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Research Article
Fibre Feeds Impact on Milk Fatty Acids Profiles Produced by Smallholder Dairy Farmers

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Abstract
Background and Objective: Fibre feed is the basis of dairy cattle ration and its quality is directly related to the quality of milk, primarily milk fatty acids. The feeds quality varies between locations. This study compared fibre feed quality between the dairy cattle area and its impacts on milk production and quality. **Materials and Methods:** Five main fibre feed (Napier grass, natural grass, rice straw, corn stover and corn husk) from 4 dairy farm areas in West Java (Pangalengan, Lembang, Cibungbulang and Sukaraja) were evaluated on their effect on milk production and quality. Parameters observed were proximate composition, cell wall fractions, *in vitro* digestibility, Relative Forage Value (RFV), milk produced, milk component and milk fatty acids. The correlation between fibre feed and milk quality was investigated. **Results:** It was found an interaction between treatments on ash, crude protein, ether extract, silica, lignin and neutral detergent fibre digestibility parameters. Napier grass has the highest quality. The Pangalengan feeds have the highest RFV. Milk from Bogor has the best quality, high unsaturated fatty acids, conjugated linoleic acids, Hypocholesterolemic/Hypercholesterolemic (HH) ratio. Correlation analysis between feed and milk quality showed that milk production and quality are influenced positively by RFV and digestibility but negatively by CF, NDF and ADF. **Conclusion:** This study concluded that dietary fibre feed quality could not directly determine milk fatty acids composition.

Key words: Fibre feed, CLA, milk, fatty acids, smallholder, unsaturated fatty acids, atherogenicity index, hypocholesterolemic

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Dairy cattle in tropical countries were established through government programs to improve the rural economy[1]. It is characterized by its small-scale dairy system[2], where fibre feed is the basis of the dairy cattle diet. The fibre feed improves farm profitability by using homegrown[2] or locally collected fibre feed. The common fibre feeds used were Napier grass, natural grass, rice straw, corn stover and corn husks[3]. The feed was used in different proportions depending on their quality and availability. In a densely populated area, fibre feed utilization is lower[4] than in a less densely area[5]. Fresh forage such as Napier and natural grass is used more frequently due to its better quality and availability. However, rice straw, corn stovers and corn husks are also used to overcome the shortage of fresh forage.

The quality of fibre feed is directly related to the quality of milk produced[6]. The quality of milk that is greatly affected by fibre feed is milk Fatty Acids (FA). The FA has been associated with human health[7]. Saturated Fatty Acids (SFAs) have been associated with an increased risk of cardiovascular disease, obesity and some cancers, especially the C12:0, C14:0 and C16:0 FA. While Unsaturated Fatty Acids (UFA), C18:0 have been associated with health-promoting index[8]. The C4:0 have been shown to have beneficial effects in inhibiting cancer cell growth, while the C6:0, C8:0 and C10:0 have been reported to reduce body fat[9]. Nutritional indices of milk fatty acids for human health have been assessed[8]. It included saturated and unsaturated fatty acid profiles, Atherogenicity Index (AI)[10] and Hypocholesterolemic/Hypercholesterolemic (HH) ratio[11]. Cows fed fresh forage, such as pastured cows, had a better milk quality than conserved forage such as hay or ensiled. The milk from silage-based diets typically contains lower Polyunsaturated Fatty Acids (PUFA)[12].

Fibre feeds quality varies between locations depending on soil, weather, topography and plant age at harvesting[13]. West Java Province is one suitable dairy cattle development area. Pangalengan District of Bandung Regency, Cibungbulang District of Bogor Regency, Lembang District of West Bandung Regency and Sukaraja District of Sukabumi Regency are some established dairy cattle areas in West Java Province. The locations are different typologically. Pangalengan is located in highland and is less densely populated. Lembang is situated in a highland but densely populated. Cibungbulang is located in less densely populated and the area is conserved for dairy estate area with private grassland. In contrast, Sukaraja is situated in lowland with a densely populated place. With the different typologies, the fibre feed quality and availability in the locations vary greatly. However, information on the variation of fibre feed quality between dairy cattle farm area and their impact on milk production and quality has not been studied.

This study compared fibre feed quality between the dairy cattle area and its impacts on milk production and quality.

MATERIALS AND METHODS

Study area: The study consisted of field and laboratory observations. Field observation was conducted in four main dairy cattle areas in West Java (Pangalengan district of Bandung Regency, Lembang district of West Bandung Regency, Cibungbulang district of Bogor Regency and Sukaraja district of Sukabumi Regency). While laboratory observation was conducted at Dairy Nutrition Laboratory, Department of Animal Nutrition and Feed Technology, Faculty of Animal Science, IPB University, Indonesia, from January, 2019-August, 2021.

Sample preparations: Five main fibre feed used in four dairy farm areas in West Java have been collected. The feeds were Napier grass, natural grass, rice straw, corn stover and corn husk. From each area, four farms were sampled randomly as replications. The 4 kg of each sample was collected. The samples were dried under the open sun for 48 hrs and then, 48 hrs in a 60°C Eyela NDO 400 (made in Japan). The dried samples were ground using a Huayi FFC 15 (made in Japan) blender at medium speed and filtered to pass a 1 mm screen. The samples were stored in a plastic container for further analysis.

Fibre feed analysis: The fibre feed samples were analyzed for their proximate composition and fibre fraction to determine Dry Matter (DM), ash, Crude Protein (CP), Ether Extract (EE), Crude Fibre (CF), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Acid Detergent Lignin (ADL) and silica. *In vitro* digestibility to measured Dry Matter Digestibility (DMD) was followed by fibre fraction residue analysis to determine NDF and ADF digestibility. The fibre feed analysis following a similar procedure as used by Despal *et al.*[3]. Relative Forage Value (RFV) was calculated according to Rocateli and Zhang[14]:

$$\text{Dry matter intake (DMI) (\%)} = \frac{120}{\text{NDF (\%)}}$$

$$\text{DMD (\%)} = 88.9\text{-}(0.799\% \times \text{ADF})$$

$$\text{RVF} = \text{DMD (\%)} \times \text{DMI (\%)} \times 0.775$$

Milk analysis: Milk produced was measured volumetrically. The 250 mL milk sample from each farm was collected from morning and afternoon milking, stored in the coolbox and transported to the laboratory. The milk fat, protein, lactose, SNF and density were measured using Bulgaria's Milkotronic milk analyzer serial I-17-817. Milk fatty acids were measured using an Agilent G4350B Gas Chromatography (GC) with a Flame Ionization Detector (FID) and HP-5 capillary column (30 m length, 0.320 mm diameter, 0.25 µm film thickness from Agilent Technologies, Palo Alto, CA, USA. The procedures were similar to those by Martha *et al.*[15] and validated with near-infrared reflectance spectroscopy (NIRS) (Buchi NIRFlex N-500 Solids Cell made in Switzerland).

Data analysis: A completely randomized factorial design was used for fibre feed data analysis by applying a multivariate test from SPSS version 21. The first factor was locations (L_1 = Pangalengan, L_2 = Lembang, L_3 = Cibungbulang and L_4 = Sukaraja). The second factor was type of fibre feeds (F_1 = Napier grass, F_2 = natural grass, F_3 = rice straw, F_4 = corn stover and F_5 = corn husks). A completely randomized design was used for milk data analysis. Analysis of variance followed by Tukey's test was run to compare between mean. The correlation between forage value and milk quality was investigated. Regression analysis was made to estimate milk quality from fibre feed quality.

RESULTS

The proximate composition of fibre feed from the different locations is shown in Table 1. The table shows that the CF content between the fibre feed type was not different but between areas. The CF content was lower in fibre feeds from Sukaraja. There was a significant interaction between locations and fibre feed factors in DM, Ash, CP and EE parameters. Rice straw from Sukaraja and corn stover from Pangalengan were drier than other fibre feeds, while Napier grass from Lembang is the moistest fibre feed observed. In all locations, ash contents in rice straw were higher than corn stover and corn husks. While in the Napier and natural grasses, the ash contents varied greatly. In all locations, CP content in Napier grass was higher than rice straw and corn husks.

Table 1: Proximate composition of fibre feed from different dairy farm areas

		Location				
Parameters	Fibre feeds	Pangalengan	Bogor	Lembang	Sukaraja	Average
DM	Napier grass	15.691^{defg}	11.076^{fg}	7.402^{g}	9.777^{cdefg}	10.987
	Natural grass	25.513^{abcde}	19.479^{bcdefg}	18.130^{fg}	17.805^{cdefg}	20.232
	Rice straw	26.217^{abcde}	21.805^{bcdef}	29.765^{abc}	36.597^{a}	28.596
	Corn stover	30.931^{ab}	21.888^{bcdef}	13.711^{efg}	14.253^{defg}	20.196
	Corn husks	13.946^{defg}	19.345^{bcdefg}	20.013^{bcdefg}	26.434^{abcd}	19.935
	Average	22.460	18.719	17.804	20.973	
Ash	Napier grass	11.359^{efgh}	14.501^{cdef}	21.888^{ab}	16.190^{bcde}	15.985
	Natural grass	11.086^{efghi}	11.907^{efgh}	13.791^{def}	13.856^{def}	12.660
	Rice straw	20.386^{abc}	23.675^{a}	19.273^{abcd}	19.424^{abcd}	20.690
	Corn stover	7.187^{ghij}	12.288^{efg}	8.726^{fghij}	10.758^{efghi}	9.740
	Corn husks	4.404^{j}	4.054^{j}	5.931^{hij}	5.085^{ij}	4.868
	Average	10.884	13.285	13.922	13.063	
CP	Napier grass	12.192^{a}	12.285^{a}	11.006^{abc}	12.201^{a}	11.921
	Natural grass	11.878^{ab}	12.270^{a}	11.797^{ab}	9.056c^{de}	11.250
	Rice straw	5.243^{g}	6.384^{fg}	6.519^{fg}	6.724^{fg}	6.218
	Corn stover	7.975^{def}	9.910^{bcd}	10.930^{abc}	9.096^{cde}	9.478
	Corn husks	6.395^{fg}	8.205^{def}	7.797^{ef}	7.524^{ef}	7.480
	Average	8.736	9.811	9.610	8.920	
EE	Napier grass	1.936^{b}	2.078^{b}	3.891^{a}	2.812^{ab}	2.679
	Natural grass	2.639^{ab}	2.109^{b}	2.578^{b}	1.949^{b}	2.319
	Rice straw	2.510^{b}	2.889^{ab}	2.622^{b}	2.307^{b}	2.582
	Corn stover	2.978^{ab}	2.361^{b}	2.223^{b}	2.411^{b}	2.493
	Corn husks	3.190^{ab}	2.815^{ab}	2.877^{ab}	2.726^{ab}	2.902
	Average	2.651	2.450	2.838	2.441	
CF	Napier grass	36.127	33.679	29.241	28.365	31.853
	Natural grass	33.786	32.853	32.559	28.929	32.032
	Rice straw	32.238	33.573	32.301	31.631	32.436
	Corn stover	32.225	31.133	30.596	28.980	30.734
	Corn husks	34.585	31.662	32.139	28.458	31.711
	Average	33.792^{a}	32.580^{a}	31.368^{ab}	29.273^{b}	

DM: Dry matter, CP: Crude protein, EE: Ether extract, CF: Crude fibre. Mean value with a different superscript in the same parameters show a significantly different interaction location×feed fibre types at $p<0.05$

Table 2: Cell wall fractions of fibre feed from different dairy farm areas

Parameters	Fibre feeds	Location Pangalengan	Bogor	Lembang	Sukaraja	Average
NDF	Napier grass	69.429	69.500	59.843	55.614	63.596[c]
	Natural grass	65.944	67.127	64.490	63.041	65.150[bc]
	Rice straw	69.455	68.922	69.059	65.599	68.258[b]
	Corn stover	67.791	67.477	65.828	63.608	66.176[bc]
	Corn husks	82.066	80.443	78.532	73.765	78.701[a]
	Average	70.937[a]	70.694[a]	67.550[ab]	64.325[b]	
ADF	Napier grass	40.700	39.448	36.704	31.626	37.120[b]
	Natural grass	37.809	35.013	35.841	32.920	35.396[b]
	Rice straw	41.157	42.380	42.062	38.013	40.903[a]
	Corn stover	35.041	36.629	35.385	33.042	35.024[b]
	Corn husks	39.656	38.115	37.994	33.589	37.338[b]
	Average	38.873[a]	38.317[a]	37.597[a]	33.838[b]	
ADL	Napier grass	5.272	4.933	6.157	4.223	5.146[b]
	Natural grass	7.388	5.612	5.200	4.908	5.777[b]
	Rice straw	7.947	8.816	8.731	6.616	8.028[c]
	Corn stover	4.495	3.908	4.337	4.186	4.231[ab]
	Corn husks	3.189	2.807	3.186	2.509	2.923[a]
	Average	5.658	5.215	5.522	4.488	
Silica	Napier grass	0.382	0.773	1.896	0.957	1.002[b]
	Natural grass	1.305	1.267	0.816	1.495	1.221[b]
	Rice straw	5.025	5.590	3.598	3.850	4.516[a]
	Corn stover	0.800	0.710	0.189	0.884	0.646[b]
	Corn husks	0.400	0.437	0.256	0.445	0.384[b]
	Average	1.583	1.756	1.351	1.526	

NDF: Neutral detergent fibre, ADF: Acid detergent fibre, ADL: Acid detergent lignin. Means values in the same row with different superscripts differ significantly ($p<0.05$)

Natural grass and corn stover, however, vary between locations. The EE content in Napier grass from Lembang is higher than Napier grass in Pangalengan and Bogor, natural grass in Bogor, Lembang and Sukaraja, rice straw in Pangalengan, Lembang and Sukaraja, Corn Stover in Bogor, Lembang and Sukaraja. The EE contents in corn husks from all areas were not different from other feeds from all locations.

The cell wall fractions of fibre feed from the different locations are shown in Table 2. The table shows that the cell wall fractions were significantly influenced by locations and type of fibre feeds. The NDF content in corn husks was the highest and in Napier grass was the lowest. The NDF in fibre feeds from Pangalengan and Bogor were higher than Sukaraja. Similar patterns were also found in the comparison of ADF parameters between locations. However, comparing the types of feeds, we found that ADF in rice straw was significantly higher than in other feeds. Locations did not significantly influence ADL contents but the variety of feeds. Corn husk was significantly higher in comparison to others. Silica content in the feeds was not different between location and feed types except for rice straw which was higher than others.

Digestibility and forage value of the fibre feeds from different locations are shown in Table 3. The table shows that the digestibility of dry matter (DMD), NDF (NDFD), ADF (ADFD) and RFV values were significantly influenced by feed types and locations. Still, there was no interaction between the two factors. DMD of Napier grass and Corn Stover were significantly higher than rice straw and corn husks. The feeds from Sukaraja were significantly higher than Pangalengan. The NDFD parameter was not significantly influenced by locations but feed types. The NDFD of Napier grass was significantly higher than natural grass and rice straw. The ADFD parameter was also not affected by locations but feed types. Rice straw ADFD was significantly lower than others. Locations and feed types influenced the RFV parameters. The RFV of rice straw and corn husks was significantly lower than others. The fibre feeds from Sukaraja have significantly higher RFV in comparison to Pangalengan and Bogor.

Milk production and quality from the different locations are shown in Table 4. The table shows that milk from Sukaraja was significantly lower than in other places. The milk components (SNF, density, lactose, protein and fat) were not significantly different between locations. The C11:0, C13:0, C17:1 cis10, C18:1, C18:1 trans9, C18:2 trans n6, C18:3 and C>20 fatty acids were not significantly different. The CLA content in milk from Lembang and Sukabumi was higher than Bogor and Pangalengan. Milk from Bogor contained lower SFA and higher UFA in comparison to milk from other locations. The milk from Pangalengan has higher AI and lower HH in comparison to other locations. Some odd C-chain fatty acids and Long-Chain Fatty Acids (LCFA) were not detected in some areas.

The correlation between fibre feeds quality with milk production and quality is shown in Table 5. The table shows

Table 3: Digestibility and forage value of fibre feed

Parameters	Forage	Location: Pangalengan	Bogor	Lembang	Sukaraja	Average
DMD	Napier grass	51.062	54.560	58.147	59.315	55.771[a]
	Natural grass	42.852	53.446	45.257	49.222	47.694[ab]
	Rice straw	29.908	29.989	34.759	34.199	32.214[c]
	Corn stover	43.506	48.864	53.294	49.406	48.768b[a]
	Corn husks	39.370	47.302	41.994	59.241	46.977[b]
	Average	41.340[b]	46.832[ab]	46.690[ab]	50.277[a]	
NDFD	Napier grass	50.890	54.970	57.028	55.196	54.521[a]
	Natural grass	40.488	52.432	41.169	47.302	45.348[b]
	Rice straw	32.667	30.275	34.717	33.901	32.890[c]
	Corn stover	41.367	46.961	51.461	48.128	46.979[ab]
	Corn husks	46.213	53.327	46.709	61.235	51.871[ab]
	Average	42.325	47.593	46.217	49.152	
ADFD	Napier grass	43.599	47.395	48.798	44.556	46.087[a]
	Natural grass	30.938	41.660	32.317	35.243	35.039[ab]
	Rice straw	23.020	20.692	29.074	25.133	24.480[b]
	Corn stover	30.083	38.703	43.028	36.399	37.054[a]
	Corn husks	32.283	39.443	38.870	50.148	40.186[a]
	Average	31.985	37.579	38.417	38.296	
RFV	Napier grass	75.757	76.841	94.266	113.860	90.181[a]
	Natural grass	83.337	84.693	86.902	92.474	86.851[ab]
	Rice straw	75.130	74.413	74.500	83.015	76.765[bc]
	Corn stover	83.748	82.233	85.699	91.523	85.801[ab]
	Corn husks	64.996	67.932	69.351	78.441	70.180[c]
	Average	76.594[b]	77.222[b]	82.144[ab]	91.862[a]	

DMD: Dry matter digestibility, NDFD: Neutral detergent fibre digestibility, ADFD: Acid detergent fibre digestibility, RFV: Relative forage value. Means values in the same row with different superscripts differ significantly ($p<0.05$)

Table 4: Milk production and quality from different dairy farm areas

Parameters	Location: Pangalengan	Bogor	Lembang	Sukaraja
Production (L/head/d)	15.635±3.215[a]	14.379±3.013[a]	13.944±3.056[a]	10.378±3.842[b]
SNF (%)	7.62±0.621	7.658±0.439	7.501±1.731	7.083±0.431
Lactose (%)	4.185±0.342	4.205±0.242	4.117±0.95	3.888±0.238
Protein (%)	2.8±0.225	2.808±0.161	2.751±0.636	2.595±0.161
Fat (%)	3.906±0.892	3.992±1.181	4.376±0.464	3.892±0.703
C6:0 (fat %)	1.773±0.371[a]	1.562±0.358[b]	1.462±0.181[b]	1.581±0.148[ab]
C8:0 (fat %)	0.897±0.215[a]	0.797±0.238[ab]	0.745±0.096[b]	0.787±0.065[ab]
C10:0 (fat %)	1.744±0.516[a]	1.386±0.373	1.387±0.203[b]	1.349±0.214[b]
C11:0 (fat %)	ND	0.007±0.044	ND	ND
C12:0 (fat %)	3.004±0.814[a]	2.512±1.061[a]	1.842±0.204[b]	1.922±0.192[b]
C13:0 (fat %)	0.02±0.084	0.006±0.038	ND	ND
C14:1 (fat %)	0.983±0.856[b]	2.742±3.024[a]	1.636±0.365[ab]	2.08±0.615[ab]
C14:0 (fat %)	8.74±1.554[a]	4.82±3.275b	3.166±0.438[c]	3.193±0.677[c]
C15:0 (fat %)	0.582±0.261[ab]	0.748±0.319[a]	0.478±0.08[b]	0.46±0.094[b]
C15:1, cis10 (fat %)	0.952±0.183[a]	0.364±0.398[c]	0.551±0.096[bc]	0.631±0.136[b]
C16:1, cis9 (fat %)	1.477±2.253[a]	0.605±0.343[b]	0.772±0.132[ab]	0.875±0.129[ab]
C16:0 (fat %)	25.106±2.965[a]	22.002±3.952[b]	17.278±1.802[c]	18.036±2.804[c]
C17:0 (fat %)	0.552±0.174[b]	0.493±0.306[b]	0.938±0.23[a]	0.963±0.279[a]
C17:1, cis10 (fat %)	0.707±0.264	1.186±4.621	0.915±0.117	1.058±0.188
C18:0 (fat %)	1.394±1.006[b]	2.902±1.352[b]	11.493±5.213[a]	12.706±5.402[a]
C18:1, cis9 (fat %)	39.488±6.312[ab]	43.014±9.257[a]	33.722±4.534[c]	36.26±3.593b[c]
C18:1, trans9 (fat %)	0.197±0.042	0.582±0.903	0.591±0.163	0.426±0.194
C18:2, trans n6 (fat %)	4.03±1.065	4.139±3.693	2.75±0.939	3.314±0.991
C18:2, cis (fat %)	5.023±1.385[b]	7.706±2.39[a]	3.628±0.827[c]	4.136±1.136[c]
C20:0 (fat %)	0.065±0.126[b]	0.056±0.138[b]	0.229±0.03[a]	0.263±0.041[a]
gamma C18:3 (C18:3 n6) (fat %)	0.009±0.045	0.06±0.18	ND	ND
C20:1, cis 11 (fat %)	0.047±0.119	0.007±0.044	ND	ND

Table 4: Continue

	Location			
Parameters	Pangalengan	Bogor	Lembang	Sukaraja
C18:3 (fat %)	0.169±0.235^{a}	0.05±0.118^{b}	ND	ND
C21:0 (fat %)	0.008±0.022	0.004±0.017	ND	ND
C20:2, cis 11, 14 (fat %)	0.132±0.123^{a}	0.09±0.155^{a}	ND	ND
C22:0 (fat %)	0.053±0.139	0.105±0.219	ND	ND
C20:3, cis 8, 11, 14 (fat %)	0.039±0.199	0.008±0.054	ND	ND
C22:1 (fat %)	0.029±0.146	ND	ND	ND
C23:0 (fat %)	0.027±0.1	0.018±0.099	ND	ND
C20:4, cis 5, 8, 11, 14 (fat %)	0.032±0.115	ND	ND	ND
C22:2, cis 13, 16 (fat %)	0.03±0.149	ND	ND	ND
C24:0 (fat %)	0.034±0.12	ND	ND	ND
CLA (fat %)	1.308±0.447^{b}	1.244±0.468^{b}	1.679±0.211^{a}	1.833±0.208^{a}
SFA (fat %)	43.993±5.865^{ab}	37.41±6.635	45.682±3.518^{a}	41.254±5.119^{bc}
UFA (fat %)	54.643±5.945^{b}	61.792±6.687^{a}	54.319±3.518^{c}	50.609±4.004^{c}
PUFA (fat %)	10.768±2.026^{b}	13.296±4.451^{a}	9.507±1.15^{b}	9.282±1.626^{b}
MUFA (fat %)	43.875±5.062^{b}	48.497±7.463^{a}	44.812±3.629^{ab}	41.328±4.253^{b}
PUFA/SFA	0.256±0.07^{b}	0.37±0.144a	0.21±0.032^{b}	0.228±0.036^{b}
AI	1.2±0.328^{a}	0.766±0.417b	0.695±0.07^{b}	0.653±0.107^{b}
HH	1.443±0.349^{b}	2.068±0.551a	1.879±0.15^{a}	2.091±0.685^{a}

Density value expressed as: 1+(0.01*x), SNF: Solid non-fat, CLA: Conjugated linoleic acids, SFA/UFA/PUFA/MUFA: Saturated/unsaturated/polyunsaturated/monounsaturated fatty acids, AI: Atherogenecity index, HH: Hypo/hypercholesterolemic ratio

Table 5: Significant correlation between fibre feed and milk quality

Parameters	DM	Ash	CP	EE	CF	NDF	ADF	ADL	DMD	NDFD	ADFD	RFV
Production (L/head/days)			-0.23									
Lactose (%)								0.24				
Protein (%)			-0.19					0.24				
Fat (%)			-0.22	0.27					-0.26	-0.26	-0.22	
C6:0 (fat %)	-0.24		0.26	-0.26	-0.32	-0.31		-0.30	0.29			0.40
C8:0 (fat %)	-0.19				-0.39	-0.27		-0.27				0.39
C10:0 (fat %)	-0.23				-0.42			-0.34	0.25			0.43
C12:0 (fat %)					-0.43	-0.24	-0.49	-0.30				0.34
C14:1 (fat %)			0.22		0.24							
C14:0 (fat %)					-0.49	-0.35	-0.55	-0.27				0.44
C15:0 (fat %)		-0.26			-0.23		-0.31	-0.28				
C15:1, cis10 (fat %)					-0.47	-0.29	-0.56	-0.33	0.29	0.24		0.40
C16:0 (fat %)					-0.47	-0.33	-0.58	-0.37	-0.31			-0.46
C17:0 (fat %)					0.23	0.33	0.32					-0.32
C17:1, cis10 (fat %)	-0.24		0.28		0.26							
C18:0 (fat %)					0.30		0.34					-0.22
C18:1, cis9 (fat %)	0.25			-0.31								
C18:1, trans9 (fat %)				0.22	0.31	0.32	0.38		-0.23			-0.32
C18:2, trans n6 (fat %)					-0.37		-0.31					
C18:2, cis (fat %)	0.23			-0.27								
C20:0 (fat %)					0.35	0.37	0.33					-0.37
C18:3 (fat %)	0.24		-0.27									
C21:0 (fat %)	0.28									-0.27	-0.27	
C20:2, cis 11, 14 (fat %)	0.27				-0.40	-0.38	-0.42					0.51
C22:0 (fat %)					-0.36	-0.37	-0.39					0.56
C23:0 (fat %)				0.25	-0.37		-0.41					0.68
C20:4, cis 5, 8, 11, 14 (fat %)					-0.35		-0.39					0.65
C24:0 (fat %)				0.23	-0.33		-0.37					0.63
CLA (fat %)					0.30	0.34	0.31					-0.33
SFA (fat %)	-0.31		0.25		-0.29	-0.41	-0.29		0.24			0.39
UFA (fat %)	0.36											
PUFA (fat %)	0.33		-0.30		-0.24							
MUFA (fat %)	0.26				0.23							
PUFA/SFA	0.44		-0.38									
AI					-0.50	-0.39	-0.55	-0.26	0.25			0.50
HH					0.48	0.25	0.50	0.30	-0.27			-0.36

CLA: Conjugated linoleic acids, SFA/UFA/PUFA/MUFA: Saturated/unsaturated/polyunsaturated/monounsaturated fatty acids, AI: Atherogenecity index, HH: Hypo/hypercholesterolemic ratio that milk production only correlated with the CP content of fibre feeds. Lactose was also correlated only with ADL. CP and ADL of fibre feed determine milk protein. Milk fat correlated with CP, EE, DMD, NDFD and ADFD. The CF, fibre fractions (NDF, ADF and ADL) and RFV correlated with many milk fatty acid parameters. In contrast, CP had only a correlation with unsaturated fatty acids C14:1, C17:1 cis10 and C18:3. EE in fibre feeds influenced milk fat, C6:0, C18:1, C18:2 cis, C23:0 and C24:0. The ADL influenced the short-chain milk fatty acids.

DISCUSSION

The insignificant difference in CF content between the fibre feed types shows that all the fibre feed used by the farmer provides sufficient fibre (29-33%) for dairy cattle. However, there are differences in CF content between locations. Fibre feeds used by the dairy farmer in Sukaraja have lower CF content in comparison to other areas. The high CF content in Bogor, due to higher sunlight intensity, stimulated plant growth and increased stem proportion[16]. The high fibre content in feeds from Pangalengan might be caused by lower rainfall, slower plant growth, advancing harvesting age and increased CF, NDF, ADF and lignin contents in the plant[17].

Interaction between locations and fibre feed factors in DM, Ash, CP and EE parameters showed that nutrient content in feeds varies between areas depending on species, soil, weather, topography and plant age at harvesting[13]. The DM content in plants is influenced by age at harvesting. Older plants resulting from increasing the cutting interval increased dry matter and nutrient yields significantly[17]. Raising temperature increased DM yield[18] and declined forage quality[19]. Advancing lignification of plant material[20] lowers CP and digestibility[17]. Lower DM in Napier grass compared to rice straw because Napier grasses were harvested at a younger age (40-60 days of cutting interval)[17] compared to rice straw collected after the rice plant's ripening stage (110-115 days)[21]. Lower DM in fibre feeds from Lembang might be caused by the shorter cutting interval of Napier and Natural grass[17]. A higher dense population puts higher pressure on land and increases the stocking rate. Farmer increased the use of agricultural by-products such as rice straw, corn stover and corn husk.

The CP content in natural grass from Sukaraja (9.0%) was lower than other areas (12%) but higher than natural grass used by Despal *et al.*[22], which were collected from the area around the Darmaga district of Bogor regency. The CP content in natural grass depended on its species type and proportion[23]. Sukaraja is less densely populated in comparison to Lembang. The area available for natural grass is higher, which resulted in a lower stocking rate and longer collecting interval of the natural grass, advanced its maturity and decreased its CP content[17].

The ash content in Napier grass from Lembang was higher than Pangalengan and Bogor. It might be caused by its location in the volcanic area of Tangkuban Perahu. Although volcanic ash soils create a productive and comfortable environment, they serve essential functions in accumulating large amounts of organic carbon and nitrogen and plentiful water storage[24]. Still, volcanic areas physically impact plants from the additional weight of ash on leaves[24]. Ash deposited on soil altered soil chemistry, nutrient content and water content and lowered soil pH, detrimental crop survival[25].

The fibre fractions (NDF and ADF) in rice straw were significantly higher than others. As a late mature plant component, lignification was advanced[20], as shown by the higher amounts of ADL, lignin and silica. Fibre is needed by ruminants such as dairy cows to maintain their rumen health and provide more acetate and butyrate in rumen fermentation as precursors for milk fat synthesis[26]. However, the cow needed digested fibre from cellulose (ADL-ADF) and hemicellulose (NDF-ADF). Lignin and silica reduced the digestibility of cellulose and hemicellulose[27]. Lignin bound cellulose and hemicellulose[28] made the cellulose and hemicellulose undigested.

The RFV value of fibre feeds from Sukaraja is significantly higher than Pangalengan and Lembang. It resulted from lower fibre fractions (NDF and ADF) and higher digestibility. The fibre feeds from Sukaraja with an average RFV of 92% can be categorized as forage grade 3, while forage from other areas can be classified as grade 4 with an RFV value less than 75-85%[29]. Napier grass, natural grass and corn stover can be used as primary forages in dairy cattle with grade 3 quality but rice straw and corn husks should not be used as the primary forage because of their lower quality. Forage quality should express the potential of forage to produce milk. In a dairy ration, roughage or fibre in the proper quantity and physical form is needed to maintain normal milk fat percentages. The feeding system can affect milk fat content and composition[30]. The use of large quantity low roughage such as rice straw and corn husks reduced nutrient availability such as protein and energy, especially in high producing dairy cows[31].

The RFV of fibre feed from Sukaraja was higher than in other areas but its milk production was the lowest. According to Krämer-Schmid *et al.*[32], milk yield increased with enhanced fibre feed (maize silage) quality (NFD digestibility). They reported that a 0.01 increase of the NDF digestibility improved daily milk yield by 82 g. In this study, fibre feeds quality did not significantly influence milk production. It might be due to the different fibre feed types used. According to Hammond *et al.*[33], cows fed maize silage produced more milk than grass silage. Analysis of correlation (Table 5) showed that milk production was only correlated with the CP of the fibre feeds, which are different between location and fibre feed types. It is suggested that fibre feed quality alone cannot determine milk production. Many other factors influenced milk production, such as genetic, nutrient intake and sufficiency, stage and period of lactations, environment and cow's health[1].

The milk components (SNF, fat, protein and lactose) were not significantly different between locations. Large variations between farms within the areas might cause it. The fat component was the most varied[34]. The milk components found in the study were comparable to those reported by Anzhany *et al.*[35] and Hasanah *et al.*[36] but lower than Molavian[31]. The lower components found in this study were protein and lactose contents.

The odd C-fatty acids (C11:0, C13:0) and unsaturated LCFA (C17:1 cis10, C18:1, C18:1 trans9, C18:2 trans n6, C18:3 and C>20) were not significantly different between locations. It might be caused by the low concentration of the fatty acids in milk and made it challenging to determine[37]. The SFA was lower and the UFA was higher in milk from Bogor than other locations, resulting in lower AI and higher HH. It indicated that milk from Bogor was healthier than in other areas. Saturated Fatty Acids (SFAs) have been associated with an increased risk of cardiovascular, obesity and some cancer diseases[38]. However, newer research showed that not all SFA were unhealthy, just C12:0, C14:0 and C16:0. The short-chain SFA (C4:0 C6:0, C8:0 and C10:0) and LCFA (C18:0 and oleic acid) have been reported to have a positive correlation on human health[9]. The healthier milk from Bogor might be caused by the high CP and fibre fractions in the feeds. The result in Table 5 showed many correlations of fibre fractions (CF, NDF and ADF) to milk fatty acids. High fibre in dairy ration such as cow raised on pasture-based increased the milk's beneficial compounds and reduced the less desirable saturated fatty acids[39].

Unlike milk from Bogor (lowland), milk from Pangalengan (highland) has higher AI and lower HH. It has resulted from high SFA and low UFA in the milk. However, Collomb *et al.*[40] reported that milk from higher altitudes was healthier than lowland due to its diverse grass mixtures but it found the contrary in this case. Dairy farms in Bogor are located in a conservated area of Cibungbulang where every farm have their forage land. Moreover, the area was less densely populated, which made natural grass more available. Pangalengan is located in horticulture and tourism areas where land is competitive; therefore, both cultivated grass such as Napier grass and natural grass was less available. Farmer used more agriculture by-products such as rice straw, corn stover and corn husks which vary in quality. Farmer in Pangalengan increased the use of concentrate, especially during the dry season.

Although the SFA was high and the UFA was low in milk from Lembang and Sukaraja, their AI and HH were similar to milk from Bogor. It suggested that milk from Lembang and Sukaraja were also healthy milk. It resulted from the different calculations of the fatty acid profiles. SFA and UFA counted based on the carbon chain, while AI and HH were calculated based on their impact on human health[38]. Not all SFA were unhealthy and related to cardiovascular risk[9]. Low AI and high HH in milk from Lembang and Sukaraja caused by the high C18:0 (LCFA). The short- and medium-chain FA (SMCFA, C4-C14) and half of the C16 are synthesized de novo, whereas the rest of the FA, including 50% of C16 and other long-chain FA (LCFA) are derived from triglyceride in the blood or Non-Esterified Fatty Acid (NEFA) mainly during negative energy balance[41]. It indicated that cows in both areas are experiencing a negative energy balance.

The CLA content in milk from Lembang (1.67%) and Sukaraja (1.83%) were higher than Pangalengan (1.31%) and Bogor (1.24%). The CLA content in the milk found in this study was higher than the standard (0.34-1.07%)[42]. Small holders used a high proportion of fibre feed to minimize feed cost[43] resulted in higher CLA in milk[44]. A high proportion of tofu waste in the ration is also related to high CLA in milk due to its high linoleic acid Damanik *et al.*[45] as a precursor for CLA synthesis Fiore *et al.*[14].

This finding can be used as a guide for farmers and extension workers to select main fibre feed feeds that support milk production and quality. Consumers can choose healthier milk based on the milk fatty acid profiles. The limitation of the study is that the fibre feed quality tested could not directly determine milk fatty acids composition. It is suggested to study the combination of fibre feed and concentrate effect on milk fatty acids composition.

CONCLUSION

It is concluded that fibre feeds quality from Sukaraja is better than other areas with an average grade of 3 (RFV 86-100). Napier, natural grass and corn stover can be used as primary fibre feed sources in the dairy diet. The RFV did not determine milk production. Based on the milk fatty acid profiles, milk from Bogor, Lembang and Sukaraja are healthier than Pangalengan. Fibre fractions (CF, NDF and ADF) correlated with many milk fatty profiles.

SIGNIFICANCE STATEMENT

This study explores the quality of fibre feeds from different dairy farm areas in West Java and their relation to milk production and milk fatty acid profiles. This study will help the researcher uncover the relationship between fibre fractions in feeds with milk fatty acid profiles produced by smallholder dairy farmers in tropical areas.

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