Inclusions of Rumen Protected Protein-Fat Supplements in the Ration of Lactating Dairy Cow: Effects on Feed Intake and Digestibility, Milk Production and Composition, and Milk Fatty Acid Profile

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This research was conducted to study the effects of rumen by pass protein-fat supplement on the performance and milk quality of dairy cow. Previous study indicated that protein capsulation effectively protects feed's Polyunsaturated Fatty Acids (PUFA) from biohydrolysis and biohydrogenation in the rumen. A latin square research design 3 × 3 × 2 was adopted (3 cows, 3 treatments, and 2 replications). The treatments were inclusion of protected protein-fat supplement (T1), inclusion of unprotected protein-fat supplement (T2), and control (C). Effects of treatments on the cow's performance were observed based on variables of nutrients intake, nutrients digestibility, and milk production. Effects on milk quality were determined by compositions of milk constituents and milk Fatty Acids (FA). Results showed that treatments have no significant effect on Dry Matter (DM) and nutrients intake, except for Extract Ether (EE) intake which was significantly different ($p<0.05$) between treatments respectively 0.460; 0.495; 0.372 kg/cow/day for T1, T2, and C. The treatments also had no significant effects on DM and nutrients digestibility. There were no significant effects of treatments observed in the variables of milk production and quality. Milk FA profiles showed protected protein-fat supplements tend to decrease the proportion of medium chain FA (C10:0-C14:0) (13.58% vs 14.75% for T1 and C) and increase the proportion of Oleic Acid (C18:1) (29.39% vs 26.21% for T1 and C). Although the effects on FA profiles were not significant, the study had indicated that inclusion of protected protein-fat supplement has positive effect to increase the value of milk FA.

Key Words: Protected protein-fat, Lactating dairy cows, Milk quality

INTRODUCTION

The modification of milk composition has been an interesting topic for animal nutritionist for more than recent 25 years. Many factors contribute on milk composition, for instance are genetic, parity, level of milk production, and nutrition. Nutrition is a predominant factor to modify milk composition, mainly for milk fat and milk FA composition. Milk FA content could be modulated until 3% whereas milk protein content only around 0.5% (Jenkins and McGuire, 2006)

Study by Solomon et al. (2000) showed an effect of feed FA composition on milk FA composition. However, feeding ration rich in PUFA content was ineffective to increase milk PUFA content due to bioydrogenation and hydrolysis of PUFA in the rumen by microbe

(Bauman and Lock, 2006). In addition, high content of fat in the diet (5-7%) has negative effect to rumen microbe and decrease the capability to digest Crude Fiber (CF) (Doreau and Chilliard, 1996; Harvatine and Allens, 2006). Fat supplementation would increase energy density of diet but decrease CF digestibilty and milk FA content. Those effects were varied by the amount of fat supplementation and the type of fat source (Palmquist and Jenkins, 1980).

The objective of this research was to study the effect of inclusion of rumen protected protein-fat supplement in the ration on the performance and milk FA quality of lactating dairy cow.

MATERIALS AND METHODS

Six lactating cross bred Frisian Holstein (milk yield 12.8 ± 1.4 l/ /d) were used in (3x3x2) Latin Square design. The treatments were: T1: inclusion of rumen protected protein-fat supplement, T2: inclusion unprotected protein-fat supplement, and control (C): no inclusion. Treatments were administered for 19 days in each period whereas the last 5 days of period was for data collection. Cows were fed a commercial concentrate ration and roughage. Concentrate was given twice a day before milking (at 6 am and 2 pm) in constant amount during the trial. Roughage consisted of maize stalk and king grass which were offered ad libitum after milking.

Protein-fat supplements were included as 10% amount of concentrate ration. Rumen protected protein-fat supplement was formulated from Crude Palm Oil (CPO) and expired skim milk. The skim milk was protected from rumen digestion by addition of 1.5% formaldehid.

Total collection of faeces was done in last 5 days of each period. After mixed and weighed, 300 g of faeces sample of each cow and period was composited and storaged in a freezer for proximate composition and fibre analysis. Feed consumption was noted every day. Feed sample (300 g) was composited for proximate composition and fibre analysis. Milk production was monitored every day. Morning and evening milk samples (200 ml) was collected, composited, and analyzed for milk component and milk FA composition.

Parameters were: nutrients intake and digestibility of dry matter (DM), Organic Matter (OM), Extract Ether (EE), Crude Protein (CP), and Crude Fiber (CF), and milk production. Effects of treatments on milk quality such as: milk constituent (fat, protein, and total solid non fat) and milk FA profile. Proximate analysis for DM, OM, EE, CP, and CF was determined according to AOAC (1984). Milk fat was analysed based on Babcock method (Soedarmadji et al., 1984). Milk protein content was determined using Kjeldahl method (AOAC, 1984). Milk FA profile was analysed using Mass Spectrum Gas Chromatography (GC-MS) with Raste Rxi-5MS coloumn. Data was analysed by generalised linier model of variance using SPSS ver. 17 software.

RESULTS AND DISCUSSION

Nutrients Digestibility

Results showed that there was no effect on feed and nutrients intake, except for EE intake. The DMI was vary from 11.9 to 12.2 kg/d). This indicated inclusion of fat, either protected or unprotected, in ration has no effect on the palatability of ration. This findings were similar to several studies published to fish oil supplementation which had no negative effect on DM intake (Cortes *et al*. 2010; Liu *et al*., 2008; Chichlowski *et al*., 2005; Lin *et al*., 1996; Chilliard *et al*., 2009; Bailoni *et al*., 2004). Effect of oil inclusion on ruminant ration were inconsistent. Inclusion of oil or oil seed in ration depressed feed intake (Lee *et al*. 2011; Hristov *et al*. 2011 and Chilliard *et al*. 2009). Johnson *et al*. (2002) reported inclusion of oily seed in the ration could increase DM intake.

Table 1. The average of nutrients digestibility (%)

Treatments	DM[ns]	OM[ns]	CP[ns]	CFt[ns]	CFb[ns]	NFE[ns]	NDF[ns]	ADF[ns]
T1	75.5	77.0	75.2	87.9	73.0	79.2	76.2	71.6
T2	74.6	76.2	75.2	88.6	72.0	78.1	74.1	70.2
C	74.6	76.2	75.6	83.5	72.1	78.2	74.4	71.3

ns Non significant; DM: dry matter. OM: organic matter. CP: crude protein. CFt: crude fat. CFbI: crude fiber. NFE: nitrogen free extract. NDF: neutral detergent fiber. ADF: acid detergent fiber. T1: protected fatty-protein. T2: unprotected fatty-protein. C: control

There were no significant differences on feed and nutrients digestibility among treatments (Table 1). High content of fat in ruminant ration mainly effect on CF digestion. However, inclusion of fat supplements had no effect on CF digestibility. Supplementation of fat in the diet has no adverse effect on the rumen digestion due to some reasons i.e. the efficacy of rumen by pass method or low level of fat supplement inclusion. Effect of fat supplementation in this study were similar to the results of Cortes *et al*. (2010) and Kalscheur *et al*. (1997) who was reporting a non significant effect of fat inclusion on CF digestibility.

Milk Production. Milk Composition. and Milk FA Profile

There was no effect of protein fat inclusion on the milk production (Table 3). This was similar to studies of Hristov *et al*. (2011) and Liu *et al.* (2008) which were use oily seeds as sources of fat in ration.

Table 2. The average of milk production and milk constituents

Treatments	Milk Production (kg/cow/day)^{ns}	SG^{ns}	Total Solid (%)^{ns}	Protein (%)^{ns}	Fat (%)^{ns}
T1	11.5	1.0	11.6	2.9	3.2
T2	11.6	1.0	12.0	2.6	2.6
C	10.5	1.0	11.0	2.6	2.5

^{ns} Non significant

SG: Specific gravity . T1: protected fatty-protein. T2: unprotected fatty-protein. C: control

In contrast, researches by Zachut *et al*. (2010), Leonardi *et al*. (2005), Johnson *et al*. (2002) and Purushothaman *et al*. (2008) showed that fat supplementation in ration increased milk production. Treatments had no effect on milk constituents. Milk fat content of T1 was 30.2% higher than control. However. this was not statistically different. Different result showed in study of Zachut *et al*. (2010) concluded that level of C18:3n-3 FA in the diet has a negative correlation with the yield and content of milk FA.

Table 3. Milk fatty acid profile (%)

Fatty Acid	T1	T2	C
Capric (C10:0)^{ns}	1.0	0.7	1.0
Lauric (C12:0)^{ns}	2.6	2.4	2.9
Myristic (C14:0)^{ns}	10.0	9.9	10.8
Palmitic (C16:0)^{ns}	37.5	37.9	35.4
Oleic (C16:1)^{ns}	1.4	1.4	1.1
Stearic (C18:0)^{ns}	14.1	14.9	14.5
Asam oleat (C18:1)^{ns}	29.4	29.1	26.2
Total of C10-C14 FAs	13.6	13.0	14.7
Total of C16 FAs	38.9	39.4	36.5
Total of C18 FAs	43.5	43.9	40.7
Total of C16:1 and C18:1 FAs	30.8	30.5	27.3

^{ns} Non significant T1: protected fatty-protein. T2: unprotected fatty-protein. C: control

Proportion of Mono Unsaturated Fatty Acid (MUFA) increased by 11.21% on T1 and by 10.46% on T2. however these were not significantly different. It was predicted that around 52% of oleic acid in milk is synthesized from desaturation of stearic acid in mammary gland (Enjalbert *et al*. cited by Bailoni *et al*..2004). High proportions of palmitic and stearic acid in the milk FA of T1 and T2 were predicted due to fat supplementation in the ration. A half of milk palmitic acid is synthesized from precursors from the diet. whilst almost all of milk stearic acid is coming from diet that is transported to mammary gland via blood and lymph (Walstra and Jennes cited by Lin *et al*.. 1996). Bailoni *et al*.. 2004 suggested that low level of fat inclusion would not have an effect on milk production and composition.

CONCLUSIONS

The use of protein-fat supplement in dairy cow ration has no negative effects on the nutrients intake, digestibility, on milk production and composition. Even though it was not significant, a decrease in the proportion of medium chain FA and an increase in unsaturated FA contributed a positive value on healthier nutrient of dairy milk.

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