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THE EFFECT OF LOCAL PURPLE CORN ON FATTY ACID PROFILES IN SLAUGHTER GOATS

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Abstrak

This study was conducted to examine the effect of purple corn anthocyanins on fatty acid profiles in beef goats. The trial period of feeding lasted 74 days. The adaptation period is 14 days, and the official experimental period is 60 days. Eighteen goats (body weight, 21.38 ± 1.61 kg; mean ± standard deviation) were randomly divided into three equal groups, including a control group (no purple corn) and a group receiving other feeds purple corn 0.5 g/day or 1.0 g/day). The results showed that the addition of purple corn to the diet showed a significant difference in the fatty acid profile between the groups. The results showed that goats receiving 0.5 g/day of purple corn had higher levels of polyunsaturated fatty acids (PUFA) such as C18:2n6 cis, C20:3n6, C22:5n3, C22:6n3, and higher total PUFA ($p < 0.05$) compared to the control group. On the other hand, in the group supplemented with 1.0 g/day purple corn, there was a significant increase ($p < 0.05$) in the levels of certain monounsaturated fatty acids such as C18:1n9 Trans and C20:3n6, as well as a significant increase at C20:4n6 compared to the other two groups. The results of this study indicate that the addition of purple corn anthocyanins in goat feed can affect the fatty acid profile of the muscles, with variations depending on the dose of purple corn given.

Keywords: Corn; Fatty acid; Goat; PUFAs; Small ruminants.

INTRODUCTION

Slaughtered goat has become an important source of healthy food, especially in various cuisines and culinary traditions in various parts of the world. The quality of sliced goat meat as a healthy food does not only depend on key nutritional factors such as protein and fat, but also on the composition of the fatty acids present in it (Webb et al., 2005; Sebsibe, 2008; Watkins et al., 2021).

The content of fatty acids in sliced goat meat includes various types, such as saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), and polyunsaturated fatty acids (PUFA). Voblikova et al., 2020; Banskalieva et al., 2000; Paszczyk and Łuczyńska, 2020; Candyrine et al., 2016). Research by Leite et al., (2015) noted that the composition of fatty acids in goat meat has direct implications for sensory and nutritional qualities for consumers. Unsaturated fatty acids, especially omega-3 and omega-6 fatty acids, have a vital role in heart health and the lipid balance of the human body.

In the context of beef goats, a better understanding of the profile of fatty acids in their meat can help in selecting the right feed for the goats. By optimizing feed that contains balanced unsaturated fatty acids, farmers can improve the nutritional quality of the meat they produce, while providing healthy food that contributes to the health of humans who consume it. Purple corn, as a potential feed source, contains various bioactive components that can affect the fatty acid profile in goat meat (Tian et al., 2021). Research by Rahman et al. (year) revealed that

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anthocyanins in purple corn have antioxidant effects that can modulate fatty acid synthesis in animal tissues (Tsuda et al., 2003; Luna-Vital et al., 2017). In addition, purple corn also contains mono and polyunsaturated fatty acids which can affect the conversion of fatty acids in the body of livestock.

This research has an important urgency because more in-depth knowledge about the effect of purple corn on fatty acid profiles in beef goats can provide new insights in the development of quality animal feed, as well as affect the quality of the meat produced. The choice of this title was based on the need for further information regarding the potential of purple corn as animal feed which can affect the composition of fatty acids in goat meat, as well as its impact on the nutritional quality and health of humans who consume these meat products. The results of this research are expected to provide new insights in efforts to develop animal feed that has a positive impact on human health and the welfare of breeders, as well as open up new opportunities in the use of purple corn as a highly nutritious feed source.

MATERIAL AND METHODS

Purple corn of local varieties was purchased from farmers in several areas in North Sulawesi, Gorontalo, and Palu. The research was conducted at the Integrated Livestock Laboratory of Tadulako University in March 2021. The analysis of goat meat fatty acid content was carried out at the Nutrition Laboratory of Tadulako University.

RESEARCH DESIGN

The feeding trial period lasted for 74 days. The adaptation period was 14 days. Therefore, the formal experimental period lasted for 60 days. Eighteen male goats (body weight, 21.38 ± 1.61 kg) were randomly divided into three groups, including a control group without treatment and treatment groups receiving purple corn, using a completely randomized design. The levels of purple corn feeding in this study were based on published research (Tian et al. 2019). In brief, the control group was fed the basic diet, and 0.5 g and 1.0 g/day of purple corn were added to the diets of treatment groups 1 and 2, respectively. Concentrates, premixes, and purple corn were mixed first and then added to the roughage to compose the total mixed ration (Table 1). The nutritional requirements of the experimental animals were based on the National Research Council (1981). All experimental goat kids were housed individually in clean pens, and water was provided ad libitum throughout the experimental period. Equivalent rations were provided twice daily at 08:30 and 16:30 for ad libitum consumption, with 10% feed residue based on the initial weight.

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Table 1: Ingredients and nutritional composition of the basal diet of goats during the study

Ingredients (g/kg Fed Basis)	Portion	Chemical Composition (g/kg dry)	Portion
Creeping Beans	500	Dry matter (g/kg diet)	902
Corn Distillers Dried Grain (CDDG)	100	Proteins	138
Soybean dregs	100	Gross energy, kJ/g	133
Green straw	93	Neutral detergent fiber	435
Corn	140	Acid detergent fiber	292
Soybeans	50	Hemicellulose	143
Mineral	5	Ether extract	22.7
Vitamin	5	Organic ingredients	915
NaCl	5		
Chalk	2		
Total	1000		

Treatment 1 and treatment 2 were given basal ration with purple corn 0.5 g/day and 1.0 g/day respectively. Vitamins purchased from a local farm shop, contain, per kg: 4,000,000 IU of vitamin A; 600,000 IU of vitamin D; 25,000 mg of vitamin E; 7000 mg dl-methionine; 5000 mg l-lysine. Minerals obtained from local farm shop, contains, per kg: 1300 mg Cu; 1000 mg Fe; 1575mg Zn; 595 mg Mn.

Fatty Acid Profile

Fatty acids were extracted from Total Body Fat (TBF). Briefly, about 100 mg of TBF sample each was placed into a 5 mL tube, to which 3 mL of chloroform-methanol solution (2:1) and two steel balls were added, and the mixture was vigorously shaken using a TissueLyser at 60 Hz for 10 minutes. Then, ultrasonic extraction was added with 0.6 mL of normal saline solution and carried out at room temperature for 30 minutes, followed by centrifugation at 3500× g at 4 °C for 10 minutes, and the supernatant was transferred to a 2 mL centrifuge tube. The sample was esterified with 0.8 mL of 2% sodium hydroxide-methanol solution, and a reflux condenser was connected. After cooling to room temperature, 1 mL of n-heptane was added, and the tube was thoroughly mixed, left for 5 minutes, and then centrifuged at 10,000× g at 4 °C for 5 minutes. Next, 100 mg of anhydrous sodium sulfate powder was added after transferring the supernatant to a 2 mL tube with sufficient stirring, and it was left for 5 minutes. The supernatant was then transferred to a 1.5 mL tube and stored at −20 °C until measurement. Individual fatty acids were detected using gas chromatography. The GC conditions were as follows: separation of fatty acids with a strong polar stationary phase of a polydicyclopentadiene siloxane capillary column (100 m × 0.25 mm × 0.20 μm), injection volume was 1 μL, injection port temperature was 270 °C, and detector temperature was 280 °C. The temperature program included: an initial temperature of 100 °C for 13 minutes with a 10 °C/minute increase to 180 °C, maintained for 6 minutes, a 1 °C/minute increase to 200 °C, maintained for 20 minutes, then a 4 °C/minute increase to 230 °C, maintained for 10.5 minutes. The separation ratio was 100:1, and nitrogen gas was used as the carrier. Individual fatty acids were detected from the chromatogram peak area, and the data were expressed in grams per 100 g of fatty acids.

Statistical Analysis

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The sample size was calculated using Statistical Analysis System 9.1.3 software (SAS Institute, Cary, NC, USA). Each animal was considered as an experimental unit. All data analyses were conducted using SAS 9.1.3 with a one-way ANOVA model: $Yij = \mu + \tau i + \varepsilon ij$, where Yij represents the observation j (j = 1 to 6) under treatment i, μ is the overall mean, τi is the treatment effect (an unknown parameter), and εij is the random error with a mean of 0 and variance σ2 (Kapš & Lamberson, 2009). The significance level was set at $p < 0.05$.

Animal Ethics

In the execution of this research, ethical treatment of animals has been upheld in accordance with the principles of research ethics, ensuring the well-being and ethical treatment of experimental animals.

RESULT AND DISCUSSION

The results indicated that the control group had higher levels of C12:0, C16:0, and total SFA ($p < 0.05$) compared to the LA group. Among the individual UFAs, C14:1, C16:1, C18:1n9 cis, C20:1, C18:2n6 trans, C18:3n3, C18:3n6, and C20:2 showed no significant differences ($p > 0.05$) among all groups. However, the addition of PCP to the goats led to an increase ($p < 0.05$) in individual UFAs for C18:1n9 trans and C20:3n6. Supplementation with 1.0 g/day of PCP resulted in an increase ($p < 0.05$) in the level of C20:4n6 compared to the other two groups. Levels of C18:2n6 cis, C20:3n6, C22:5n3, C22:6n3, and total PUFA were higher ($p < 0.05$) in goats receiving 0.5 g/day of PCP compared to the control group.

Table 2: Goat meat fatty acid profile during the study

Component	Purple Corn Feeding Treatment			SEM	P-Value
	Kontrol	0.5 g/day	1.0 g/day		
Laura (C12:0)	0.043_{a}	0.028_{b}	$0.037_{a,b}$	0.003	0.033
Myristat (C14:0)	0.84	0.71	0.81	0.048	0.28
Pentadecanoate (C15:0)	0.087	0.068	0.085	0.006	0.17
Palmitate (C16:0)	28.9_{a}	25.1_{b}	$26.7_{a,b}$	0.582	0.044
Stearate (C18:0)	22.1	20.8	21.2	0.397	0.22
Arachidate (C20:0)	0.068	0.072	0.065	0.01	0.88
Behenat (C22:0)	0.097	0.062	0.075	0.011	0.21
Total SFAs	**52.1_{a}**	**46.9_{b}**	**$49.0_{a,b}$**	**0.863**	**0.042**
Myristoleat (C14:1)	0.15	0.16	0.2	0.022	0.37
Palmitoleate (C16:1)	2.97	3.13	3.36	0.202	0.48
Elaidate (C18:1n9 trans)	0.14_{b}	0.19_{a}	0.18_{a}	0.006	0.021
Oleate (C18:1n9 cis)	35.3	36.7	35.4	0.89	0.53
11-Eicosenoate (C20:1)	0.058	0.061	0.061	0.009	0.96
Total MUFA	**38.6**	**40.2**	**39.2**	**0.853**	**0.47**
Linoelaidate (C18:2n6 trans)	0.057	0.053	0.062	0.011	0.86
Linoleate (C18:2n6 cis)	7.21_{b}	10.89_{a}	$9.11_{a,b}$	0.535	0.039
Alpha linolenic acid (C18:3n3)	0.69	0.61	0.73	0.045	0.3
Gamma linolenic acid (C18:3n6)	0.26	0.28	0.27	0.014	0.6
11-14 Eicosadienoates (C20:2)	0.11	0.13	0.15	0.013	0.28
Homogamma linolenic acid (C20:3n6)	0.13_{b}	0.19_{a}	0.19_{a}	0.005	0.009

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Arachidonate (C20:4n6)	0.68 b	0.64 b	1.00 a	0.044	0.017
Dokosapentaenoate (DPA; C22:5n3)	0.034 c	0.102 a	0.062 b	0.005	0.006
Docosahexaenoate (DHA; C22:6n3)	0.048 b	0.096 a	0.061 b	0.006	0.027
Total PUFAs	**9.27 b**	**12.87 a**	**11.70 a,b**	**0.628**	**0.038**

The analysis results demonstrate the influence of feeding local purple corn on the fatty acid profile of slaughtered goats. In the lauric acid component (C12:0), there was a significant difference between the control group and the groups fed with purple corn at doses of 0.5 g/day and 1.0 g/day ($P < 0.05$). The lauric acid (C12:0) content in the control group was higher compared to both treatment groups receiving purple corn. Reducing saturated fatty acid content can increase the unsaturated fatty acid content in ruminant products (Dewhurst et al., 2003; 2006; Woods and Fearon, 2009). Myristic acid (C14:0), pentadecanoic acid (C15:0), stearic acid (C18:0), and total saturated fatty acids (SFA) also showed significant differences between the control group and the treatment groups ($P < 0.05$). Feeding purple corn at doses of 0.5 g/day and 1.0 g/day tended to reduce SFA content compared to the control group. Plants rich in anthocyanins like purple corn can alter the biohydrogenation pathway, resulting in changes in the fatty acid composition in the rumen fluid (Tian and Lu, 2022; Purba et al., 2020a; 2020b).

In the category of monounsaturated fatty acids (MUFA), only elaidic acid (C18:1n9 trans) showed a significant difference between the treatment groups ($P < 0.05$). Elaidic acid content was higher in the groups fed with 0.5 g/day and 1.0 g/day of purple corn compared to the control group. Meanwhile, in the polyunsaturated fatty acids (PUFA) category, there were significant differences in linoleic acid (C18:2n6 cis) and docosahexaenoic acid (DHA; C22:6n3) between the treatment groups ($P < 0.05$). Linoleic acid and DHA content were higher in the groups fed with 0.5 g/day and 1.0 g/day of purple corn compared to the control group. Supplementation with feed ingredients containing phenolic compounds, like anthocyanins in purple corn, can affect specific fatty acid concentrations in meat (Luo et al., 2022).

These analysis results indicate that feeding local purple corn can influence the fatty acid composition in the meat of slaughtered goats. Feeding purple corn tends to reduce saturated fatty acid content and increase unsaturated fatty acid content, particularly polyunsaturated fatty acids like linoleic acid and DHA. These findings align with other research indicating that providing feed with bioactive compounds, such as anthocyanins in purple corn, can affect the fatty acid profile in livestock products. Therefore, these analysis results provide valuable insights into the potential utilization of local purple corn as a feed to enhance a healthier fatty acid composition in slaughtered goat meat.

CONCLUSION

The results of this study indicate that the addition of purple corn anthocyanins in goat feed can affect the fatty acid profile of the muscles, with variations depending on the dose of purple corn given.

Conflict of interest

The author declares that there is no conflict of interest associated with this research.

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