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EFFECT OF STEAMING ON NUTRIENTS CONTENT OF FLAXSEED AS A FEED INGREDIENT

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ABSTRACT

This study aims to determine the effect of steaming on the content of feed substances in flaxseed as animal feed. Flaxseed (*Linum usitatissimum*) is a cereal plant with a high protein, energy, and fat content. Still, flaxseed also contains antinutrient substances, namely tannins and phytic acid, inhibiting feed substances' absorption. Antinutrients can be decreased by the steaming method. The research material is flaxseed. The study used laboratory experiments with a complete random design (CRD), four treatments, and five replications, covering treatment: P0 = flaxseed without treatment, P1 = Flaxseed steamed for 10 minutes, P2 = Flaxseed steamed for 20 minutes, P3 = Flaxseed steamed for 30 minutes. The observed variables are feed substances dry matter, crude protein, crude fiber, crude fat, ash, gross energy, NDF, ADF, tannins, and phytic acid. The analysis used analysis of variance (ANOVA) and Duncan's Multiple Range Test. The results showed that the treatment had no significant effect ($P>0.05$) on the dry matter but had a very substantial impact ($P<0.01$) on crude protein, crude fiber, crude fat, ash, gross energy, NDF, ADF, tannin, and phytic acid. The treatment can be concluded to decrease feed substances, including dry matter, crude protein, crude fat, ash, gross energy, NDF, ADF, tannins, and phytic acid, but cannot decrease crude fiber. The best treatment was steaming flaxseed for 30 minutes.

1. INTRODUCTION

Breeds, feed, and management are factors that affect the success of the livestock. These three factors are the system's unity that must be considered; if one factor is neglected, then the other factor will give less than maximum results. Selecting the right feed ingredients in livestock will produce quality feed to meet nutritional needs and increase livestock productivity. Based on the content of feed substances, feed ingredients can be divided into five groups, namely feed ingredients as energy sources (CP < 20% and CF < 18%), protein sources (min. 20%), mineral sources, vitamin sources, and feed addictive (Putra, 2019). Flaxseed is a whole grain that is still foreign in Indonesian society. Whole flaxseed and flaxseed flour can be used as feed for poultry, pork, and cows. Flaxseeds contain linolenic acid and linoleic acid, which is good for livestock growth. The content of feed substances in flaxseed is a crude protein (CP) 20.3%, crude fiber (CF) 12.39%, crude fat 37.1%, Calcium 1.7%, phosphorus 3.7%. Total Dietary Fiber (TDF) is 24.5% and metabolic energy 3654 – 4277 Kcal/kg, but it has antinutrients, namely phytic acid and tannins, that are quite high (Kajla et al., 2015; Singh & Mridula, 2011). Antinutrient substances, namely tannins and phytic acid, can affect livestock health, feed utilization, and productivity. Antinutrient substances contained in flaxseeds require processing to reduce antinutrient substances' percentage. The technology of processing feed materials through heating also needs to be considered the length of time used. Heating for too long can damage the content of feed substances in flaxseeds, such as amino acids. One of the technologies of processing feed materials through heating is wet heating by steaming. Steaming can minimize the decrease in the content of feed substances in livestock ingredients. In addition, steaming is easy for anyone with a simple tool. Based on the description above, there needs to research on the effect of the steaming time on the content of flaxseed feed substances as animal feed ingredients.

2. METHODS

The material used in this study is flaxseed. This study used laboratory experiment methods with Complete Random Design (CRD) with four treatments of 5 repetitions. The treatments performed in this study include,

P0 = Flaxseed without treatment (Control)
P1 = flaxseed with steaming for 10 minutes
P2 = flaxseed with steaming for 20 minutes
P3 = flaxseed with steaming for 30 minutes

The observed variables are dry matter (%), crude protein (%), crude fiber (%), crude fat (%), ash (%), gross energy (Kkal/kg), NDF (%), ADF (%), tannins (%) and phytic acid (%). The research data were analyzed using variance analysis (ANOVA) of the Complete Random Design (CRD) followed by Duncan's Double Distance test.

3. RESULTS AND DISCUSSION

3.1. *Effect of Steaming on Percentage of Feed Substances Proximate Analysis of Flaxseeds (Linum usitatissimum)*

Table 1 Average effect of treatment on percentage of Dry Material (DM), Crude Protein (CP), Crude Fiber (CF), Crude Fat, Ash, and Gross Energy (GE) of Flaxseed

	Treatments			
	Control	Steaming for 10 minutes	Steaming for 20 minutes	Steaming For 30 minutes
Dry material (%)	96,54±0,12	95,74±1,14	96,28±0,26	95,46±1,33

Crude protein (%)	21,97±0,03^{b}	21,70±0,26^{ab}	21,91±0,06^{b}	21,43±0,30^{a}
Crude Fiber (%)	13,90±0,02^{a}	18,30±0,22^{d}	16,82±0,05^{c}	16,03±0,22^{b}
Crude fat (%)	31,76±0,04^{d}	26,71±0,32^{c}	24,10±0,06^{a}	25,08±0,35^{b}
Ash (%)	3,27±0,00^{c}	3,14±0,04^{b}	3,21±0,01^{c}	3,06±0,04^{a}
Gross Energy (Kcal/kg)	6125,67±7,63^{c}	6017,49±71,44^{b}	6059,02±16,23^{bc}	5822,36±81,20^{a}

3.1.1. *Dry Matter*

Table 1 shows that steaming had no significant effect (P>0.05) on flaxseed's percentage of dry matter. Dry materials in P1 (95.74%), P2 (96.28%), and P3 (95.46%) decreased to P0 (96.54%) due to the steaming process. Steaming can increase the water content in flaxseeds so that there is a decrease in dry matter in the flaxseed. This is comparable to Diana (2016), who stated that steaming could affect the water absorbed in a feed material so that it produces dry weight or decreased mass in the feed material. Feed ingredients with a high content of dry matter have a low shelf life, so the feed material is easily damaged if stored for a long time (Ridla, 2014).

3.1.2. *Crude Protein*

Protein is needed by livestock to form body tissues. The analysis in Table 1 shows that treatment had a very significant effect (P<0.01) on the percentage of crude protein in flaxseed. The results showed a decrease in the percentage of crude protein. The decrease in crude protein occurs due to protein denaturation caused by the heat generated in the steaming process. Permatasari (2019) stated that protein in feedstuffs, after steaming, undergoes protein denaturation to form a new, more straightforward structure, and protein levels in feedstuffs will decrease. The highest percentage result is P0 or treatment without steaming. This happens because P0 does not go through the wet heating process, so it does not change its protein structure. The percentage of crude proteins produced in the study was P1(21.70%), P2(21.91%), and P3 (21.43%). This percentage is higher than the crude protein resulting from Kajla et al. (2015) that the protein content in flaxseed reaches 20.3%.

3.1.3. *Crude Fiber*

Carbohydrate compounds that cannot be hydrolyzed by both acids and bases consisting of hemicellulose, cellulose, and lignin so that they are difficult to digest by livestock are called crude fibers. The results showed that the steaming had a very significant effect (P<0.01) on the crude fiber of flaxseed. The Duncan Multiple Range Test results showed that the steaming of P1, P2, and P3 can increase the crude fiber content of flaxseeds. Steaming flaxseed for 10 minutes (P1) resulted in the highest crude fiber (18.30%), while steaming for 20 minutes (P2) and 30 minutes (P3) gradually decreased by 16.82% and 16.04%, respectively. This shows that the length of steaming time, the less to increase in the crude fiber content in flaxseed. The increase in crude fiber at the beginning of steam, that is, 10 minutes, occurs due to the process of starch gelatinization, which begins with swelling of starch granules due to water absorption during the heating process gel formation occurs (Wahyuni & Sjofjan, 2018).

The steaming treatment for 20 and 30 minutes of crude fiber gradually decreases. During the heating process, starch granules will be developed back and forth if they do not exceed the temperature of starch gelatinization. Conversely, if it has passed the gelatinization temperature, the starch granules will be fixed (not back and forth) (Widyatmoko, 2015). In addition, during the steaming process, the decomposition of the cell wall of flaxseeds causes a decrease in the percentage of crude fibers. Steaming and the length of drying time in the oven can also result in a decrease in crude fiber in the feed (Samben & Puspaningrum, 2021).

3.1.4. *Crude Fat*

Results of the study from Table 1 show that steaming has a very significant effect (P<0.01) on the crude fat content contained in flaxseed. The average percentage of crude fat in this study was 24.10%-31.76%. The highest percentage result is the P0 treatment, a control treatment without steaming. There is a decrease in the percentage of crude fat due to steaming, a method of processing wet heating that cannot increase fat levels in a feed and feed ingredient (Sipayung et al., 2015). The decrease crude fat in P1, P2, and P3 treatments are caused by the breakdown of fat by the heat generated in the steaming process. Broken fat will come out and will be visible in steaming water. Zhongqi et al. (2015) stated that the mineral content in feedstuffs varies depending on how they are processed, but generally, it will decrease due to the heating process. Low-fat boiling point causes crude fat to suffer damage due to the steaming process. The boiling point of fat is 50-52°C (Daulay et al., 2014).

3.1.5. *ash*

Based on the results of the research contained in Table 1. It shows that the ash content contained in flaxseed is treated with P1 (3.14%), P2 (3.21%), and P3 (3.06%) decreased compared to P0 treatment (3.27%). The presence of heat generated during the heating process in the form of wet heating that is steaming causes a decrease in the percentage of ash. Jacoeb et al. (2012) explained that the decrease in the percentage of ash is caused by the presence of heat generated in the steaming process so that the minerals in a feed material are soluble in water. Meanwhile, the low percentage of ash produced affects the quality and shelf life that lasts longer (Winarno & Wirakartakusumah, 1974).

3.1.6. *Gross Energy*

Table 1. Showed that the average gross energy of flaxseeds in the study decreased from non-steaming treatment by 6125.65 Kcal/kg compared to the 10-minute steaming treatment of 6017.49 Kcal/kg, then increased the steaming for 20 minutes by 6059.02 Kcal/kg, and in the steaming treatment for 30 minutes experienced the lowest decrease of 5822.36 Kcal/kg. The results of the analysis are seen in Table 1. Indicates that the treatment exerts a very significant effect (P<0.01) on the gross energy of flaxseed. The results showed that the gross energy in P1, P2, and P3 decreased compared to P0. This happens because steaming can change the chemical and physical structure in flaxseeds due to the steaming process so that the high hemicellulose in flaxseeds can be hydrolyzed in part due to the presence of water vapor produced in the steaming process. Steaming treatment can increase the digestibility of feed ingredients. Crude fiber fractions can be converted into a simple form through steaming to be used as poultry feed materials (Wardani et al., 2004).

3.2. Effect of Steaming on Percentage of Feed Substances Van Soest Analysis of Flaxseeds (Linum usitatissimum)

Table 2 Average effect of treatment on percentage of Neutral Detergent Fiber (NDF), and Acid Detergent Fiber (ADF) Flaxseed

	Treatments			
	Control	Steaming for 10 minutes	Steaming for 20 minutes	Steaming for 30 minutes
NDF (%)	39,13±0,05[c]	49,77±0,59[d]	37,43±0,10[b]	21,96±0,31[a]
ADF (%)	29,21±0,04[b]	46,53±0,55[d]	32,83±0,09[c]	24,83±0,34[a]

3.2.1. *Neutral Detergent Fiber (NDF)*

Table 2. shows that the steaming treatment of flaxseeds has a significant effect (P<0.01) on NDF of Flaxseed. The quality of flaxseeds increased without treatment (P0) by 39.13% to flaxseed treatment with 10 minutes of steaming (P1) by 49.77% and gradually decreased in P2, P3 treatments by 37.43% and 21.96%. The steaming treatment for 30 minutes obtained the lowest results compared to other treatments. P1 treatment increases the value of NDF to P0 but gradually decreases in P2 and P3 treatment. This increase is in line with the increasing percentage of crude fibers in the treatment. A decrease in NDF levels occurring in feed material can affect the level of crude fiber contained in the feed material (Anam et al., 2012). Gallo et al. (2019) explained that the longer the warming, the lower the NDF level. Piłat & Zadernowski (2010) explained that the NDF contained in flaxseed flour is as much as 38.1%. P2 and P3 treatments have a lower percentage of NDF compared to the percentage of NDF produced by Piłat & Zadernowski (2010), which is 37.43% and 21.96%.

3.2.2. *Acid Detergent Fiber (ADF)*

The treatment exerts a noticeable influence (P<0.01) on the amount of ADF in flaxseed flour. Based on Table 2. There was an increase from treatment without (P0) by 29.21% to flaxseed treatment with 10 minutes of steaming (P1) of 46.53% and steaming of flaxseeds for 20 minutes by 32.83%. Meanwhile, the 30-minute flaxseed steaming treatment (P3) decreased and became the lowest ADF percentage at 24.83%. The decrease in ADF content in the 30-minute steaming treatment (P3) is caused by an overhaul of the cell wall due to heat generated from the steaming process. Putri et al. (2020) stated that an overhaul of the cell wall causes the decrease in ADF levels in a feed ingredient to be more straightforward. Namely, glucose and the presence of part of the cell wall and hemicellulose that dissolves in the heating process so that there is an increase in Acid Detergent Solution (ACS) and a decrease in ADF levels. The 30-minute steaming treatment resulted in the lowest percentage of 24.83%. This percentage is lower than the percentage of ADF flaxseed flour by Pilat & Ryszard (2010), which is as much as 27.2%. Sandi et al. (2010) state that ADF and NDF are negatively correlated to the digestibility of a feed ingredient. The lower the percentage of ADF and NDF, the higher the digestibility of the feed ingredients.

3.3. Effect of Steaming on Percentage of Antinutrients Substances of Flaxseeds (Linum usitatissimum)

Table 3 Average effect of treatment on the percentage of tannins and phytic acid on flaxseeds (Linum usitatissimum)

Treatment	Tanin	Asam fitat
P0	$3{,}01\pm0{,}00^{d}$	$42{,}96\pm0{,}05^{d}$
P1	$2{,}86\pm0{,}03^{c}$	$38{,}39\pm0{,}46^{c}$
P2	$2{,}39\pm0{,}01^{b}$	$33{,}88\pm0{,}09^{b}$
P3	$2{,}06\pm0{,}03^{a}$	$29{,}73\pm0{,}40^{a}$

3.3.1. *Tannins*

Tannins can form complex compounds with proteins, thus causing deposition in proteins. In addition, tannins also bind to mucosal proteins, affecting the absorption power of feed substances in the digestive organs (Qur'any, 2020). Results are presented in Table 3. It shows that steaming had a significant effect ($P<0.01$) on the percentage of tannins in flaxseed. The steaming treatment carried out a row decreased from the concussion treatment (P0) by 3.01%, to consecutive tannin value of 10-minute steaming of flaxseeds (P1) by 2.86%, the steaming of flaxseeds for 20 minutes (P2) by 2.39%, and the steaming of flaxseeds for 30 minutes (P3) by 2.06%. This suggests that steaming treatment can reduce the content of tannins contained in flaxseeds. The decrease in the percentage of tannins in flaxseeds is caused because the phenol compounds in flaxseeds are water-soluble, so during the steaming process that produces water vapor and heat, tannins in flaxseeds decrease. Tannins can be removed or lowered using other methods such as decorating, heat soaking, or cooking (Singh, 1998). In addition, tannins are phenol compounds that cannot withstand heat; tannins will be damaged at a temperature of 50°C (Handayani et al., 2016). Meanwhile, the steaming of flaxseeds in this study was carried out when the water for steaming began to boil so that the steaming temperature was more than 50°C.

3.3.2. *Phytic Acid*

Phytic acid is a compound that can bind to proteins or amino acids and phosphorus, which can result in the performance of digestive enzymes being hampered so that it cannot be digested in the digestive tract. Research results are in Table 3. It shows that steaming had a significant effect ($P<0.01$) on the percentage of phytic acid in flaxseeds. Steaming treatment on flaxseeds decreased in P0 (42.96%), P1 (38.39%), P2 (37.67%), and P3 (29.72%). This shows that the treatment given in the form of steaming can reduce the content of phytic acid contained in flaxseeds. Pramita (2008) stated that heating with a temperature of 50-52°C could reduce the content of phytic acid contained in various types of koro. According to Russo & Reggiani (2013), the content of phytic acid owned by flaxseeds is as much as 33.4-40.7%.

4. CONCLUSION

The length of steaming against flaxseeds (*Linum usitatissimum*) can decrease the content of antinutrient substances (tannins and phytic acid), fiber fractions (NDF and ADF), and the content of feed substances such as DM, CP, crude Fat, ash, and GE, but cannot decrease the crude fiber. The best treatment is the steaming of flaxseeds (*Linum usitatissimum*) for 30 minutes.

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