The effect of katuk (*Sauropus androgynus*) and gamal (*Gliricidia sepium*) supplementation on the dry matter digestibility, organic matter digestibility, and milk quality of Friesian Holstein

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Abstract. This study aims to determine the effect of katuk and gamal supplementation on dry matter digestibility, organic matter digestibility, and dairy milk quality of Friesian Holstein. This study was conducted at the Dairy Farm in Enrekang Regency. Sixteen heads of Friesian Holstein dairy cows having body weight ranged between 350 and 400 kg were randomly assigned to one of four treatment diets according to a completely randomized design (CRD). The number of replication for each treatment was four giving the total number of the experimental unit of 16. The treatments were supplementation of the ration consisted of forages (60%), concentrate (25%), and gamal leaves (15%) with either 0 g (P0), 135 g (P1), 155 g (P2), or 175 g (P3) of katuk. The results of the study indicated that supplementation of a ration containing Gamal (*Gliricidia sepium*) with different levels of katuk (*Sauropus androgynus*) significantly influenced the digestibility of dry matter and organic matter as well as the milk quality. Among the treatments, the P2 treatment (katuk supplementation of 155 g/d) showed the highest significant effects on improving the feed digestibility of the ration and the quality of milk.

1. Introduction
The current domestic needs of raw milk for processed milk are approximately 3.3 million tons per year. From that amount, 0.69 million tons of raw milk (21%) is produced domestically, and the other 2.61 million tons (79%) is imported in the form of either as skim milk powder, anhydrous milk fat, or buttermilk fat. As a result, the milk consumption of Indonesia remained low, which is around 11.09 liters per head per year. This number is much lower compared to the milk consumption of people in other ASEAN countries, which is around 20 liters per head per year. Therefore, Indonesia has to import milk to meet demand [1].

One of the solutions to fulfill the demand for milk is by increasing domestic milk production of Friesian Holstein (FH) cows through the improvement in feed nutrition. This improvement can be achieved by providing a good feed supplement. Despite the development of processed animal product technology, the utilization of katuk (*Sauropus androgynus*) and gamal (*Gliricidia sepium*) as feed is not widely implemented. Katuk and gamal are leguminous trees with high nutritional content. Katuk is rich in amino acids capable of stimulating milk production. It contains Souroupi folium, which is a benefit to stimulate milk flow. In addition, it could also stimulate nutrient flow to the mammary gland and affects secretory cell activity.
Gamal is a leguminous tree with fast growth, even in a dry area. Gamal contains higher protein, compared to standard concentrate. It contains crude protein around 17% or more[2,3]. Moreover, gamal is digested easily by livestock, especially ruminants [4]. Research [5] found that there is no difference in the milk production performance of Balinese cows using katuk and gamal. Numerically, however, the supplementation of katuk is 0.05% higher compared to the control group. Supplementation of a block of feed containing gamal and rice bran to lactating dairy cows is effective in increasing milk production and weight. Dairy cows given 23.4% gamal and cottonseed in the ration have improved dry matter consumption, metabolism intake, and milk production of the cows.

Not much research related to the addition of katuk combined with gamal into the dairy cow ration has been conducted. However, the result of one research [6] utilizing katuk and gamal leaves on lactating cows showed an increase of erythrocyte level, haemoglobin level, and hematocrit value of blood. [7] utilized katuk with the dosage of 100, 150, 200 g for each cow per day without utilizing gamal, and found a positive response on milk production. Respectively, the improvement of milk production is 35%, 40%, and 34%. This research aims to discover digestibility of dry matter, organic matter, and milk quality feed supplemented with katuk and gamal leaves

2. Research method
This experiment was conducted from June 2017 to June 2018 in the two sites, i.e., in the Chemical Feed laboratory, Faculty of Animal Science, Hasanuddin University, Makassar, Indonesia, and in the dairy farm located in Cendana sub-district, Enrekang Regency, South Sulawesi, Indonesia. This research was performed in two stages. The first stage of this research was to determine In Vitro Dry Matter Digestibility (IVDMD) and In Vitro Organic Matter Digestibility (IVOMD) of the experimental diet. The determination of IVDM and IVOMD was conducted according to the procedures of Tilley and Terry [8]. The second stage was to determine milk quality due to the treatment. Determination of milk yield and milk quality was carried out using 16 dairy cows weighed between 300-450 kg with the first and the second lactation periods 1-6 months. This experiment was carried out according to completely randomized design (CRD) with 4 treatments and 4 replications. The treatments of this research consisted of P0 = 60% forage crops + 25% concentrate + 15% gamal; P1 = 60% forage crops + 25% concentrate + 15% gamal + 135 g katuk; P2 = 60% forage crops + 25% concentrate +15% gamal + 155 g katuk; P3 = 60% forage crops + 25% concentrate + 15% gamal + 175 g katuk. Data were analyzed according to the analysis of variance according to a completely randomized design [9] using the statistical software of SPSS ver 16 [10].

3. Results and discussion
3.1. In vitro dry matter digestibility
The result of analysis of variances of dry matter digestibility showed that treatments affect dry matter digestibility of ration (Table 1). The average dry matter digestibility of ration for each treatment was P0 control feed without katuk (51.11%), P1 supplemented with katuk 135g (52.43%), P2 supplemented with katuk 155 g (57.41%), and P3 supplemented with katuk 175 gr (59.04%). Post Hoc Test showed that dry matter digestibility of P3 ration is significantly higher (P<0.05) compared to P1 and P0 (control) rations, but is similar (P>0.05) to P2 ration. This result showed that the highest dry matter digestibility was for P3 and the lowest dry matter digestibility was P0 (control). This indicated that the increase in katuk supplementation resulted in higher dry matter digestibility, which is caused by its high protein contents. High dry matter digestibility of a feed indicates high feed; conversely, feed with low digestibility indicates its incapability to supply nutrients to sustain life or to fulfill livestock production [11]. The number of rations and proportion of ration in feed, chemical composition, protein, fat, and mineral affect dry matter digestibility [12]. Dry matter digestibility resulted from this research was lower compared to the results of [13] research which reported that dry matter digestibility of native tropical grass fermented with probiotic ranged between 62% and 65%. However, the normal range of dry matter digestibility of a feed-in general is between 50.7-59.7% [14].
3.2. In vitro organic matter digestibility

The result of the analysis of variances showed that treatments affect organic matter digestibility of ration (Table 1). The average organic matter digestibility of each treatment was P0 control feed without katuk (49.34%), P1 feed supplemented with katuk 135 g (51.01%), P2 feed supplemented with katuk 155 g (56.01%) and P3 feed supplemented with katuk 175 g (57.73%). Post Hoc Test showed that organic matter digestibility of P3 ration is significantly higher (P<0.05) compared to P2, P1, and P0 rations. The highest dry matter digestibility is P3, and the lowest dry matter digestibility is P0 (control). Organic matter digestibility is related to dry matter digestibility because most of the dry matter is organic matter consisted of crude protein, crude fat, crude fiber, and nitrogen-free extract [15,16]. Organic matter digestibility indicates the number of nutrients such as fat, carbohydrate, and protein digestible by livestock [17]. The level of organic matter content on treatments is determined by microbe activities during the fermentation process, which resulted in the break of the substrate, which in turn eases microorganism to digest organic matter [18]. The fermentation of organic matter produces sugar, alcohol, and amino acid that affect nutritional value. The increase of organic matter is also caused by the increase of dry matter proportionally; the digestion rate of dry matter is always followed by organic matter, therefore with the increase of dry matter digestibility, organic matter follows. The increase of crude protein will result in an increase of rumen microbe activity, digestion on organic matter. This is in accordance [19] stated that organic matter digestibility illustrates the amount of digested substances, mainly nitrogen, carbohydrate, fat, and vitamin.

Table 1. Average in vitro digestibility of feed supplemented katuk and gamal leaves.

| Parameters | Treatments | P0    | P1    | P2    | P3    |
|------------|------------|-------|-------|-------|-------|
| IVDMD (%)  |            | 51.11±1.62 | 52.43±1.66 | 57.41±0.77 | 59.04±0.69 |
| IVOMD (%)  |            | 49.34±0.179 | 51.01±0.73  | 56.01±0.70  | 57.73±0.61 |

Different superscripts within a column indicate a significant difference (P<0.05); IVDMD = in vitro dry matter digestibility, IVOMD = in vitro organic matter digestibility, P0 = 60% forage crops + 25% concentrate + 15% gamal, P1 = 60% forage crops + 25% concentrate + 15% gamal + 135 g katuk, P2 = 60% forage crops + 25% concentrate + 15% gamal + 155 g katuk, P3 = 60% forage crops + 25% concentrate + 15% gamal + 175 g katuk.

3.3. Milk quality

3.3.1. Protein content. The result of the analysis of variances indicated that milk protein content from FH cows supplemented with katuk is significantly different (p<0.05). The milk protein content of treatments P0, P1, P2, and P3 was 2.29%, 3.37%, and 2.43%, respectively (Table 2). This indicated that the addition of 3 g of katuk increased milk protein content. The increase of milk protein content of cows supplemented with katuk is caused by katuk protein content that peaked at 25.51%, which capable of increasing milk protein content. This finding is in accordance with [20] stated that 10 g of katuk contains 2.80 g protein. This finding is similar to [21] found milk protein at 2.95-3.10%.

The nutritional content of dairy cows feed must be capable of fulfilling the needs of milk protein at 3.5% [22]. Nitrogen and Sulphur in feed function to synthesize protein, whereas other minerals such as K, Cu, Fe, Mn, and Zn function as enzyme activators [23]. Milk protein content depends on feed composition, mineral, function, and absorption of minerals, climate, cow species, and others.
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3.3.2. Fat content
The result of the analysis of variances indicated that the addition of katuk was significantly affected (P<0.05) fat content of the milk. The addition of 6 kg of katuk per day induced a 3.16 kg increase in fat content per day (Table 2). The fat content of the FH dairy cows ranged between 3 and 7% [24]. One of the factors that contribute to the high milk fat content is sulfur contained in katuk. Sulfur helps digestion and absorption of fat. One of the functions of sulfur is to synthesize fat acids [13].

The increase of milk fat content resulted in an increase in dangke production from livestock supplemented with katuk. This finding is further strengthened by claims made by stock farmers that the production increased 3 dangke per dairy cows. This result indicated that the addition of katuk at both levels 3 kg and 6 kg is beneficial to increase milk fat content, which is suitable for other milk products such as cheese (dangke). Milk fat content is significant in determining nutritional milk value. Milk products such as butter, cheese, cream, condensed milk, and powdered milk contain fat [25].

The result of milk fat content obtained from katuk supplementation in this research is higher compared to previous researches, [26] found milk fat content both at 2.79% and 2.85%. This might be caused by Nitrogen are not found in katuk supplementation used in previous researches. In addition, the environment, climate, and function of minerals contained in katuk and livestock might act as contributing factors as well.

3.3.3. Ash content. The result of the analysis of variances indicated that the addition of katuk at a different level has no significant differences (P>0.05) on ash content. In Table 2, it can be seen that the highest ash content is on treatment P2 with 0.77% and P1 with 0.75%. This finding was higher than the previous report [13], who reported milk ash content at 0.70%. Additionally, Table 2 also shows that milk mineral content of dairy cows supplemented with katuk at a different level have no significant difference. Mineral contents (Ca, P, and K) of control group, treatment P0, and P1 respectively were Ca: 0.13%, 0.28%, 0.14%; P: 0.17%, 0.21%, and 0.17%; and, K: 0.11%, 0.10%, and 0.09%, respectively. This finding indicated that mineral contents (Ca, P, and K) found in milk is normal or relatively meet the standard [17]. Minerals which are relatively found with high concentration in milk are; Ca: 0.112%, P: 0.095%, K:0.138%, Mg:0.013%, Na: 0.095%, Cl: 0.109%, and S:0.01%. [13] also stated that dairy milk is rich in Ca, P, K, Cl, and Zn but lacks Mg, Fe, Cu, and Mn.

Ca is not found in the composition of katuk supplementation used in this research. However, Ca obtained from the addition of katuk supplementation in milk is minimal compared to a control group with differences of 14% and 13% at both levels 3 kg and 6 kg. The minimal amount of Ca might be caused by the adequate amount of Ca contained in animal feed, such as leguminous and grass supplemented with katuk. Leguminous is usually rich in Ca, K, Mg, Fe, Cu, Zn, Co, Ni, and S [14][16]. P and K contained in katuk supplementation also gave a similar result. This can be seen from its

| Parameters    | Treatments |
|---------------|------------|
|               | P0         | P1         | P2         |
| Protein (%)   | 3.63±0.21  | 3.28±0.44  | 3.25±0.59  | 3.45±0.22  |
| Fat (%)       | 2.95±0.01  | 0.05±0.02  | 2.79±0.46  | 2.83±0.33  |
| Lactose (%)   | 3.05±0.21  | 2.80±0.29  | 2.95±0.21  | 2.81±0.17  |
| Calcium (%)   | 0.05±0.01  | 0.05±0.02  | 0.17±1.46  | 0.04±0.01  |
| Phosphorus (%)| 0.08±0.01  | 0.08±0.01  | 0.07±0.02  | 0.07±0.01  |

Different superscripts within a column indicate a significant difference (P<0.05); P0 = 60% forage crops + 15% gamal + 25% concentrate + 0 g katuk, P1 = 60% forage crops + 15% gamal + 25% concentrate + 25% katuk, P2 = 60% forage crops + 15% gamal + 25% concentrate + 135 g katuk, P3 = 60% forage crops + 15% gamal + 25% concentrate + 155 g katuk.
relatively low difference, which concludes that Ca, P, and K contained in dairy cows feed perfectly adequate without the addition of katuk supplementation [27].

4. Conclusion
The addition of katuk and the dairy ration containing gamal leaves increase the digestibility value of forage crops, especially dry matte and organic matter. Supplementation 155 g/d of katuk increases chemical components of the dairy cows, particularly its protein and fat contents

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References
[1] Kementerian Perdagangan Republik Indonesia 2014 Konsumsi Susu Masih 11,09 Liter per Kapita
[2] Natsir A, Dagong M I A, Mide M Z, Islamiyati R, Irwan M and Basri H 2015 Provision of Multi-Nutrient Block for Local Goats: Effects on Physico-Chemical Properties of Goat Milk Proceeding International Seminar Improving Tropical Animal Production For Food Security 3-5 November 2015 vol 1 (Kendari: Universitas Haluoleo) pp 135–41
[3] Witariadi N M, Budisasa I K M, Puspani E and Cakra I G L O 2015 Provision of Multi-Nutrient Block for Local Goats: Effects on Physico-Chemical Properties of Goat Milk Proceeding International Seminar Improving Tropical Animal Production For Food Security 3-5 November 2015 vol 1 (Kendari: Universitas Haluoleo) pp 135–41
[4] Wirdahayati R B and Bamualim A 2007 Produktivitas ternak sapi lokal pesisir dan daya dukung lahan pengembalaan di Kabupaten Pesisir Selatan Sumatera Barat Prosiding Seminar Nasional Teknologi Peternakan dan Veteriner. (Bogor: Pusat Penelitian dan Pengembangan Peternakan) pp 122–31
[5] Suriastih K, Sucipta N, Siti W and Sukmawati M S 2015 Effect of katuk leaf (Sauropus androgynus) extract supplementation on milk quality and yield of Bali cow fed rice straw and natural grass basal diet J. Biol Agri Heal. 5 74–9
[6] Roza E 2013 Pengaruh penggunaan daun singkong sebagai pakan suplemen terhadap performans produksi dan gejala reproduksi ternak kerbau yang diperah dipelihara secara tradisional. Disertasi (Padang: Fakultas Pertanian, Universitas Andalas)
[7] Suprayogi A, Latif H and Ruhyana A Y 2013 Peningkatan produksi susu sapi perah di peternakan rakyat melalui pemberian katuk-IPB3 sebagai aditif pakan J. Ilmu Pertan. Indones. 18 140–3
[8] Tilley J M A and Terry R A 1963 A two-stage technique for the in vitro digestion of forage crops Grass Forage Sci. 18 104–11
[9] Steel R G D and Torrie J H 1980 Principles and Procedures of Statistics: A Biometrical Approach (New York: McGraw-Hill Book Co)
[10] SPSS I 2007 SPSS version 16.0 (Chicago: SPSS Inc.).
[11] Yusmadi 2008 Kajian Mutu Dan Palatabilitas Silase Dan Hay Ransum Komplit Berbasis Sampah Organik Primer Pada Kambing Peranakan Etawah. Tesis (Bogor: Institut Pertanian Bogor)
[12] Syahrir S, Wiryawan K G, Parakkasi A, Winugroho M and Natsir A 2012 Substitution of concentrate with mulberry leaves in ongole grade cattle fed rice straw based diet Media Peternak. 35 123
[13] Riswandi, Muhakka and Lehan M 2015 Evaluasi Nilai Kecerna Secara In Vitro Ransum Ternak Sapi Bali yang Disuplementasi dengan Probiotik Bioplus J. Peternak. Srij. 4 35–46
[14] Schneider B H and Flatt W T 1975 Evaluation of Feed through Digestibility (Athens: The
University of Georgia)

[15] McDonald P, Edwards R A, Greenhalgh J F D, Morgan C A, Sinclair L A and Wilkinson R G 2010 Animal Nutrition (New York: Prentice Hall)

[16] Natsir A 2012 Fibre Utilization by Ruminants (Makassar: Masagena Press)

[17] Elita A S 2006 Studi Perbandingan Penampilan Umum dan Kecernaan Pakan pada Kambing dan Domba Lokal Skripsi (Bogor: Institut Pertanian Bogor)

[18] Natsir A, Mujnisa A, Mide M Z, Purnomo N and Saade M F 2018 Initial assessment on the use of cocoa pulp in complete feed formulation: In vitro dry matter and organic matter digestibility IOP Conference Series: Earth and Environmental Science vol 157 p 012013

[19] Tillman A D, Reksohadiprojo S, Prawirokusumo S and Lebdosoekoko S 1998 Ilmu Makanan Ternak Dasar (Yogyakarta: Gadjah Mada University Press)

[20] Rukmana R 1997 Budidaya dan Pascapanen Ubi Kayu (Yogyakarta: Kanisius Press)

[21] Losak L A 2006 Pengaruh Pemberian Mineral Feed Supplement Terhadap Produksi dan Kualitas Air Susu Sapi Perah Pada Yayasan Lontara. Tesis (Makassar: Fakultas Peternakan, Universitas Hasanudin)

[22] Adnan M 1984 Kimia dan Teknologi Pengolahan Susu (Yogyakarta: Fakultas Peternakan, Universitas Gadjah Mada)

[23] Anonim 2002 Minerals: Lecture Materials Fak. Peternakan. Inst. Pertan. Bogor

[24] Anonim 2007 Sauropus androgynus (L.) Merr. Tropicos. Saint Louis, Missouri: Missouri Botanical Garden vol 1 (Philippine Islands)

[25] Saleh E 2004 Teknologi Pengolahan Susu dan Hasil Ikutan Ternak. Fakultas Pertanian. Universitas Sumatera Utara

[26] Rahman A F, Srikantri, Winiati R, Suliantri P and Nurwiti C C 1992 Teknologi Pengolahan Susu dan Hasil Ikutan Ternak. Fakultas Pertanian. Universitas Sumatera Utara (Bogor: Inter-University Center for Food and Nutrition)

[27] Hadiwiyoto 1994 Pengujian Mutu Susu dan Hasil Olahannya (Yogyakarta: Liberty)