B-16.9 Development of Nutritional Management Technologies for Controlling CH_4 Emissions from Ruminants in Southeast Asia (Final Report)

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Abstract

In order to develop the nutritional management technologies for controlling CH_4 emissions from ruminants in Southeast Asia, the following two experiments using Holstein cows have been conducted.

1) In the experiment 1, it was examined about the influence which nutritive value of tropical grass exerted on methane emission from ruminants. Four of heifer or dry cow were fed sudangrass silage, bahiagrass hay and rice straw, nutritive value of those grasses were measured. And, the amount of methane formation was measured by respiration test. TDN content in sudangrass, bahiagrass and rice straw were 62, 55, 54% and methane emission per dry matter intake in sudangrass, bahiagrass and rice straw were 31.3, 37.7 and 36.6L/day, respectively.

2) In the experiment 2, it was examined about the influence of additive sweet potato for milk production and methane emission from cow. Four milking cows (less than 10kg of milk production) that milk productivity is the same as Southeast Asian dairy cows were fed bahiagrss hay or bahiagrass hay and sweet potato. When a potato was added to hay, milk production, milk element and dry matter intake showed a tendency of increasing. And, methane emission from cow decreased by adding a potato on the 146L/ day from the 260L/ day. Furthermore, methane emission per milk productions decreased to 25.5L by adding a potato from 48L.

From the above results, It considered that it was effective to add kind of potato to roughage with using the high amount of nutrition in order to control methane emission from cattle in Southeast Asia area by nutritional management.

Key Words Ruminants, Southeast Asia, Methane, Nutrition, Hot Environment

1. Introduction

It knows that methane emission from ruminants changes by the quality of the feed. Espesially, it increase as much as to intake low quality forage. And, methane emission from ruminants shows a tendency of increasing under hot environment. Therefore, methane emission from ruminants in Southeast Asia where low quality tropical grass and agricultural by-product are main feed is thought to be large amount than it in the advanced country. But, it considers that methane emissions can be decreased by the improvement of the quality of the feed and the improvement of nutrition balance. Methane that is released by livestock in the warm Southeast Asia is thought to occupy about 20% of methane that it is released by ruminants in the whole world. Furthermore, the decrease of methane emissions is a big subject in this area from increase in the livestock head will be being

expected.

On the other hand, the feed resources which are the same as the Southeast Asia are being used in Kyushu area. And, it is possible that the weather condition which is the same as these areas is created, too, in Kyushu. Therefore, development of technology for controlling methane emissions by nutritional improvement which is suitable for these areas is being asked by Southeast Asia various country.

2. Research Objectives

In order to develop the nutritional management technologies for controlling methane emissions from ruminants, at first, it must measured methane when various tropical grass were digested by cattle. The influence which the nutritive value of tropical grass exerts on methane emissions is explained by these experiments. Furthermore, how to grow it is explained with the way of selecting tropical grass which is suitable for controlling methane emissions from ruminants.

And, it aims at the development of the technology that methane formation is controlled by raising activity of microorganism in the rumen. Therefore, the influence of additional starch of potato which can obtain it at a low price in this area on methane formation is explained. And, it contributes to enhancing the precision of inventory in these areas based on these informations.

3. Material and Methods

(1) Experiments 1

sudangrass silage, bahiagrass hay and rice straw were used for the experiment. Sudanese glass was mown three times, and made to roll-wrapped silage. Other 2 grass species used the first cut. Four Holstein heifers or dry cows were fed above forages, nutritive value of those grasses were measured. And, the amount of methane formation was measured by respiration test in the environment controlled room.

(2) Experiments 2

Four Holstein milking cows (less than 10kg of milk production) that milk productivity is the same as Southeast Asian dairy cows were fed bahiagrss hay or bahiagrass hay and sweet potato. The amount of methane formation was measured by respiration test in the environment controlled room. And, the amount of TDN of the feed, dry matter intake, milk production and milk element were measured.

4. Results and Discussion

(1) The influence of feeding tropical grass on methane emissions from ruminants

Table 1 shows the influence of feeding tropical grass on methane emissions from ruminants.

There were many amounts of methane emissions from cattle with bahiagrass hay and rice straw which dry matter intake (DMI) is larger than sudangrass. Relationship between DMI (y) and methane emission (x) could be shown with the equation of $y=-46.508+41.179x$ (figure 1). Shibata et al. [1] reported the equation of $y=-0.127+34.360x$. DMI at this time is the range of 1.5 times from 1 time of the maintenance, and the inclination is big in both equation. Furthermore, they reported that the inclination of the equation becomes big as much as DMI decrease. The nutritive value of the grass used in this experiment is low, and moreover the appetite of cattle is thought to decrease by the high temperature. Therefore, it thought that this inclination became big from DMI is being about equal to the amount of maintenance.

Table 1. The influence of feeding tropical grass on methane emissions from ruminants

Forage	Cutting	Hay/Silage	TDN (%)	DMI (kg/d/head)	CH_4 (L/d/head)	CH_4 /DMI (L/kg)
Sudangrass	1	Silage	59.2	6.45	206.0	31.9
Sudangrass	2	Silage	61.0	5.15	155.0	30.1
Sudangrass	3	Silage	57.4	5.85	186.1	31.8
Bahiagrass	1	Hay	54.8	6.85	258.1	37.7
Rice straw	1	Hay	53.6	8.08	295.5	36.6

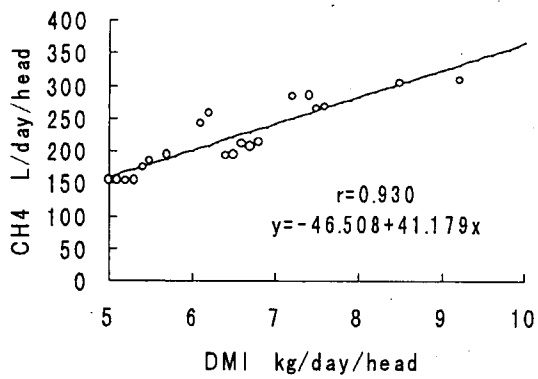

Figure 1. Relationship between DMI and CH_4 emissions

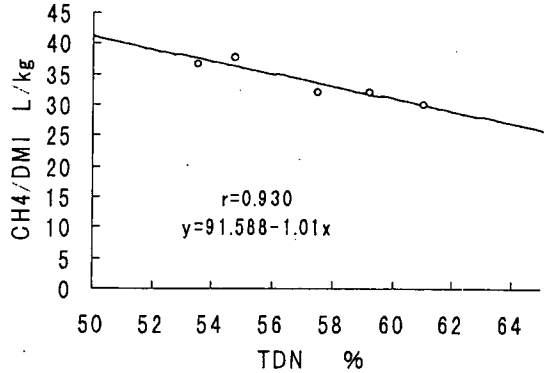

Figure 2. Relationship between TDN content and CH_4 emissions

Methane emissions varied in grass species, cutting, and so on. There were fewest methane emissions per DMI in sudangrass which TDN content was highest in three species. Methane emissions per DMI decreased as much as the rate of TDN content of grass was high when DMI was about equal as shown in the figure 2. Kurihara et al. [2] also reported showing a tendency of being the same as this experiment in the comparison of the feed that the rate of concentrate / roughage is different. Furthermore, they reported that this tendency becomes as strong as temperature increase. On the other hand, the energy requirements of cattle increases, and DMI is also increase under hot environment [3]. Therefore, methane emissionss increase remarkably. In the tropical area, it considers that it is very effective to feed cattle the high TDN content diet which energy requirements can be filled in even if DMI is restricted to reduce methane emissions from cattle.

(2) Influence of additive sweet potato for milk production and methane emission

In the table 2, The feed compositions and digestibility of bahiagrass hay and potato were shown. A potato contains much starch, and its digestibility is high, so it is effective to fill energy.

Table 3 is shown that the influence of additive potato for milk production, milk elements and methane emissions from dairy cows. DMI and milk production showed the tendency that it increased by adding a potato. Methane emissions decreased in the opposite direction by adding a potato. Methane emissions per 4% fat-corrected-milk (FCM) decreased to about the half by adding a potato (figure 3). And, the relationship between

methane emissions and FCM production were shown in figure 4. Methane emissions per FCM productions decreased as much as FCM production increased. Shibata [4] reported that it is appearing more remarkably at the milk productivity is low level. Therefore, it is important to enhance ability of the dairy cow in the area where cattle fed the low quality feed in developing country. When the FCM production was small, it was shown that it was very effective toward increase in FCM making methane emissions decrease as for this experiment as well.

From the above result, to reduce CH_4 emissions from ruminants in Southeast Asia, it was effective that to feed high TDN content grass, and to add energy source like potato.

Table 2. Feed compositions and digestibility of bahiagrass hay and potato (DM %)

Feed	CP	EE	CF	NFE	Ash	ADF	NDF	digestibility
Hay	6.5	1.4	32.8	50.5	8.8	41.8	74.8	51.4
Potato	2.9	0.3	2.5	91.4	2.9	3.8	5.4	80.8

Table 3. The influence of feeding potato on milk productivity and methane emissions

Treatment		Hay	Potato
Body Weight	kg	573.5	569.3
DMI	kg/日	6.9^{A}	8.6^{B}
Hay	kg/日	6.9	3.1
Potato	kg/日	—	5.5
Milk Production	kg/日	4.67	4.92
F C M	kg/日	5.39	5.73
Milk Fat	%	5.07	5.12
Milk Protein	%	3.46	3.85
Milk Sugar	%	3.83	3.38
Solids-not-fat	%	8.28	8.23
Methane Emissions	L/日	259.1^{A}	146.3^{B}

A,B : $P<0.01$

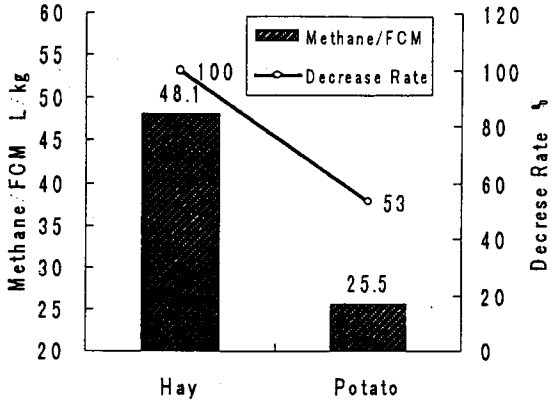

Figure 3. Influence of additive potato for methane emission

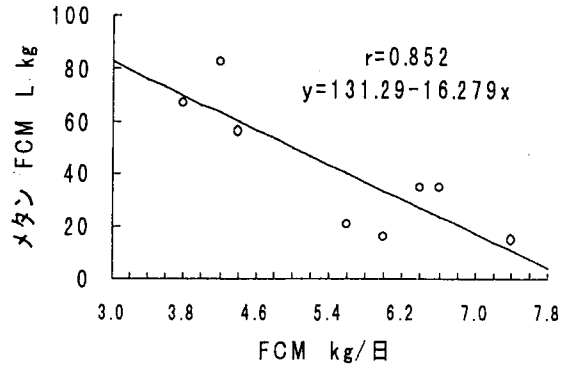

Figure 4. Relationship between milk production and methaneemissions

5. References

1) Shibata, M., F. Terada, K. Iwasaki, M. Kurihara and T. Nishida, Methane production in heifers, sheep and goats consuming diets of various hay-concentrate rations. Anim. Sci. Technol. (Jpn), 63:1221-1227.1992.

2) Kurihara, M. and T. Nishida, Global Environment Research of Japan in 1995 (II). 624-627. Research and Information Office Global Environment Depeartment Environment Agency Government of Japan. 1996.

3) Shiya, S., F. Terada, The physiological response of milking cow under hot environment. Proc. Jpn. Soc. Anim. Nutr. Metab. 41:61-68. 1997.

4) Shibata, M, The controlling Greenhouse Gases in Animal Production. (5). 32-62. Society for Livestock Technology. 2000.