results in suppressing pathogenic bacteria.

Yakhkeshi et al. (2011) say that a drop in pH followed by an increase in BAL population in the digestive tract has a big effect on the gut's shape and improves its ability to digest food. When the pH of the digestive tract goes down, it makes the digestive tract more acidic, which is good for the digestive tract of broilers. Changes in gut microflora populations lead to changes in enzyme activity in the gastrointestinal tract. Colonies of Bifidobacterium and Lactobacillus on the digestive tract make digestive enzymes, which make the digestive enzymes in the gut work better.

Organic Matter Digestibility

Table 3 shows that the treatment gives the highest organic matter digestibility value is P3 in 74.78 ± 2.78% and then successively followed by P4 (73.30 ± 3.21%), P2 (72.55 ± 1 , 62%), P1 (70.21 ± 2.03%) and the lowest is P0 of 65.15 ± 3.77%. Based on the results of statistical analysis, it is known that the addition of flour clove of 0.5-1% were significantly (P <0.01) can improve the digestibility of dry matter compared with control treatment.

The higher of dry matter digestibility, increased digestibility of organic matter and the higher chance of nutrients that can be utilized for the production and the lower digestibility of DM will affecting in the lower digestibility of organic matter and the lower of nutritional used by broilers (Kadim, et al., 2002).

The addition of plant extracts in the form of essential oils can improve the nutrient digestibility of broilers compared to a control treatment in the form of a basal diet without the addition of essential oils (Chao et al., 2010). The nutrient digestibility of the diet is influenced by the chemical composition, processing, and amount of food consumed (Tillman et al., 2005).

Tabel 2. Effect of clove meal addition on nutrient digestibility

Treatments	DM digestibility (%)	Organic Matter Digestibility (%)	Apparent protein digestibility (%)	TDP (%)
P0	59.50 ± 3.79^{A}	65.15 ± 3.77^{A}	55.35 ± 5.35^{a}	56.45 ± 5.33^{a}
P1	65.34 ± 2.31^{AB}	70.21 ± 2.03^{AB}	61.71 ± 4.18^{ab}	62.78 ± 4.15^{ab}
P2	67.92 ± 1.96^{B}	72.55 ± 1.62^{B}	64.74 ± 4.26^{b}	65.88 ± 4.26^{b}
P3	70.52 ± 3.36^{B}	74.78 ± 2.78^{B}	66.42 ± 5.38^{b}	67.51 ± 5.33^{b}
P4	68.42 ± 3.81^{B}	73.30 ± 3.21^{B}	66.09 ± 4.70^{b}	67.21 ± 4.63^{b}

Small and large superscript in the same column shows the significant effect (P <0.05) and highly significant (P <0.01) in each variable.

Apparent and True Protein Digestibility

The results of the statistical analysis show that the addition of clove meal as a feed additive has a significant effect (P <0.05) on increasing the apparent and true protein digestibility. The digestibility of the protein depends on the protein content of the feed ingredients and the many proteins that enter the digestive tract (Kadim, et al., 2002)

The use of clove extract can be used as a natural growth promoter to replace the use of antibiotics in raising the digestibility of commercial broiler chicken feed (Dalkilic, 2009). Yakhkeshi (2011) states that the pathogenic bacteria will compete with their host in the use of nutrients in the digestive tract of broilers, thereby reducing the availability of nutrients to be utilized by the broiler. pH in every part of the small intestine is different, the duodenal pH is 5–6, the jejunum pH is 6,5–7, and the ileum pH is 7–7.5 (Gaunthier, 2002). The optimum pH of enzyme pepsin in chickens with optimum enzyme activity is at pH 2.8 (Bohak, 1969).

Essential oils stimulate the production of digestive secretions that are useful to control the pH appropriate for enzyme digestion (Brenes and Roura, 2010) Essential oil has a pH of 7, and the neutral pH of essential oils helps the digestive tract, especially the small intestine, in neutralizing chime acidity (Brenes and Roura, 2010). The quality of feed protein affects the digestibility of protein in broiler chicken; proteins are degraded by hydrolytic enzymes (Wahyu, 2004).

A determination of digestibility was conducted to determine how much of the substances contained in the feed can be absorbed for basic life, growth, and production. If the quality of feed decreases, it will affect the digestibility of feed, besides, the absorption of nutrients in the intestinal mucosa will also affect the digestibility of nutrients (Cheeke, 2005).

Metabolizable Energy

Metabolizable energy is the result of gross energy consumption and gross energy excretion through excreta. The mean values of Apparent Metabolizable Energy (AME), True Metabolizable Energy (TME), Nitrogen Corrected Apparent Metabolizable Energy (AMEn) and Nitrogen Corrected True Metabolizable Energy (TMEn) are presented in Table 3. The results of statistical analysis show that the addition of clove meal as a feed additive has no significant effect (P <0.05) on increasing AME, TME, AMEn and TMEn.

It can be seen from the table AME value that from the highest to the lowest, respectively, are treated P3 (2843.20 ± 103.69 kcal / kg), P4 (2791.58 ± 140.12 kcal / kg), P1 (2754.38 ± 48.01 kcal / kg), P2 (2728.21 ± 51.72 kcal / kg) and P0 (2676.77 ± 278.65 kcal / kg). Descriptively, Table 3 shows the trend of increasing metabolizable energy value by the addition of clove meal in the diet. Metabolizable energy affected by the amount of feed and energy consumption as well as the efficiency of energy use by livestock. Apparent Metabolizable Energy represents the difference between energy consumption and energy excretion (NRC, 1994).

Tabel 3. Effect of clove meal addition on Metabolizable energy

Treatments	AME (Kcal/kg)	TME (Kcal/kg)	AMEn (Kcal/kg)	TMEn (Kcal/kg)
P0	2676,77 ± 278,65	2684,06 ± 278,14	2482,24 ± 269,82	2489,52 ± 269,31
P1	2754,38 ± 48,01	2761,42 ± 47,71	2559,38 ± 45,63	2566,42 ± 45,38
P2	2728,21 ± 51,72	2735,71 ± 52,06	2540,79 ± 55,12	2548,29 ± 55,45
P3	2843,20 ± 103,69	2850,36 ± 103,29	2653,37 ± 110,42	2660,53 ± 110,12
P4	2791,58 ± 140,12	2798,96 ± 139,56	2608,98 ± 135,58	2616,36 ± 135,02

Results of research have shown that the TME value is higher than the AME value. The AME is different because the calculation doesn't take into account the number of energizing molecules that come from the body. During a fast, energy for basic needs comes from the body's own feces and urine, as well as from the body's own breakdown of tissue.Part of this energy comes from the nitrogen-containing end product (Wolynetz and Sibbald, 1984). Sibbald (1980) says that AME doesn't take into account the value of the energy that comes from sources inside the body.

Dalkilic's (2009) research shows that adding clove extract at a concentration of 400 ppm makes it easier to digest proteins and can be used as a natural growth promoter instead of antibiotics because it kills bacteria.The addition of essential oils and the like to the diet can increase the productivity of livestock through the creation of environmental conditions that promote the optimum growth of beneficial bacteria. Favorable environments for the growth of certain bacteria can activate and stimulate endogenous enzymes, resulting in increased digestibility of nutrients (Samadi, 2004). Enzymes have specific traits and are influenced by temperature, pH, enzyme concentration, substrate, and activator (Bedford and Apajalahti, 2022)).

The determination of metabolic energy needs to be corrected for the amount of nitrogen retention because the ability of chickens to utilize the gross energy of crude protein varies greatly (McDonald et al., 2010).. The calculation of metabolic energy that is not corrected by the retention of N (retained nitrogen) when broken down will be expressed as the energy lost as urine (Barzegar, et al., 2020).

CONCLUSION

To sum up, the addition of clove meal (*Syzygium aromaticum* L.) at 0.75% levels in diets can be used as a natural growth promoter and improve dry matter, organic matter, protein, true digestible protein, and metabolizable energy value.

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