Dietary Protected Feed Supplement to Increase Milk Production and Quality of Dairy Cows

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Abstract. The efforts to improve and optimize productivity of dairy cows require sufficient availability of nutrients, especially high energy in the early period of lactation. Increasing energy intake in dairy cows can be conducted by increasing the density of energy. The research aimed to evaluate dietary protected feed supplement on milk production and quality, including: fat, protein, and lactose content of Friesian Holstein dairy cow milk. Protected feed supplement was produced from sardine fish oil, through saponification and microencapsulation protection methods. The experiment consists of two treatments i.e. P0: basal diet (control) and P1: basal diet + 3 % protected feed supplement. Each treatment was repeated 15 times. Data were analyzed by independent samples t-test analysis. Results showed that supplementation of protected sardine fish oil had no effect on lactose content, but increased milk yield production (p<0.01), milk fat content (p<0.05), and protein content (p<0.05).

1. Introduction
Milk production and composition of dairy cattle is influenced by the nutrients consumed. Nutrients are chemical substances in feedstuffs that can be mobilized and utilized for basal maintenance, production, and reproduction [1]. Nutritional factors are an important aspect in the lactation management of dairy cows. The efforts to improve and optimize the production performance of dairy cows require sufficient availability of nutrients, especially high energy in the early period of lactation. Increasing the energy intake for dairy cows can be conducted by increasing the energy density of feed by using fat (oil). One of potential energy source that is widely available and cheap is sardine fish oil [2]. Sardine fish oil contains high unsaturated fatty acids. Unsaturated fatty acid supplementation is proven to be able to increase energy efficiency through increasing energy density and sustain the efficiency improvement of milk protein synthesis through increasing the flow of nitrogen (N) non-ammonia into the duodenum [3].

Protected fat supplementation in dairy cows is expected to be able to fulfill the energy needs, especially in early lactation in order to gain optimum milk production, healthy, and especially dairy cattle conditions related to ideal Body Condition Score [4]. Protection treatment is needed to gain the real benefit from the presence of energy source supplementation or protein in feed. In the unsaturated fatty acid supplementation, protection is required to prevent unsaturated fatty acids from ruminal microbes biohydrogenation. Protection is also useful to eliminate the negative effects of high concentration of unsaturated fatty acid supplementation, and reduction in fibre degradability. Therefore
the aim of current study was to evaluate the protected feed supplementation on milk production and quality, including: fat, protein, and lactose content of Friesian Holstein dairy cows.

2. Materials and Methods

2.1 Sample preparation

Thirty of Friesian Holstein cows in the Dairy Cattle Breeding Centre, Ministry of Agriculture Baturaden, Indonesia were employed in this study with an average lactation period of 75 days and an average body weight of 575 kg. They were weighed initially to determine their daily feed requirement. Body condition score (BCS) of dairy cows used in this study was 3 ± 0.2 (scale 1 – 5). This study used 30 individual (2.5x1.5) m² cages, the feed facility consisted of a concentrate feed, forage and drinkers. The feed treatment was conducted for 1 month. Protected feed supplement was produced from sardine fish oil, through saponification and microencapsulation protection methods. The experiment consists of two treatments i.e.: basal diet (P0; control diet) and basal diet + 3 % protected feed supplement oil (P1). Each treatment was repeated 15 times. All animals were given feed according to their individual requirement, based on dry matter intake [5].

Dry Matter Intake (DMI)= \( (0.372 \times \text{FCM} + 0.0968 \times \text{BW}^{0.75}) \times (1 - e^{-0.192 \times (\text{WOL} + 367)}) \)  

Where,

- FCM: fat corrected milk
- BW: body weight
- WOL: week of lactation

2.2. Measurement of fat, protein and lactose

Fat, protein, and lactose content were analyzed in the laboratory using milk analyzer Lacto Scan MCC50.

2.3 Data analysis

Data obtained in current study were analyzed by independent Student's t-test using SPSS 22.

| Table 1. Feedstuffs composition and nutrient content of treatment diets |
|-----------------|------|------|
| Item            | P0   | P1   |
| Feedstuff composition, % |     |      |
| Elephant grass  | 50   | 50   |
| Concentrate 1   | 40   | 37   |
| Concentrate 2   | 10   | 10   |
| Protected sardine fish oil | -   | 3    |
| Total amount    | 100  | 100  |
| Analyzed nutrients content, % |     |      |
| Crude Protein   | 14.29| 14.24|
| Extract Ether   | 4.57 | 4.69 |
| Crude Fibre     | 23.45| 22.99|
| Ash             | 13.06| 13.30|
| Total Digestible Nutrient | 61.60| 62.44|
3. Result and Discussion
Milk production and quality of dairy cows milk are shown in table 2.

| Variables                  | P0      | P1      |
|----------------------------|---------|---------|
| Milk productions (liters)   | 17.29\(^a\) | 20.18\(^c\) |
| Milk fat (%)                | 3.41\(^b\) | 3.66\(^a\) |
| Milk protein (%)            | 2.76\(^b\) | 2.81\(^a\) |
| Milk lactose (%)\(^m\)      | 3.96    | 4.04    |

P0 = basal diet without supplementation, P1 = basal diet with protected feed supplement; 
\(^a\)Different superscript in the same row indicates significant difference \((p<0.05)\); \(^m\)Non-significant different. 
\(^b\)Different superscript in the same row indicates highly significant difference \((p<0.01)\)

Result showed that dietary supplementation of protected feed supplement increased milk yield \((p<0.01)\). The enhancement in milk production in this study might be attributed to the presence of protected sardine fish oil supplementation, which improves the energy density of the diets, which in turn improve milk production. [6] stated that fat (oil) can be used to fulfill energy requirements in early lactation period in dairy cows. In addition, [7] observed that milk production of dairy cows can be pursued with increased energy density. Results of this study were in line with previous findings of [7] (2005) and [8] that stated supplementation of protected fat in the diet increased milk production of dairy cows. However, result of this study differs from previous studies [9]; [10] that reported non-significant milk production improvement following dietary supplementation of protected fat.

Supplementation of protected feed supplement increased milk fat content \((p<0.05)\). This might showed that protected fatty acids in the diet can be transferred directly into milk fat formation. [11] stated that total milk fat production was depend on the balance transfers of long-chain fatty acid ration to milk fat and milk fat synthesis in the mammary gland. This result was consistent with finding of [7] which reported that protected fat supplementation increased fat content of milk. Different result was reported by [12] which indicated reduction in milk fat content following fish oil and canola oil supplementation.

Protein content of the milk in supplemented cattle (P1) was higher than P0 \((p< 0.05)\). This might be caused by the increased of energy availability due to the supplementation of protected fat that stimulate milk protein synthesis. Protected fat is an alternative for energy source that has a role in the synthesis of milk protein. The high milk protein in P1 probably is due to the coating material used in the microencapsulation process used to protect fat, calculating 50% soybean meal of the total amount of raw materials used or 1 : 1 sardine fish oil used. The result was in line with the report of [13] that noted combination of fat supplementation and high quality protein stimulated milk production and protein.

There was no different found in lactose content of milk from both groups. It might be because protected fat added in the diets as energy source is used more for milk production, milk fat synthesis, and milk protein, rather than for lactose improvement. [14] stated that, glycerol is a substrate for the glucose synthesis in gluconeogenesis in lactating cattle that was generally used for energy rather than be used as a precursor of milk lactose. There fore, dietary fat addition did not give significant effect on lactose content of milk.

4. Conclusion
Results showed that supplementation of protected sardine fish oil had no effect on lactose content, but increased milk yield production, milk fat content, and protein content. Supplementation of protected sardine fish oil in dairy cows was able to increase milk production and quality of dairy cows.
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