Supplementation of Rumen By Pass Protein-Fat: Effect on Feed Intake, Nutrient Digestibility and The Profile of Duodenal Digesta Fatty Acids

Lilis Hartati[1)*], Ika Sumantri[1)] and Ali Agus[2)]

[1)]Faculty of Agriculture, Lambung Mangkurat University, Jl A Yani km 36, Banjarbaru, South Kalimantan, Indonesia
[2)]Faculty of Animal Science, Gadjah Mada University, Jl Fauna 3, Bulaksumur, Yogyakarta 55281, Indonesia
***Corresponding author e-mail: lilishartati_gk@yahoo.co.id**

Abstract. The aim of this research was to study the effects of rumen by pass protein-fat supplementation (RBPF) on feed intake, nutrients digestibility and profile of duodenal digesta of fatty acids. Two rumen fistulated and duodenum canulated dairy cows were fed ration that consisted of king grass and concentrate (60:40). The concentrate was supplemented with 20% RBPF. The feeding trial was conducted for four weeks in which the first week was the control period, the second week was the adaptation period, the third week was the early collection period and finally the fourth week was the late collection period. The samples of duodenal digesta were collected 1 hour before morning feeding and 1, 3 and 5 hours after morning feeding. The cows were fed twice a day and concentrate was offered before forage. The results showed that in comparison to the control, supplementation of RBPF increased nutrients intake of dry matter (DM) (6.95 vs. 6.27%), organic matter (OM) (6.20 vs. 5.70%), crude fat (CF) (0.49 vs. 0.41%), crude fiber (CFb) (1.84 vs. 1.49%) and nitrogen free extract (NFE) (3.23 vs. 3.03%), while the crude protein (CP) intake decreased (0.64 vs. 0.77%). Supplementation of RBPF improved the nutrients digestibility of dry matter (67.24 vs. 62.15%), organic matter (68.71 vs. 65.29%), crude fiber (66.20 vs. 57.46%) and nitrogen free extract (72.37 vs. 66.47%). RBPF supplementation also increased linoleic acid content in duodenal digesta sample at 1 and 3 hours after feeding. In conclusion, RBPF supplementation did not negatively affect feed intake and nutrient digestibility. RBPF also increased the proportion of linolenic acid, eicosapentaenoic acid (EPA) and docosahexsaenoic acid (DHA) in duodenal digesta until 3 hours after feeding.

Key words: RBPF, supplementation, feed intake, nutrient digestibility, fatty acid

Abstrak. Penelitian ini bertujuan untuk mengetahui pengaruh suplementasi protein-lemak by pass rumen terhadap konsumsi, kecernaan nutrien serta profil asam lemak pada digesta duodenum sapi perah. Dua ekor sapi perah berfistula rumen dan berkanula duodenum diberi pakan hijauan dan konsentrat dengan rasio 60:40, diberi suplemen protein-lemak by pass rumen 20% dari konsentrat. Percobaan dilakukan selama 4 minggu, minggu pertama adalah periode kontrol, minggu ke-2 periode adaptasi, minggu ke-3 periode koleksi awal dan minggu ke-4 periode koleksi akhir. Sampel digesta duodenum diambil 1 jam sebelum pemberian pakan dan 1; 3 serta 5 jam setelah pemberian pakan. Ransum diberikan dua kali sehari dengan konsentrat lebih dulu sebelum hijauan. Dibanding periode kontrol, suplementasi protein lemak by pass rumen sebanyak 20% menaikkan konsumsi bahan kering (BK) (6,95 vs 6,27%), bahan organik (BO) (6,20 vs 5,70%), lemak kasar (LK) (0,49 vs 0,41%), serat kasar (SK) (1,84 vs 1,49%) dan bahan ekstrak tanpa nitrogen (BETN) (3,23 vs 3,03%) tetapi menurunkan konsumsi protein kasar (PK) (0,64 vs 0,77%). Suplementasi protein lemak by pass rumen juga memberikan kecernaan BK, BO, SK dan BETN (67,24 vs 62,15%; 68,71 vs 65,29%; 66,20 vs 57,46%; 72,37 vs 66,47%) yang lebih tinggi dibanding kontrol. Suplementasi lemak by pass rumen juga menaikkan proporsi asam lemak linolenat pada jam ke-1 dan ke-3 setelah makan. Pemberian protein-lemak by pass rumen dalam ransum tidak berpengaruh negatif terhadap konsumsi dan kecernaan nutrien pakan serta meningkatkan proporsi asam lemak linoleat, EPA (eicosapentaenoic acid) dan DHA (docosahexsaenoic acid) digesta duodenum.

Kata kunci: protein lemak by pass rumen, suplementasi, konsumsi, kecernaan nutrien, asam lemak

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Introduction

The generally maximum fat content in ruminant ration is 5% and higher dose will diminish microbial activities to digest crude fiber (Palmquist et al., 1993; Doreau and Chilliard, 1996). Free fatty acids in the rumen tend to attach the feed and microbial particles that affect fermentation of mainly structural carbohydrates (Wattiaux and Grummer, 1995).

Fat is a cold nutrient with highly dense energy, so fat supplementation to the livestock will provide an energy source. Fat can also reduce heat stress to the lactating cows during hot weather. During digestion and absorption in the body, fat released a lower heat than carbohydrate or protein, called cold nutrient (Wattiaux and Grummer, 1995). Some reviews (Palmquist and Jenkins, 1980; Chilliard, 1993) stated that the use of fat bypass not only increased yield and milk fat content but also decreased the level of milk protein and feed intake. The addition of fat in ration increased the fiber digestion but depended on the influence of fat added (Czerkawski and Clapperton, 1984). Double protection models namely the protection of fat and protein were expected to give better effect on the production and quality of milk without negative effect on consumption and nutrient digestibility. This research was part of the research stage to determine the effect of protein supplementation of rumen bypass fat given to dairy cows.

Materials and Methods

Two rumen fistulate and duodenum canulated dairy cows fed forage (king grass) and concentrate (wheat brand) in ratio 60:40. The concentrate was supplemented with 20% of Bypass Protein-Fat (RBPF). The RBPF consisted of crude palm oil (CPO) and skim milk (1:3), mixed and then sprayed with formaldehyde to obtain 1.5% formaldehyde content in the mixture. The feeding trials was conducted for four weeks, in which the first week was the control period, the second week was the adaptation period, the third week was the early collection period and finally the fourth week was the late collection period.

The cows were fed twice a day with concentrate first then forage. Feed intake and fecal output were recorded daily, sampled for 250 g per cow per period as composite, then analyzed for dry matter, organic matter, crude prrotein, crude lipid and crude fiber. Feed intake and digestibility of feed nutrient were calculated and analyzed descriptively.

The samples of duodenal digesta were collected 1 hour before morning feeding and 1, 3 and 5 hours after morning feeding. The samples were analyzed fatty acid profile by gas chromatography. Data was obtained analyzed descriptive.

Result and Discussion

Data on Table 1 shows that the RBPF supplementation did not change nutrient consumption within treatments, thereby not inducing negative impact on consumption of the dairy cows. Nevertheless, there was a trend that the late supplementation and early supplementation were higher than that of Control was due to ration palatability.

The use of crude palm oil as a raw material protecting fat became one of the factors decreasing consumption of nutrients because crude palm oil was not smelly like fish oil. The use of fish oil decreased dry matter intake because it was associated with palatability to livestock (Vafa et al., 2012). Likewise, Kargar et al. (2010) reported that hydrogenated palm oil and yellow grease in dairy cows did not affect dry matter intake. The addition of CLA protected (de Veth et al., 2005, Suksombat and Chullanandana, 2008), long-chain fatty acid soap (Cervantes et al., 1996; Naik et al., 2009), tallow and soybean meal (Weigel et al., 1997) did not affect feed intake.

Table 1. Nutrient consumption (Kg DM/day)

Treatment	DM	OM	CP	CF	Cfb	NFE
Control	6.27	5.70	0.77	0.41	1.49	3.03
Early supplementation	6.68	5.89	0.74	0.61	1.57	2.98
Late supplementation	6.95	6.20	0.64	0.49	1.84	3.23

DM: dry matter, OM: organic matter, CP: crude protein, CF: crude fat, CFb: crude fiber, NFE: nitrogen free extract

Table 2. DM, OM, CP, CF, CFb and NFE digestibility (%)

Period	DM	OM	CP	CF	CFb	NFE
Control	62.15	65.29	69.82	76.33	57.46	66.47
Early supplementation	55.44	56.92	62.15	60.04	46.92	60.25
Late supplementation	67.24	68.24	68.71	48.23	66.20	72.37

DM: dry matter, OM: organic matter, CP: crude protein, CF: crude fat, CFb: crude fiber, NFE: nitrogen free extract

In contrast, different results reported that feeding fat combined with protein by pass did not affect total DM intake (Maiga and Schingoethe, 1997), but some review (Palmquist dan Jenkins, 1980; Chilliard, 1993) stated that feeding fat by pass decreased feed intake. Lohrenz et al. (2010) who used protected fat, Chilliard et al. (2009), Lee et al. (2011) and Hristov et al. (2011) reported that feeding of oil and oilseed decreased feed intake.

RBPF supplementation also did not affect negatively on digestibility nutrient, in spite of an increasing trend of nutrient digestibility as shown in Table 2. Table 2 shows decreasing in vivo nutrient digestibility in early supplementation; however the late supplementation increased assumedly due to rumen microbial activity. The RBPF supplementation can predict the rumen microbial adaptation by changing nutrient supplies at early periods in the rumen. This is similar to Table 1 that it was not different on the feed intake, however feed intake tended to increase from early period to late supplementation period. This also strengthened the prediction of 3 weeks adaptation to eliminate RBPF effect supplementation on digestibility nutrient.

The RBPF supplementation did not have negative effect on digestibility nutrient but increasing crude fiber digestibility, thereby proving that effective protection method in RBPF did not influence digest process in the rumen. The lower crude fat digestibility in late supplementation period than control period predicted increasing digesta duodenum fatty acid to result in lower absorbability than control.

The use of formaldehyde as a protective agent affected the protozoa population (Tiven, 2011), but decrease in the population of protozoa usually led to the increased rumen microbial proliferation (Kim et al., 2007) so that the degradation of feed in the rumen were not affected by addition of protected fat. Cortes et al. (2010) with calcium soap of flaxseed oil, and Kalscheur et al. (1997) with sunflower oil reported a not significantly different digestibility.

Czerkawski and Clapperton (1984) reported that feeding fat in cows ration increased crude fiber digestibility, but the effect on digestibility depended on the supplemented fat type. Feeding fat combined with protein by pass increased dry mater digestibility and TDN (Total Digestible Nutrient) (Shell et al., 1978). In contrast, Shell et al. (1978) reported that feeding fat combine with protein by pass increased crude fat digestibility.

Lee et al. (2011) reported that the use of coconut oil as much as 500 g/head/day in the diet of dairy cows decreased crude fiber digestibility. Castro et al. (2009) reported

Table 3. Duodenum digesta fatty acid profile (% relative)

Fatty acid	Hour of sampling (after feeding)							
	H-1		H+1		H+3		H+5	
	C	T	C	T	C	T	C	T
Palmitoleic (C16:1)	0.96	0.01	1.28	1.06	1.12	0.52	1.12	1.12
Oleic (C18:1)	0.52	0.01	1.16	0.08	0.01	0.01	0.01	0.01
Linoleic (C18:2)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Linolenic (C18:3)	1.23	0.56	0.74	0,90	0.59	0.95	0.59	0.08
EPA (C20:5)	0.38	0.01	0.10	0.12	0.01	0.12	0.29	0.01
DHA (C22:6)	0.09	0.05	0.09	0.14	0.01	0.13	0.03	0.01

C= Control; T= Treatment

different result using sunflower oil and hydrogenated palm oil in sheep ration that increased the digestibility of dry matter, organic matter and crude protein, crude fat digestibility while, NDF and ADF were not affected. Bhatt et al. (2011) reported that palm oil decreased organic matter digestibility.

The different results have been reported that additional oil in ration decreased organic matter digestibility significantly (Sutton et al., 1983), dry mater digestibility, cellulose digestibility, and protein digestibility (Davison and Woods, 1960), but increased the crude fat digestibility (Davison and Woods, 1960; Mattos and Palmquist, 1974). The other result reported that additional sunflower oil in ration did not influence dry mater digestibility (Kalscheur et al., 1997) and organic matter digestibility (Wu et al., 1994).

RBPF supplementation increased fluctuation of palmitoleic acid proportion in duodenum digesta until 5 hours after feeding. The increasing oleic acid proportion happened at 1 hour after feeding, but the increasing in treatment lower than control, whenever linoleic acid did not change. In the treatment, linolenic acid proportion increase higher than control until 3 hours after feeding.

RBPF supplementation also increased EPA proportion in treatment until 3 hours after feeding, but fluctuating increased in control. The increasing DHA lasted until 3 hours after feeding. Klusmeyer and Clark (1991) reported that feeding fat and protein in dairy cows increased fatty acid C14:0, C16:0, C18:0, C18:1, C18:2 and C18:3 flow to duodenum.

Conclusion

RBPF supplementation in dairy cows resulting in no negative effect on feed intake and nutrient digestibility. There was an increasing trend in feed intake and nutrient digestibility, increasing proportion of linolenic acid, EPA and DHA duodenal digesta until 3 hours after feeding.

Acknowledgement

We express our gratitude to DP3M Ditjen Dikti of National Education Ministry for funding the research in project of Hibah Pekerti IV 2006-2007.

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