Combination Effect of Feed Supplements on Milk Yield and Milk Quality of Dairy Cattle

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***Abstract*—This study was to evaluate the effects of feed supplements containing tannins, NPN and mineral on milk yield and milk quality of dairy cattle. Nine lactating dairy cows were designed in experiment by a completely randomized design with 3 treatments and 3 replications. Treatment consists of R0: Total Mixed Ration (TMR); RA: TMR + supplements A; RB: TMR + supplement B. The results showed that supplementation of feed supplements A and B were no effect on milk yield and quality but were had significantly different effect on Milk production efficiency for MPE (Milk yield/FCM). Feed supplement A can increase milk yield by 20.88% and feed supplement B increase milk yield by 8.07% compare with only TMR feeding. All supplementation feed supplement had average milk yield higher than control feed. In conclusion the feed supplements increase feed efficiency for dairy cattle.**

***Index Terms*—milk yield, milk quality, dairy cattle, feed supplement**

I. Introduction

The low forage quantity available in dry season and low quality protein concentrated feed lead to decrease productivity of dairy cattle in Indonesia. Farmer could not use high price of good quality concentrated feed and use an abundance of low quality feed. Feed supplement could be good solution for enhance digestibility and absorbance of nutrient in dairy cattle. Feed supplement give an advantage solve feed inefficiency, increase digestible capability of rumen microbial and improve rumen metabolism [1]. Beside for meet nutrients requirement, feed supplement containing material for increase feed consumption hence its type, doses and price should be well assessed in dairy cattle experiment [2].

Some feed supplement containing some material combination such as tannins, NPN *slow release*, leguminose, molasses, mineral dan vitamine. Tannins could protect protein as protein by pass in rumen metabolism at specific doses [3]. NPN *slow release* is a king of cheap price of protein feed that could be used by rumen microbe continuously all day and was synchronized with energy expenditure of ruminant. N-precursor for rumen microbe could be provided as cheap price protein feed (NPN) which could be utilized gradually in accordance with availability of energy, thus increasing the production of microbial protein and finally the use of fiber in the rumen would be more efficient and for supply nutrients intestine. Minerals, molasses and vitamins also increase productivity of dairy cows because they were utilized for shape of rumen microbes that can assist in the process of fermentation and digestibility.

Feed supplements containing single cell protein from tofu waste and seaweed have good nutritional value for ruminants [4]-[15]. Micro mineral containing in feed supplement (cobalt, selenium, and zinc) increases activity of rumen microbes to digest feed. Mineral cobalt and zinc mineral supplementation may increase the activity of rumen microbe and improve digestibility of feed [2]. The concentration of some minerals and vitamins is decrease after gestation in cows could be solved by addition of feed supplement which it effect to health and milk production [5].

Dairy scientists have made enormous strides in increasing milk yields of our herds through better nutrition, animal health, improved genetics, and implementation of management techniques [6]. The main constraints of finding ruminant raw materials for animal feed are as follows: (1) the characteristics of the feed basic material that are commonly perishable have caused difficulities in the handling, distribution and processing of livestock feed, (2) the raw material of feed from agricultural waste has low palatability [7]. Supplement we choose must make up for the main nutrient deficient [8].

The objective of this study was to evaluate supplementation effect of feed supplement containing tannins, NPN slow-release, single cell protein, minerals and vitamins on milk yield and milk quality in dairy cattle.

II. Material and Methods

A. Animals and Experimental Diets

Nine lactation dairy cattle (FH) were used and individually penned indoors had average weigh 475.49±31.2kg and daily milk yield 15±1kg/d. Cows were fed a total mixed ratio-TMR (60% forage and 40% concentrate) as experimental diets. The addition of feed supplements is mixed well with concentrated feed 200g/head/day in the morning feeding.

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Experimental diet was total mixed ration containing 60% forage and 40% concentrated feed. The TMR for this experiment was analysed for proximate [14] and, Fiber analysis [16]. TMR containing 12.19% protein, 4.38% fat, 22.98% crude fiber, 6.19% ash and 7.22% moisture content

B. Experimental Feed Supplement

Feed supplement in this experiment is combination from some ingredients as their known functions for rumen manipulation. Tea waste rich containing tannins as protein protector for protein by pass, *Hibiscus rosasinensis* leaf containing high sapponine, clove oil, mineral Zn, Cobalt, Vitamin A and others are ingredients that were formulated in two kind of feed supplement (Supplement A and B) (Table I).

TABLE I. FEED SUPPLEMENT FORMULATION A AND B

Supplement A	Supplement B
Tea waste	Tea waste
H. rosasinensis leaf	Slow Release Urea (SRU)
Clove oil	Mineral Zn
Tapioca waste	Selenium
Coconut cake meal	Complex Mineral Ca-Fish oil
Mineral Zn	Single cell protein
Sodium bicarbonate	Cobalt
Salt	Sodium bicarbonate
Urea	Seaweed
Molasses	Vitamin A

C. Milk Yield and Milk Quality Measurement

Animals were milked at 05:00 in the morning and at 17:00 in the afternoon. Milk Yield (MY) daily was calculated from both of milk collection (Kg) and milk yield also was calculated as fat corrected milk yield (4% FCM) using equation from NRC (2001) [9]:

$$\text{FCM 4\% (Kg/d)}=((0.4+0.15*\ \%\text{milk fat})*\text{milk yield}) \quad (1)$$

Milk quality was analyzed by *Lactoscan MCC50* Serial Number 6538 calibration 1 Cow T, where milk quality testing performed every 1 week for fat, protein, Solid non fat (SNF), total solid, density and lactose concentration. Milk production efficiency was calculated as ratio dry matter intake (DMI): Milk yield (MPE1) and ratio dry matter intake (DMI): FCM4% (MPE2).

$$\text{MPE1} = \text{DMI/MY} \quad (2)$$

$$\text{MPE2} = \text{DMI/4\%FCM Milk yield} \quad (3)$$

D. Statistic Analysis

Treatments of this experiment were 1) RO: control experiment using total mixed ration (TMR), 2) RA: TMR with feed supplement A, 3) RB: TMR with feed supplement B, which were assigned and analyzed completely randomized complete design with 3 replication (3×3). The data was analyzed by using GLM procedure of SAS 9.1.3 for windows statistical package and significantly different if followed by Duncan test [10]. The model used was as follow:

$$Y_{ij} = \mu + \alpha_i + e_{ij} \quad (4)$$

where Y_{ij} is observed value, μ is general mean, α_i is treatments using feed supplement effect and e_{ijk} = standards error.

Parameters measured were milk yield, MPE (Milk Production Efficiency) and the quality of milk (fat, protein, SNF, total solid, density and lactose).

III. RESULT AND DISCUSSION

A. Milk Yield

Supplementation feed supplement A and B did not significantly affect milk yield (P>0.05). However, they tend to produce higher milk yield than the control. Milk yield was highest in supplementation feed supplement A 16.64kg/day and B 14.87kg/day when control had lowest milk yield 13.76kg. Feed supplement can increase milk yield by 20.88% and 8.07% compared to controls. 4% fat corrected (FCM) milk yield was similar effect with milk yield without fat correction. The highest milk yield 4% FCM was obtained from supplementation A 16.15kg/day when the lowest was control 13.86kg/day (Fig. 1).

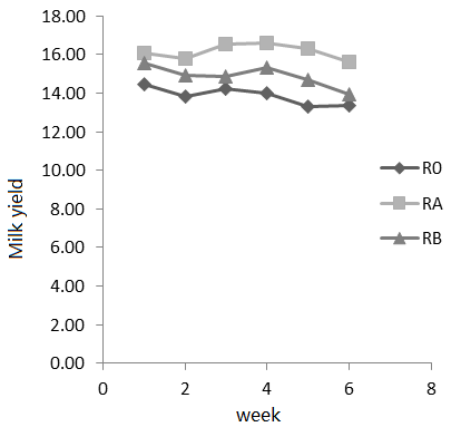

Figure 1. Weekly milk yield at supplementation feed supplement at 8 week periods experiment.

The results of milk yield indicated that initial milk yield after supplementation has a positive function in maintaining and improving milk yield after initial. Animals without supplementation had decreasing milk yield 0.70kg/day compared to early milk production. Milk yield also was affected by quality of feed consumption. Same value of dry matter intake might not effect on same milk yield and quality, depend on milk production efficiency value (MPE1 and MPE2). MPE describes a quality value of feed for dairy cattle, especially protein quality [1]. Milk yield is also more influenced by energy than protein [11].

Supplement A was formulated by some ingredient containing high protein sources are from coconut meal and urea (NPN) as well as the energy source of cassava and molasses, thus effect on the amount of milk yield more value than supplement B or control. Other study said improvements in milk production require the use of high crude protein feeds [12].

Some objectives of supplementation to increase milk production per cow, increase stocking rate and milk production per unit of land, improve the use of forage with higher stocking rate, maintain or improve body condition score, increase length of lactation and increase milk protein content by energy supplementation [13], so evaluation of supplementary feeding is important.

Added a xylanase-cellulase enzyme solution to a dairy cow TMR based on alfalfa hay and silage reported can increase in milk production [17]. Some studies have repoted use of bovine ST, thrice daily milking and long day photoperiod can increase milk yield [18]-[20]. Improved circulating glucose may have supported increased lactose synthesis, and therefore milk yield, because lactose is the osmotic regulator for the mammary gland uptake of water [21].

Milk Production Efficiency (MPE) could be interpreted as 1kg milk yield from 1 kg dry matter intake by animal, where the optimal values ranging from 1.4 to 1.8. Both of MPE1 and MPE2 results were significantly different results for milk yield values. MPE values could optimize dry matter intake through feed supplement that can improve the digestion and absorption nutrient [22]. This might be related to the building blocks formulation of feed supplement as a source of tannins, saponin, coconut cake, minerals, urea and molasses that can help increase the production of microbial protein in the rumen so that the use of more efficient fiber and nutrient supply to the host's intestinal utilized to increase, especially in the fermentation process and digestion of nutrients.

A low level (0.5mL/kg of TMR DM) of enzyme did not improve milk production efficiency, its effect depended upon the dosage. Exogenous feed enzymes that contain fibrolytic activities may help enhance fiber digestion in the rumen, which could lead to improved feed conversion efficiency [23]. Efficiency of milk production increased 2 to 4 percent with recommended level of 11 grams to 22 grams monensin per ton of total ration dry matter (TMR) on a dry matter basis [15].

B. *Milk Quality*

Feed supplement was no effect on milk quality, but supplementation lead to increase the components in milk such as fat, protein, SNF, total solids, density and lactose. The best results were produced from cow's milk with feed supplement A compare with control and feed supplement B. High value of MPE at supplementation might effect on milk quality because of efficiency nutrient absorbtion from dry matter intake. Protein and energy containing in feed supplement effect to changing milk composition indirectly (Table II). This means that good nutritional status of the dairy cattle with both feed supplement A and B might effect on milk yield and more for milk quality.

Others author reported the yield of milk fat and milk protein was significantly higher for treatments of cotton seed cakes supplement compared with other treatments without concentrate supplement and cows fed on clover and Sorghum stover [24]-[26]. Genotype had a significant effect on all milk production parameters, high merit cows had the highest yield of milk, fat, protein, and lactose, whereas the low merit cows had the lowest milk fat, protein, and lactose concentrations [27].

TABLE II. EFFECT OF COMBINATION OF FEED SUPPLEMENT ON MILK YIELD AND MILK QUALITY OF DAIRY CATTLE

Item[1]	Treatmeant[2]		
	R0	RA	RB
Milk yield (kg/d)	13.76 [a]	16.64 [a]	14.87 [a]
4% FCM (kg/d)	13.86 [a]	16.15 [a]	14.90 [a]
DMI (kg/d)	14.50 [a]	14.81 [a]	14.53 [a]
MPE1	0.95 [a]	1.13 [b]	1.02 [ab]
MPE2	0.96 [a]	1.09 [a]	1.03 [a]
Milk component (%)			
Fat	3.87[a]	4.01 [a]	3.94 [a]
Protein	3.02 [a]	3.18 [a]	3.07 [a]
Density	28.38 [a]	29.73 [a]	28.85 [a]
Lactose	4.79 [a]	5.01 [a]	4.86 [a]
Solids non fat	8.76 [a]	9.14 [a]	8.89 [a]
Solids	0.70 [a]	0.74 [a]	0.71 [a]
Milk component yield (kg/d)			
Fat	0.536 [a]	0.648 [a]	0.587 [a]
Protein	0.419 [a]	0.441 [a]	0.426 [a]
Density	3.933 [a]	4.121 [a]	3.999 [a]
Lactose	0.664 [a]	0.694 [a]	0.674 [a]
Solids non fat	1.214 [a]	1.267 [a]	1.232 [a]
Solids	0.097 [a]	0.103 [a]	0.098 [a]

[1]DMI = Dry Matter Intake; MPE 1 = Milk Production Efficiency 1 (Milk yield (kg/d)/DMI (kg/d)); MPE 2 = Milk Production Efficiency 2 (4% FCM (kg/d)/DMI (kg/d)), [2]R0 = TMR; RA = TMR + supplement A; RB = TMR + supplement B. Different superscript in the same column and row indicate significant difference (P<0.05).

IV. CONCLUSION

The results showed that supplementation of combine feed supplement was significantly affect to increase milk yield because of high nutrient containing in dry matter intake. However, there was a tendency increasing milk yield depending on ingredients formulated in the feed supplement. In addition, milk production efficiency affected to milk quality because of efficiency nutrient absorb was described by dry matter intake. More long time periods and sum of animal were completely will explain the effect of combination of feed supplement on milk yield and quality of dairy cattle.

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REFERENCES

[1] S. Susanti and E. Marhaeniyanto, "Correlation between Nitrogen digestibility and retention with milk production in crossbreed friessian holstein with pollard and rice brand," *Jurnal Protein*, vol. 15, no. 2, pp. 130-135, 2007.

[2] H. T. Uhi, "Catalytic supplement based on gelatinized sago, NPN, and micro minerals for ruminant in marginal areas," Doctoral program dissertation, Post Graduate Scholl Bogor Agricultural Institute, Bogor, 2005.

[3] Soebarinoto, "Evaluation of some forage legume trees as a source of protein for animal," Dissertation, Post Graduate Faculty, Bogor Agricultural Institute, Bogor, 1986

[4] M. Syarwani, "Single cell protein production from *Aspergillus oryzae* enriched with minerals Ca and P," *Jurnal Teknologi Separasi*, vol. 1, 2008.

[5] F. L. Yang, X. S. Li, and B. X. He, "Effects of vitamins and trace-elements supplementation on milk production in dairy cows: A review," *African Journal of Biotechnology*, vol. 10, no. 14, pp. 2574-2578, 2011.

[6] E. E. Connor, J. L. Hutchison, K. M. Olson, and H. D. Norman, "Triennial lactation symposium: Opportunities for improving milk production efficiency in dairy cattle," *J. Anim. Sci.*, vol. 90, pp. 1687-1694, 2012.

[7] Y. Retnani, I. G. Permana, and L. C. Purba, "Physical characteristic and palatability of biscuit bio supplement for dairy goat," *Pak. J. Biol. Sci.*, vol. 17, pp. 725-729, 2013.

[8] I. Blackwood and E. Clayton, "Supplementary feeding of cattle. Primefact 341," NSW Department of Primary Industries, 2007.

[9] NRC, *Nutrient Requirements of Dairy Cattle*, 7th ed., Washington, D.C.: National Academy Press, 2001.

[10] *SAS 9.1.3 Procedures Guide*, 2nd ed., vol. 1, 2, 3, and 4, SAS INSTITUTE Inc., Cary, NC, 2006

[11] G. H. Schmidt and L. D. V. Vleck, *Principles of Dairy Science*, San Francisco: W. H. Freeman Co., 1974, pp. 558.

[12] R. A. Law, F. J. Young, D. C. Patterson, D. J. Kilpatrick, A. R. G. Wylie, and C. S. Mayne, "Effects of dietary protein content on animal production and blood metabolies of dairy cows during lactation, "*J. Dairy Sci.*, vol. 92, pp. 1001-1012, 2009.

[13] R. Kellaway and S. Porta, "Feeding concentrates supplements for dairy cows," Dairy Research and Development Corporation, Melbourne, Australia, 1993.

[14] AOAC, *Official Methods of Analyses*, 12th ed., Washington, DC, 1998.

[15] M. F. Hutjens, "Dairy efficiency and dry matter intake," in *Proc. 7th Western Dairy Management Conference*, Reno, NV, 2005, pp. 71-76.

[16] P. J. Van Soest and R. H. Wine, "Use of detergent in the analysis of fibrous feed, IV. Determination of plant cell-wall constituents," *Journal of the Association of Official Agriculture Chemists*, vol. 50, pp. 50-55, 1967.

[17] G. E. Lewis, W. K. Sanchez, C. W. Hunt, M. A. Guy, G. T. Pritchard, B. I. Swanson, and R. J. Treacher, "Effect of direct-fed fibrolytic enzymes on the lactational performance of dairy cows," *J. Dairy Sci.*, vol. 82, pp. 611-617, 1999.

[18] I. R. Dohoo, K. Leslie, L. DesCôteaux, A. Fredeen, P. Dowling, A. Preston, and W. Shewfelt, "A meta-analysis review of the effects of recombinant bovine somatotropin. 1. Methodology and effects on production," *Can. J. Vet. Res.*, vol. 67, pp. 241-251. 2003.

[19] E. H. Wall and T. B. McFadden, "Use it or lose it: Enhancing milk production efficiency by frequent milking of dairy cows," *J. Anim. Sci.*, vol. 86, pp. 27-36, 2008.

[20] G. E. Dahl, B. A. Buchanan, and H. A. Tucker, "Photoperiodic effects on dairy cattle: A review," *J. Dairy Sci.*, vol. 83, pp. 885-893, 2000.

[21] S. Rigout, S. Lemosquet, A. Bach, J. W. Blum, and H. Rulquin, "Duodenal infusion of glucose decreases milk fat production in grass silage-fed dairy cows," *J. Dairy Sci.*, vol. 85, pp. 2541-2550, 2002.

[22] M. R Ventura and J. I. R Castañón, "The nutritive value of seaweed (*Ulva lactuca*) for goats," *Small Ruminant Research*, vol. 29, no. 3, pp. 325-327, 1998.

[23] L. Holtshausen, Y. H. Chung, H. Gerardo-Cuervo, M. Oba, and K. A. Beauchemin, "Improved milk production efficiency in early lactation dairy cattle with dietary addition of a developmental fibrolytic enzyme additive," *J. Dairy Sci.*, vol. 94, no. 2, pp. 899-907, 2011.

[24] S. J. Morrison and D. C. Pattersonhe, "Effects of offering a range of forage and concentrate supplements on milk production and dry matter intake of grazing dairy cows,"*J. Grass and Forage Science*, vol. 62, no. 3, pp. 332-345, 2007.

[25] G. A. Broderick and E. Sterrenburg. (1996). Effect of replacing alfalfa silage with red clover silage in the diets of lactating dairy cows. Research Summaries. [Online]. pp. 113-115. Available: http://www.dfrc.wisc.edu/Research_Summaries/RS96_pdfs/RS96-49.pdf

[26] M. Anila and S. Q. Muhammad. (2009). Variation in milk composition and its relationship with physiological states and management in crossbred cattle under tropical conditions. [Online]. Available: http://en. engormix. com/

[27] J. Kennedy, P. Dillon, L. Delaby, P. Faverdin, G. Stakelum, and M. Rath, "Effect of genetic merit and concentrate supplementation on grass intake and milk production with Holstein Friesian dairy cows," *Journal of Dairy Sci.*, vol. 86, no. 2, pp. 610-621, 2003.

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