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The Effect of Protected *Nothopanax scutellarium* Merr on Milk Production and Mastitis in Etawah Crossbreed Goats

Research Article

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ABSTRACT

Nothopanax scutellaium Merr (NSM) is a plant that is often used as a mixture in dishes in Indonesia. NSM is anti-inflammatory, effective in treating wounds and inflammation, treating anemia, and treating and facilitating milk production. The aim of this study was to the effect of protected *Nothopanax scutellarium* Merr on milk production and mastitis in Etawah crossbreed goats. A total of 16 lactating Etawah crossbreed goats were used in a 4 × 4 randomized block design. The study treatment was P0= 30% concentrate + 70% forage + 20 mg NSM; P1= 30% concentrate + 70% forage + 20 mg NSM saponin protection; P2= 30% concentrate + 70% forage + 20 mg NSM tannin protection; and P3= 30% concentrate + 70% forage + 20 mg NSM capsule protection. Variables observed were feed consumption (dry matter (DM), crude protein (CP), crude fibre (CF), ether extracts (EE), Ca, and P), milk yield, milk quality (DM, specific gravity, fat, protein, and lactose), and mastitis (somatic cell count (SCC), California mastitis test, and total milk bacteria). Differences among treatments were compared using Duncan's range test. The results showed that NSM protection treatment affected consumption of dry matter, protein, energy, fat, Ca, and P feed (P 0.01), increased milk yield of Etawah crossbreed goats (P 0.05), did not affect milk quality (P 0.05), and reduced mastitis (SCC and bacterial count) (P 0.05). The conclusion of the study was that the NSM protection treatment could reduce mastitis in Etawah breed goats. The protective treatment of tannins and saponins in NSM increased milk production and feed consumption.

KEY WORDS goat, milk, *Nothopanax scutellarium* Merr, protection, saponins, tannins.

INTRODUCTION

Research on increasing goat milk production has been carried out through the provision of exogenous feed and hormones. However, goat's milk yield, which is higher at the start of lactation, decreases more rapidly and has higher mastitis (Adriani *et al.* 2004a; Adriani *et al.* 2019). The general reaction that occurs in udder cells experiencing mastitis is the infiltration of inflammatory cells from the blood to the site of inflammation, accompanied by impaired milk synthesis (Barlowska *et al.* 2013; Cinar *et al.* 2015). The result is a decrease in lactose, casein, and milk fat (Geary *et al.* 2012). Decreasing lactose can reduce milk production, because lactose has the ability to bind water for milk yield (Televicius *et al.* 2021). For this reason, it is necessary to find a solution so that mastitis can be reduced and milk yield increased. One of them is by giving *Nothopanax scutellarium* Merr (NSM).

Nothopanax scutellarium Merr is one of the plants used in traditional medicine for treating wounds and functions as an anti-inflammatory and anti-bacterial (Nuri *et al.* 2009; Rachma *et al.* 2020), effectively treats wounds and inflammation, anemia, breast inflammation, swelling, and expelling milk (Marina and Astuti, 2012), and increases milk yield. NSM contains flavonoids, saponins, phenols, terpenes, coumarins, and alkaloids (Rahmi *et al.* 2020).

The role of NSM as an anti-infection and treatment of breast inflammation is expected to reduce mastitis in goats, resulting in an increase in milk yield. So that the nutrients and active substances of NSM are not disturbed in the digestive tract, protection is carried out (Afdal *et al.* 2021; Darlis *et al.* 2021). The process of protecting feed ingredients can use protectors such as tannins, saponins, and capsules (Wina *et al.* 2005). This condition will protect NSM from microbial degradation in the rumen. Protection using tannins and saponins can influence the fermentation process in the rumen. Tannins and saponins can reduce protein degradation and synthesize microbial proteins (Ani *et al.* 2015). Additionally, it can provide more bypass protein to the back of the intestine. Apart from this, the effect of tannins and saponins in the ration reduces rumen ammonia concentration, excretion of N from the rumen, and ammonia emissions from manure (Sliwinski *et al.* 2002).

Protection with tannins, saponins, and capsules in livestock can protect feed nutrients from rumen microbial degradation and increase nutrient absorption (Adriani and Yurleni, 2020). Saponin protection also increases feed digestibility and reduces the number of rumen protozoa (Eden *et al.* 2016). Afdal *et al.* (2020) research shows that giving *Colleus amboinicus* can increase rumen protozoa. The same thing was obtained in preliminary research using NSM. So efforts need to be made to reduce protozoa in the rumen. Reducing protozoa in the rumen can improve the digestion and absorption process. The administration of tannins and saponins can suppress methane gas in the rumen (Gou *et al.* 2008; Hidayah, 2016). Methane is a gas formed from the anaerobic fermentation process of feed ingredients in the rumen by methanogenic bacteria which reflects the loss of feed energy (Patra and Saxena, 2010). Sugoro and Yunianto (2006) reported that the number of protozoa decreased when buffalo were given tannin supplements in their rations. This condition results in increased digestion and absorption of feed nutrients. The research results of Afdal *et al.* (2021) that increased provision of protozoa is theoretically a predator of bacteria. Therefore, consuming bacteria will affect the fermentation process in the rumen and other side effects such as rumen methanogenesis, acid production, and pH. This is in line with the results of research by Tan *et al.* (2011), who found that tannins play an important role in reducing protozoa. Based on the above conditions, we want to know the effect of protected NSM on milk yield and mastitis in Etawah crossbreed goats.

MATERIALS AND METHODS

A total of 16 lactating Etawah crossbreed goats aged 1.5-2.0 years with an average body weight of 35.61 kg were used for the study. Goats were fed according to their needs, this was obtained from measuring the dry matter consumption of goat feed for 1 week before the research, drinking water was given *ad libitum*. A randomized block design was used in this study with four treatments and four groups. Research treatments include the following: P0= 30% concentrate + 70% forage + 20 g NSM without protection; P1= 30% concentrate + 70% forage + 20 g NSM saponin protection; P2= 30% concentrate + 70% forage + 20 g NSM tannin protection; and P3= 30% concentrate + 70% forage + 20 g NSM capsule protection. The chemical compositions of basal feed are shown in Table 1. The nutritional content of NSF and active substances can be seen in Table 2.

Table 1 Chemical composition of basal feed

Nutrition	Forage (analysis results)	Concentrate (analysis results)	Feed* (calculation result)
Dry matter (%)	19.00	67.00	33.5
Crude protein (%)	9.50	21.06	12.97
Crude fat (%)	2.04	3.24	2.40
Ether extract (%)	34.94	26.48	32.40
Ca (%)	3.06	0.85	2.39
P (%)	0.21	0.32	0.24
Energy (kcal/kg)	3745.00	4095.00	3849.50
Ash (%)	11.44	10.27	10.09

Table 2 Nutrient content and active substances in the leaves of *Nothopanax scutellaium* Merr

Nutrition	*Nothopanax scutellaium* Merr
Dry matter (%)	19.73
Crude protein (%)	18.11
Fat (%)	3.38
Energy (kcal)	3862
Ether extract (%)	14.83
Ash (%)	0.89
Ca (%)	0.89
P (%)	0.22
Saponins (%)*	1.32
Flavonoids (%)*	0.87
Water essence (%)*	31.32
Alcohol essence (%)*	9.34
Tannins (%)*	1.08
Alkaloids *	-
Phenolic *	+
Triterpenoid*	+
Steroida*	+
Glycoside*	+

The study goats were kept in individual cages measuring 0.8 × 1.2 m. Goats are fed 2 times a day at 7:00 a.m. and 4:00 p.m. The feed given is a mixture of 70% forage (natural grass) and 30% concentrate. The dominant natural grass is kumpai grass (*Hymenachne amplixicaulis*). The concentrate ingredients consist of bran, soybean meal, coconut meal, tofu dregs, top mix and salt. Before the study started, milking was carried out for one week to obtain the initial milk production of each goat. The salt yield obtained is grouped from the highest production to the lowest. Then randomization was carried out according to the design used.

NSM is obtained by taking the leaves, chopping them into 1-2 cm pieces and dried at 40 ^{0}C. After drying, the NSM was ground using a blender to form Simplicia. The refined NSM is protected with tannins, saponins and tablets. Extract Saponin and tannin were prepared following procedure Ghaffar and El-Elaimy (2012) with slight modification. Tannin extract from banana stems is made by blending banana stems mixed with water 1:1 The liquid obtained is filtered with gauze and used for NSM protection. NSM protection is carried out by mixing the liquid obtained with NSM in a 1:1 ratio, then drying at a temperature of 60 ^{o}C. The same thing is done for saponin protection. Saponin extract is obtained from hibiscus leaves (*Hibiscus rosa sinensis* L) which are mixed with water 1:1,.5 then blended and filtered. This liquid is mixed with NSM 1:1 (Afdal *et al.* 2020). Capsule protection is carried out by inserting NSM simplicia into the capsule.

Feed consumption is obtained by weighing the amount of feed given with the remaining feed. The difference is then averaged into feed consumption per day during the study. Milking the goats is done by hand 2 times a day at 7:00 a.m. and 17:00 p.m.

Milking is done by cleaning the udder using a damp cloth, then giving 70% alcohol to prevent contamination with microbes. Milk yield obtained from morning and evening milking was weighed, after that it is averaged to obtain milk production.

Sampling for analysis of milk quality is done once a week. Milk samples were taken as much as 150 ml which were put in plastic and stored in a cooling box. Milk samples were brought to the laboratory for analysis. Milk fat analysis used the Gerber method (Tesfay *et al.* 2015). Milk protein was measured according to the method used by Rowlard (1938) and the specific gravity of milk used a lactodensimeter. Milk sampling for mastitis examination is carried out once a week. Milk samples were taken as much as 50 ml for SCC and milk bacteria. SCC and total milk bacteria were calculated using the Breed and Prescott methods, respectively (Schalm *et al.* 1971). For CMT it is done before milking with the criteria (-) no milk coagulation occurs, (+) slight curdling and disappears in 10 seconds, (++) there is thickening and settling but the gel has not formed, (+++) thickens and settles at the bottom of the paddle and (++++) formed a gel on all samples and convex surfaces. The observed variables were feed consumption (DM, CP, EE, CF, Ca and P), milk production and milk quality (DM, NSF, Specific gravity, fat, protein, lactose), mastitis (SCC, California mastitis test and milk bacteria count).

The data obtained were analyzed for variance using the SAS program (SAS, 2004). Differences among treatments were compared using Duncan's range test.

RESULTS AND DISCUSSION

Feed consumption of Etawah crossbreed goats treated with protected *Nothopanax scutellarin* Merr can be seen in Table 3.

NSM protection had a very significant effect on the dry matter consumption of Etawah crossbreed goats (P<0.01). NCM protection with tannins and saponins significantly increased the consumption of DM but greatly decreased it with capsule protection and without protection. This condition is suspected because the protection of tannins and saponins can reduce protozoa in the rumen and ensure a better digestive process. This result is in line with Tan *et al.* (2011), who found that tannins played an important role in reducing protozoa in the rumen from 5.83 × 107 to 4.73–4.11 × 107 by administering 15 mg/500 mg of tannins and reducing methanogenic bacteria *in vitro*.

The average dry matter consumption of these results was relatively lower than in other studies, where the dry matter consumption of Etawah crossbreed goats was 1443.14 g/head/day with a range of 1253.5–1524.4 g/head/day (Adriani *et al.* 2004b). Relatively the same as the research of Afdal *et al.* (2021), namely 1192-1245 gr/head/day. However, this consumption is higher than the study by Singh and Gupta (2008), which found that the consumption of local goats in India is 733 g/day. Goat DM consumption is influenced by the energy and protein content of the feed. NSM protection had a very significant effect on the consumption of protein, fat, energy, and crude fiber of Etawah crossbreed goats (P<0.01) and had a significant effect on Ca and P consumption. This consumption is in line with the dry matter of the feed. Where the dry matter consumption of tannin and saponin treatments was higher than the control.

The average protein consumption of Etawah crossbreed dairy goats in this study was lower than that of Adriani *et al.* (2004a) who obtained 225-234 g/head/day. Relatively the same as other studies which found protein consumption in lactating PE goats between 201,27-210.27 g/head/day (Afdal *et al*. 2021).

Table 3 Feed consumption of Etawah crossbreed goats treated with the protection of *Nothopanax scutellarin* Merr (NSM)

Parameter	Treatment			
	P0	P1	P2	P3
Dry matter (g/head/day)	1021.08±38.18^{A}	1089.22±47.10^{B}	1077.62±10.37^{B}	970.18±38.19^{C}
Crude protein(g/head/day)	144.48±7.29^{A}	160.47±7.01^{B}	156.85±2.81^{B}	129.45±10.38^{C}
Ether extract (g/head/day)	40.85±1.60^{A}	44.67±1.94^{B}	43.87±0.63^{B}	37.46±2.53^{C}
Crude fiber(g/head/day)	563.61±19.85^{A}	606.58±26.28^{B}	598.49±6.70^{B}	528.94±29.48^{C}
Ca (g/head/day)	42.61±1.68^{a}	45.26±1.96^{b}	44.84±0.39^{b}	40.74±1.90^{c}
P (g/head/day)	4.14±0.16^{a}	4.52±0.19^{b}	4.46±0.06^{b}	3.80±0.26^{c}

P0: 30% concentrate + 70% forage + 20 mg NSM; P1: 30% concentrate + 70% forage + 20 mg NSM saponin protection; P2: 30% concentrate + 70% forage + 20 mg NSM tannin protection; and P3: 30% concentrate + 70% forage + 20 mg NSM capsule protection.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).

Table 4 Milk yield and quality of Etawah crossbreed goats based on *Nothopanax scutellarin* Merr (NSM) protection treatment

Parameter	Treatment			
	P0	P1	P2	P3
Milk production (g/head/day)	216.08±61.60^{a}	217.41±14.08^{a}	234.82±11.97^{b}	174.27±55.40^{c}
Dry matter (%)	13.37±0.39	13.41±0.69	13.09±0.86	13.26±1.30
Specific gravity	1.028±0.04	1.028±0.03	1.028±0.05	1.028±0.05
Proteins (%)	3.70±0.13^{A}	3.70±0.17^{A}	3.76±0.11^{A}	3.40±0.20^{B}
Lactose (%)	3.53±0.11^{A}	3.53±0.15^{A}	3.57±0.10^{A}	3.24±0.18^{B}
Solid non fat (SNF) (%)	7.83±0.47^{A}	7.82±0.36^{A}	7.94±0.23^{A}	7.18±0.43^{B}

P0: 30% concentrate + 70% forage + 20 mg NSM; P1: 30% concentrate + 70% forage + 20 mg NSM saponin protection; P2: 30% concentrate + 70% forage + 20 mg NSM tannin protection; and P3: 30% concentrate + 70% forage + 20 mg NSM capsule protection.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).

Table 5 Mastitis of Etawah crossbreed goats in response to *Nothopanax scutellarin* Merr (NSM) protection

Parameter	Treatment			
	P0	P1	P2	P3
California mastitis test (CMT)	4.17±0.69	3.00±1.08	3.17±1.39	3.08±0.77
Somatic cell count (SCC) × 10^3 (cell/mL)	0.81±0.16^{a}	0.67±0.13^{b}	0.64±0.07^{b}	0.62±0.06^{b}
Milk bacteria × 10^3 (cell/mL)	3.05±0.19^{a}	2.63±0.45^{b}	2.91±0.11^{b}	2.76±0.23^{b}
pH	6.29±0.03	6.30±0.01	6.19±0.07	5.31±0.07

P0: 30% concentrate + 70% forage + 20 mg NSM; P1: 30% concentrate + 70% forage + 20 mg NSM saponin protection; P2: 30% concentrate + 70% forage + 20 mg NSM tannin protection; and P3: 30% concentrate + 70% forage + 20 mg NSM capsule protection.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).

The milk yield and quality of Etawah crossbreed goats treated with NSM protection can be seen in Table 4. NSM protection significantly increased milk production of Etawah crossbreed goats (P<0.05). P2 treatment is different from P0, P1 and P3. P3 treatment is different from P0 and P2, while P0 and P1 are not different. Tannin protection results in the highest milk yield. This condition is thought to be because protection can increase nutrient absorption and breast milk production. The research results of Oyedapo *et al.* (2010) that saponins and flavonoids can stabilize lysosomal membranes, while tannins and saponins can bind cations, so they can stabilize erythrocyte membranes and macromolecules. This condition is caused because the erythrocyte components are similar to the lysosomal membrane (Idrus *et al.* 2018). The lysosomal membrane contains as many as 50 degrading enzymes such as protease, lipase, glycosidase, nuclease, sulfatase, and phosphatase. If this enzyme comes out of the membrane, it will stimulate inflammation. Because the lysosomal membrane is similar to the erythrocyte membrane, extracts that can stabilize erythrocytes can also stabilize lysosomes, thereby increasing breast milk production. In these conditions, NSM is thought to contain flavonoids which function as anti-oxidants, can increase the body's endurance, and increase breast milk production. NSM contains flavonoids 0.44 Quercetin Equivalent (%w/w), antioxidant activity, DPPH 55.52%, fat 1,83%, crude fiber 1,05 and protein 3.07% in 100 g NSM (Rachma *et al.* 2020).

NSM protection had no significant effect on dry matter and the specific gravity of Etawah crossbreed goat milk (P>0.05). The average dry matter of Etawah crossbreed goat milk is 13.22 ± 0.92%. This result is relatively high from research by Afdal *et al.* (2021) which states that the dry matter range for goat's milk is 8.10-10.37%.

NSM protection had a very significant effect on protein, lactose and solid non fat (SNF) of Etawah crossbreed goat milk (P<0.01). The treatment at P3 is different from P0, P1 and P2, but P0, P1 and P2 are relatively the same. The average milk protein in this study was 3.64 ± 0.20. The average of this protein is relatively similar to Adriani and Yurleni (2020) at 3.59% with a range of 3.56-3.62%. The increase in protein and milk fat is thought to be due to an increase in feed digestibility, resulting in more blood nutrients for milk synthesis. Administration of NSM is thought to affect the transport of nutrients from the blood into mammary gland cells for the synthesis of milk protein and fat. According to Rhoads and Nagolka (2007), milk protein is synthesized using amino acids from blood and milk fat from blood fatty acids.

Etawah crossbreed goat mastitis in response to NSM protection can be seen in Table 5. NSM protection had no significant effect on the CMT and pH of Etawah crossbreed goat milk (P>0.05). The average CMT of goat milk was 3.17 ± 1.45. In the mastitis test using CMT, milk coagulation occurs as a reaction occurs between the CMT reagent and milk. This change in consistency is caused by CMT reagents containing aryl sulfonates which can break down the nuclei of somatic cells or leukocyte cells in breast milk, causing the breast milk to curdle. According to Barlowska *et al.* (2013) and Kumar *et al.* (2020) the higher the mastitis in the cow, the higher the number of somatic cells in the milk. This condition causes the reaction with the reagent to increase and thicken (Nurdin, 2007).

Milk pH is a measure of the health of the udder gland as a milk producer. An increase in milk pH above 6.75 is thought to cause mastitis in goats which is usually followed by a decrease in milk protein content. However, milk pH has a low sensitivity (28.9%) to indicate subclinical mastitis (Sudarwanto and Sudarnikia, 2008).

There was a decrease in SCC in goat's milk in response to NCM administration (P<0.05). This condition is thought to be because NCM is anti-inflammatory. This is the opinion of Hyun *et al.* (2004) that the decrease in milk SCC is thought to be because NSM is anti-inflammatory, effective in treating wounds and inflammation, treating anemia, efficacious in treating breast inflammation and swelling and increasing breast milk production (Marina and Astuti, 2012), and has an antioxidant activity of 23, 03%. (Eden *et al.* 2016). So NSM can reduce inflammation in the udder. NSM can also stabilize erythrocyte membranes with a concentration of 125 ppm providing the highest inhibition percentage, namely 80.64% (Sukmawati *et al*. 2020).

NSM also contains flavonoids which are compounds that are useful as diuretics, antibacterials and antioxidants, treating inflammation of the udder (Robinson, 1963). This condition ensures that the udder glands become healthier. In addition, NSM contains fat 1,83%, protein 3.07%, carbohydrates 10.43%, crude fiber 1.05 %, Energy 70.49 Kcal/100 g, antioxidant activity 55,52 %, phenolic 11,32 mg GAE/100g, flavonoids 0.44 and, caroten 817 ppm (Rachma *et al.* 2020). These results are relatively similar to research by Adriani and Yurleni (2020) who obtained SCC from NSM treatment which was able to reduce the SCC of Etawah crossbreed goats, from 789.24 to 665.78 cells/ml

The number of bacteria in Etawah crossbreed goat milk decreased with NSM administration (P<0.05). The treatment of P0 is different from P1, P2 and P3. However, between P1, P2 and P3 there is no difference. The research results of Primadiamanti *et al.* (2020) that NSM can reduce the number of *Staphylococcus aureus* bacteria with higher inhibitory power when administered above 60000 ppm. In general, mastitis is caused by the bacteria *Streptococcus agalactiae*, *Streptococcus uberis*, *Streptococcus dysgalactiae*, *Escherichia freundii*, *Escherichia freundii*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Escherichia coli*, and *Aerobacter aerogenes* (Suwito *et al.* 2013; Pradika *et al.* 2019). The research results of Suwito and Indrajulianto (2013) showed that there were 55.55% *Staphylococcus aureus*, 27.77% Pseudomonas sp, 8.33% *Streptococcus* sp, and 8.33% *Bacillus* sp in milk from mastitis goats.

CONCLUSION

The conclusion of the study was that the NSM protection treatment could reduce mastitis in Etawah breed goats. The protective treatment of tannins and saponins in NSM increased milk production and feed consumption.

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