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Optimization of the use Total Mixed Ratio (TMR) in Lactation Dairy Cattle

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Abstract:
Objective: This study aims to analyze the effect of the use of concentrate in TMR feed on milk production, milk quality and the economic value in lactating dairy cows.
Methods: Experimental research method and Completely Randomized Design included 3 treatment feeds using concentrate in TMR feed, T1=20% concentrate; T2=30% concentrate; T3 = 40% concentrate of TMR feed DM requirement which was repeated 3 times. In each treatment, fresh forage was given ad libitum. The variables observed were dry matter intake (DMI); organic matter intake (OMI); milk production and quality; and economic value. The data obtained were analyzed for variance and LSD test to determine differences between treatments.
Result: The increasing use of concentrate in TMR feed significantly increased milk production from 9.49 to 15.07 (liter/head/day). Density of milk significantly increased from 1.02822 to 1.02973 g/ml; non significant in DMI and OMI but tended to increase in DMI (kg/head/day) from 11553 to 12760 and OMI from 8.887 to 10,833 (kg/head/day), significant in Economic Value decreased from 22538 to 21412.67. (IDR/kg DM); significant in lactose and TSNF levels of milk increased from 3.81% to 4.19% and the TSNF value of fresh milk was 7.72% to 8.13%; significantly reduced milk fat content from 3.92% to 2.97%.
Conclusion: The greater the use of concentrate in TMR feed for FH dairy cows can increase production and quality of milk such as milk density, Lactose, and SNF but reduce milk fat and the economic value of feed (feed cost for the production of 1 kg DM).

Keywords: Concentrate; Economical feed; FH dairy cattle; Milk quality

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1. INTRODUCTION

Total Mixed Ratio (TMR) feed is different in formulation with complete feed which refers to the standard % crude protein (CP) 12-14%, Total digestible nutrient (TDN) 65% and crude fiber (CF) > 18%. The ratio of concentrate and fresh forage in TMR feed was arranged based on the mass requirement of nutrients, either dry matter, digestible protein (DP) or TDN energy in the form of dry matter (DM). Practically there are guidelines for feeding dairy cows which are almost the same as TMR feed which emphasizes the amount of fresh forage feeding 10% of body weight (BW) and the amount of concentrate 1-2% BW.
The right ratio in the use of concentrates and fresh forage in TMR feed from DM requirements for lactating dairy cows can increase milk production and fresh milk quality, especially the density and fat of fresh milk. The need for DM feed for ruminants is 2-3% BW per head/day, while for lactating dairy cows the need for DM is formulated as fresh milk production (liters) divided by 1.2 [1]. Furthermore, the provision of forage has more effect on the

fat content of milk. The availability of forage as feed slightly causes a decrease in milk fat content due to the low crude fiber content. Concentrated feed plays an important role in the diet of dairy cows to meet the high energy and nutrient requirements for milk production [2]. While concentrate feed has a function to meet the needs of protein, carbohydrates, fats and minerals that can not be met forage feed [3]. The fiber content in the concentrate is less than 18% and the TDN content is more than 65%. Dairy cattle breeding in Indonesia is still inferior to beef cattle fattening. One of the obstacles faced by farmers is the limited source of forage feed. This has an impact on the amount of milk produced and affects the welfare of smallholder farmers [4].

TMR feed is ruminant feed made by mixing forage and concentrate at a ratio of 60:40. With this ratio and the calculation of the right formulation can meet the needs of nutrients and crude protein or TDN energy. The standard requirement for dry matter is 3% body weight. Thus, it is estimated that the use of concentrate in TMR feed for dairy cows is 1-2% BW while the amount of forage is 10% BW. Corn straw is a type of agricultural by-product that can be reused to meet ruminant feed needs. Indonesia has a large supply of corn straw throughout the year. Corn straw production in Indonesia can reach 11 million tons/year, but its utilization as ruminant feed is not optimal..

So it is necessary to do research on the percentage of concentrate use in TMR feed which can have the best impact on the production and quality of fresh milk from lactating dairy cows. This study aims to analyze the effect of using corn straw-based TMR feed on the production and quality of fresh milk as well as the economic value of the feed.

2. MATERIALS AND METHOD

This research was carried out in independent dairy farms in Dadapan Village, Pagak District, Malang Regency, using the experimental method and Completely Randomized Design (CRD) covering 3 treatment i.e 20, 30, and 40% concentrate in TMR feed, respectively. The treatment was repeated in three groups of dairy lactation cattle so that the total number of Fries Holland (FH) dairy cows was 12. The cage used is an individual system for each dairy cow that is tied heard to heard. Facilitated feed and drinking places and scales for weighing feed as well as milking machines and lactoscans.

The treatment feed was the use of factory concentrate in TMR feed according to the treatment and ad libitum provision of forage for tebon corn. With the composition of the feed as follows T1 = 20% concentrate in TMR; T2 = 30% concentrate in TMR; and T3 = Use of 40% concentrate in TMR. Furthermore, the nutritional content (DM and OM) of concentrate and fresh corn flour were tested periodically at the Central Laboratory of the Islamic University of Malang. Dairy cows are placed in the cage by drawing randomly.

Research Variable

The variables observed were milk production and milk quality as well as the economic value of feed using concentrate ratio in TMR feed using the following parameters:

• Feed Consumption (DMI, OMI) Kg per head/day

The amount of feed given both concentrate and fresh corn forage was reduced by the amount of leftover feed and scattered (gr/head) of both feed ingredients during the 30-day study.

• Fresh milk production (liters/head/day)

The number of liters of fresh milk from the morning and evening milking per head per day from the average milk production during the study.

• Economic Value of Feed

The economic value of feed is the cost of feed needed to produce 1 kg of DM milk (DM/100 x production of fresh milk), which is formulated as the feed conversion value multiplied by the price per Kg of dry matter feed.

• Fresh milk quality analysis

Collecting fresh milk produced and taking samples for analysis of SG, fat and protein content of each sample.

Data Collection Procedure

The cages were cleaned and sanitized to avoid disturbances during the study. Lactation dairy cows were selected based on the relatively the same milk production criteria or 12 cows that did not have different lactation periods.

Concentrated feed was given according to treatment, while the provision of fresh tebon forage and drinking water was ad libitum. The results of the CBC calculations for each treatment are listed in Table 1.

$$\sum \text{Concentrate Use (Kg)} = \%\ \text{Concentrate Use x DMI X} \frac{100}{\text{DM}} \text{Concentrate}$$

Data on feed consumption and fresh milk production from each treatment were recorded for 50 days of the study and tabulated according to the data needed in the study. Then calculated the content of DM and OM in the feed to calculate the level of feed consumption (DMI, OMI), fresh milk production, fresh milk quality, and the economic value of feed.

Data Analysis

The data obtained were analyzed using the ANOVA test (Analysis of Variance), if there are results that have a very real or significant effect, followed by the LSD test (Least Significant Difference) to find out the differences between treatments as well as to choose the optimum treatment.

3. RESULT AND DISCUSSION

Result

The results of the analysis of variance (ANOVA) showed that the use of concentrate in TMR feed at a dose of 20% - 40% of DM requirements had a significant effect (P<0.05) on fresh milk production, feed conversion, fresh milk quality (Specific Gravity (SG), % Lactose, % Fat, % SNF, Protein) and income, but had no significant effect (P>0.05) on feed consumption (DMI, OMI) and the economic value of feed. The average fresh milk production, feed conversion, fresh milk quality (specific gravity, % lactose, % fat, % SNF) and the economic value of feed (IDR) and feed consumption (DMI, OMI) are presented in Table 2.

The results of the analysis (Table 2) showed that the use of concentrate in feed resulted in significantly different production, both at 20%, 30%, and 40% concentrates (9.49 liters, 12.11 liters, and 15.07 liters). This was also followed by the specific gravity of the milk produced (1.0282 g/ml, 1.0289 g/ml, and 1.0297 g/ml), the percentage of lactose (3.81%, 3.92%, and 4, respectively). 19%), fat percentage (3.92%, 3.07%, and 2.97%), and TSNF (7.72%, 7.93%, and 8.14%).

4. DISCUSSION

The results showed that the dose of concentrate used in TMR feed had no significant effect (P>0.05) on the consumption of DMI and OMI in lactating FH dairy cows. It is shown that F Count is smaller than F Table which is 5%. However, the average DMI and OMI for each treatment tended to increase, this was because the nutritional needs of the feed depended on the production of fresh milk. The use of concentrate in TMR feed produces higher amounts of fresh milk as well [5].

In table 2 above, the highest DMI number is in the use of 40% concentrate in feed compared to other treatments. This is due to the concentrate in T3 as much as 40% of the need for DM feed, which is much higher than in T1 and T2 and ad libitum corn forage so that the T3 treatment consumes more concentrate. Based on [6] the dry matter requirement for feed for lactating cows is 12.4 kg/head/day to produce 10 kg of milk. Providing high quality forage for lactating cows is very important [7]. It has been shown that feed efficiency is directly related to forage digestibility, whereas increasing feed digestibility results in an increase in feed efficiency. In addition to forage, livestock are given concentrate. Concentrates are almost always easier to digest than forages [8].

The ability to consume dry matter (DMI) is a barrier for livestock in an effort to meet the nutritional needs of feed needed for basic life, growth/milk production and reproduction. He further explained that the consumption of dry matter plays an important role in obtaining energy, protein, vitamins and minerals. One thing that needs to be considered in feeding lactating FH dairy cows is the consumption of dry matter for various levels of body weight as a guide in determining the amount of feed that must be provided [9].

The results showed that increasing the percentage of concentrate used in TMR feed could significantly increase milk production TMR feeding can maintain pH balance in the rumen and help increase fermentation yields because it produces rumen bacteria with the same mixture of ingredients and nutrients in the rumen [10]. This leads to increased milk production, health, and reproductive performance [11]. On the average of milk

production in all treatments using concentrate and forage of Tebon corn in TMR feed, there were differences in T1, T2, and T3. The high production of fresh milk for FH cows is due to the use of concentrate in TMR feed, so that the supply of energy and amino acids for milk synthesis is higher. On the other hand, the low production of fresh milk for FH cows is due to the unfulfilled supply of energy needed for fresh milk production. The factor that affects the increase in production is feeding, because feed plays an important role for lactating cows to increase the metabolism of udder gland cells to synthesize milk. This is in accordance with the opinion of [12] that the provision of corn silage can increase milk production.

The results showed that the greater the use of concentrate in TMR feed, the higher the fat content of fresh milk. This is due to the increased use of concentrate in the TMR feed, which reduces the consumption of DM feed and forage for maize meal and maize meal silage. Thus, the amount of consumption of crude fiber forage from Tebon corn also decreases so that the microbial fermentation process of crude fiber in the rumen and reticulum of cows produces less than optimal acetic acid and beta butyric acid, besides that acetic acid functions as a basic ingredient (precursor) for the formation of milk fat.

In the use of 40% concentrate, the milk fat content decreased by 0.95%, this was due to the concentration being used more than the need for DM feed so that the consumption of forage was less. Furthermore, according to [13] that cellulolytic bacteria in the rumen will ferment crude fiber in the feed into Volatile Fatty Acid (VFA) with a high acetic acid composition. The main content of fat is acetic and butyric acid, the higher the crude fiber content of the feed, the higher the acetic and butyric acid levels of rumen-decomposing microbes [14]. VFA is a precursor of the milk fat component. Low levels of milk fat will reduce nutritional value, so the benefits provided by milk are reduced. The results of the average value of milk fat content in this study are lower than those of [15] with the average fat content of fresh milk of 3.95%.

In addition to the consumption of dietary fiber which is an indicator of the size of the milk fat content, there are several other factors that affect the percentage of milk fat content, namely the health of livestock and the milking interval because the longer the milking time is carried out, the fat content in milk will be more consistent. This is in accordance with the opinion of [16] that the factors that affect the fat content in milk are genetic factors, feed, maintenance methods, climate, lactation period, and animal health. Furthermore, the increasing use of concentrate in TMR feed significantly increased the levels of SNF in fresh milk. This is due to the higher concentration of feed, which means that the consumption of non-fiber organic matter in the feed is more so that there is more material for the synthesis of fresh milk SNF. Indonesian National Standard (2011) [17] explained that the minimum Solid Non Fat content was 7.8% - 8%. At T3 the value of Total Solid Non-Fat was at the highest, this was due to the provision of concentrate at T3 of 40% of the need for DM feed, much more than the provision of concentrate in T1 and T2. The average results of this study were 7.93%, much higher than the research of [18] with the results of an average total SNF level of 1.27%, while [19] explained that an increase in SNF along with an increase in the metabolic energy supplied by the supplement and also the provision of additional energy will often increase the SNF of milk. The better the quality of feed with the use of more concentrate, the protein needs of feed are more fulfilled so that the quality of milk increases.

The total value of solid milk depends on the amount of feed nutrients consumed by dairy cows as ingredients for milk components. One part of the VFA is propionic acid which is one of the basic ingredients for forming lactose in milk [20]. VFA is also used as an energy source and carbon skeleton for protein formation, where the components that make up milk SNF include protein and lactose. Changes in Non-Fat Dry Matter (NFDM) or Solid Non-Fat (SNF) were largely influenced by changes in the protein content in milk [21].

The results showed that the use of concentrate in TMR feed had a very significant effect ($P<0.01$) on the specific gravity of fresh milk. It is shown F Count is greater than F Table which is 5%. The value of the specific gravity of fresh milk in each treatment at T1 = 1.0282 g/ml, P2 = 1.0286 g/ml, and T3 = 1.02973 g/ml. This has complied with [17] that the specific gravity value in fresh cow's milk is at least 1.0280 g/ml. The use of different ratios of concentrates and forage to corn meal in TMR feed, the amount of nutrient consumption is different so that it affects the specific gravity of milk. This is in accordance with the opinion of [22] that the specific gravity of milk is strongly influenced by the nutrient content in the feed. In addition, the more use of concentrate in feed the

more palatable so that feed consumption [23] also increases which is used to produce milk solids or dry matter as well as the SG value of fresh milk.

Furthermore, the results showed that the use of concentrate in the Total Mixed Ratio (TMR) feed had an effect on increasing the lactose content of FH's fresh milk. This is due to the use of concentrate in feed will reduce forage consumption as a result the consumption of DM concentrate is greater, especially NFE which is a component of milk lactose. The results of the LSD test, treatment T2 = 3.94^{a}% and treatment T3 = 4.19^{b}% were not different but at T3 = 4.19^{b}% were significantly different from treatment T1 = 3.81^{a}%. In the T3 treatment, there was an increase of 0.38%. The level of lactose in milk can be used as the main indication in determining the quality of fresh milk. The requirements for the quality of fresh milk [17] include a lactose content of 3.7% - 4%. The lactose content of milk is directly proportional to the production of milk produced, in other words, the lactose content of milk is higher when the milk production increases.

The economic value of feed is the same as the feed conversion value, where a higher value indicates a less efficient or more expensive feed cost to produce 1 kg of DM milk. The results showed that increasing the percentage of concentrate used in TMR feed could significantly reduce the economic value of feed, so that feed costs were cheaper.

The decrease in the economic value of feed is accompanied by a decrease in the value of feed conversion because feed consumption is relatively the same but milk production can increase significantly. Even though the price per kg of DM feed is more expensive with the use of 40% concentrate, the economic value of the feed has decreased by Rp. 1.162. This is due to the use of higher concentrates, the higher the milk production will be. The high concentrate can temporarily increase milk production [24].

5. CONCLUSIONS

The more percentage of concentrate used in TMR feed can significantly increase the production and quality of fresh milk including SG, lactose, total SNF, feed consumption (DMI and OMI) tends to increase and reduces the economic value of feed. The use of the best percentage is the addition of 40% concentrate in TMR feed

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Table 1. Concentrated Needs

DMI=10 kg /1,2 = 8,33 Kg	Concentrated Needs	
	Concentrate DM	Concentrate as fed
T1 (K20%DMI)	1.67 kg	2.03 kg
T2 (K30%DMI)	2.49 kg	3.05 kg
T3 (K40%DMI)	3.33 kg	4.06 kg

Table 2. Average milk production, feed conversion, fresh milk quality, economic value , DM and OM consumption.

Treatment	**T1**	**T2**	**T3**
Milk production (liter)	9.49[a]	12.11[ab],	15,07[b].
Feed convertion	9.85[a]	9.44[a]	8.69[b].
Specific gravity (g/ml)	1.028[a]	1.029[ab]	1.029[b]
% Lactose	3.81[a]	3,92[a]	4.19[b]
% Fat	3.92[b]	3,07[a]	2.97[a]
% TSNF	7,72[a]	7,93[a]	8.14[b]
Feed Economy (IDR)	22538[a]	22430[a]	21412[b].
DMI (kg/cow/day)	11.553	12.627	12.760
OMI (kg/ cow/day)	9.850	9.350	8.400

T1=20% concentrate; T2=30% concentrate; T3=40% concentrate. Different letters in the same column indicate significant differences (P<0.05)

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