UTILIZATION OF CARROT WASTE IN THE DIET AND ITS EFFECT ON RUMEN MICROBIAL POPULATION AND DIET ECONOMIC EFFICIENCY OF DAIRY COWS

U. Hidayat Tanuwiria, A. Rohana, Mansyur, L. Budimulyati, and Trisna

Faculty of Animal Science, Padjadjaran University,
Jalan Raya Bandung-Sumedang, Km.21. Jatinangor 40600

ABSTRACT

The objectives of this research were to examine the substitution of carrot waste to native grass in diet and its effect on rumen microbial population and diet economic efficiency of FH cows. The experimental design was Randomized Block Design with four treatments each replicated five times. The treatments were R0 (66% native grass + 34% concentrate), R1 (60% native grass + 40% concentrate), R2 (33% native grass + 33% carrot leaf + 34% concentrate), dan R3 (33% native grass + 16.5% carrot leaf + 16.5% carrot tuber + 34% concentrate) all based on dry matter content of feed offered. The results suggested that the substitution of carrot waste to native grass were significantly (P<0.05) affected to rumen protozoa population and diet economic efficiency (*income over feed cost* = IOFC) but not on rumen bacteria population. The highest IOFC value was R2 (substitution of carrot leaf to native grass).

Keywords: carrot waste, rumen microbial, IOFC, dairy cow

PEMANFAATAN LIMBAH WORTEL DALAM RANSUM DAN PENGARUHNYA TERHADAP POPULASI MIKROBA RUMEN DAN EFISIENSI RANSUM PADA SAPI PERAH

ABSTRAK

Penelitian bertujuan untuk mengetahui pengaruh subtitusi rumput lapangan oleh limbah wortel dalam ransum terhadap populasi mikroba rumen dan efisiensi ekonomis ransum pada sapi perah yang sedang laktasi. Percobaan dilakukan terhadap 20 ekor sapi perah FH laktasi periode ketiga dan rataan bobot badan 410,5 ± 43,7 kg dengan Rancangan Acak Kelompok (RAK) empat macam ransum perlakuan dalam lima kelompok sebagai ulangan. Perlakuan berupa R0 (66% Rumput lapangan + 34% konsentrat), R1 (60% Rumput lapangan + 40% konsentrat), R2 (33% Rumput lapangan + 33% daun wortel + 34% konsentrat), dan R3 (33% Rumput lapangan + 16,5% daun wortel + 16,5% umbi wortel + 34% konsentrat) semua disusun berdasarkan 100% bahan kering. Peubah yang diamati adalah populasi bakteri dan protozoa rumen, nilai efisiensi penggunaan ransum dan *income over feed cost* (IOFC). Hasil penelitian menunjukkan bahwa subtitusi 50% rumput lapangan oleh limbah wortel dalam ransum mempengaruhi (P<0,05) populasi protozoa rumen dan efisiensi penggunaan ransum tetapi tidak berpengaruh terhadap populasi bakteri rumen. Nilai IOFC tertinggi diperoleh pada subtitusi 50% rumput lapangan oleh daun wortel (R2).

Kata Kunci : Limbah wortel, mikroba rumen, IOFC, Sapi Perah

INTRODUCTION

Dairy cow farmer in the horticulture area of Cikajang, Garut district, often utilizing carrot waste (*Daucus carota*) as an additional feed especially during season of the carrot harvest. Amount of carrot waste is vary according to season and it is giving time in accordance with carrot season. Viewed from the nutrient content, carrot waste like as carrot leaf contains crude protein 14.84%, crude fibre 20.9% and nitrogen free extract (NFE) 43.1%, whereas carrot tuber contains crude protein 7.0%, crude fibre 5.1% and NFE 72.3%. Excellence differ from carrot waste is carrot tuber frequently contains β carotene. The availability of carrot waste is the high enough that is fresh carrot leaf per hectare 25 tons/harvest, as well as the rest of the carrot tubers after grading process are often used as feed.

As fibrous feed, carrot waste can be used as substitution some of native grass. Quality of carrot waste as ruminant feed not even determined by its nutrient content but also it is important to know its giving effect to rumen microbe population. Microbes and fermentation activity in rumen is one of characteristic of digestive system of ruminant. Rumen microbes are involved in degrading feed into rumen to be simple product, that can be used by rumen microbes as well as it surrogate livestock. Microbe activity is very dependent on the availability of nitrogen and Energy. Main Groups of microbes that play a role in ruminant digestion is bacteria, protozoa and fungi which amount and composition varies depending on the feed consumed.

Microbe is bacteria that were most in ferment carbohydrate cell of plants. The presence of bacteria in the rumen of cattle ruminant have the ability to utilize cellulose, hemicellulosa and crude fibre are a source of energy for production. Unlike the bacteria, protozoa are not able to directly utilize ammonia as the nitrogen source. N source for the growth of protozoa derived from feed protein and rumen bacteria engulfed (Arora, 1989). There are two opinions about the presence of protozoa. The first opinion states that the presence of protozoa reduced the bacteria leave the rumen. Other opinion states that the presence of protozoa is needed to maintain rumen pH. Protozoa can immediately retained the carbohydrate that is easily dissolved in the body. This Group can prevent the conversion rate of readily fermentable carbohydrate (RFC) which is turned into lactate acid by the bacteria.

Based on this is facts, it is necessary to conduct research and study conducted on the utilization of waste carrot as alternative for grass native in the ration for rumen microbe populations and its direct impact on the efficiency ration and economic efficiency in the dairy cow ration

MATERIAL AND METHODS

Research carried out on 20 heads of Fries Holstein dairy cow (FH) in their 3rd period of lactation and 3rd to 6th lactation week. Daily milk production of 9.9 and 20.1 kg/day or the average of 15.68 ± 3.16 kg /day. Body weight of cows at the beginning of the research are 410.5 ± 43.7 kg. Diet used consists of native grass, carrot waste (leaves and tubers), and concentrate feed from KPGS Cikajang. Nutrient content of the feed components diet and nutrient diet for each treatment are presented in Table 1 and 2.

Table 1. Nutrient content of the Feeds (Based on 100% dry matter)

Nutrient	Consentrate	Native grass	Carrot Leaf	Carrot tubers
		%		
Dry matter	88.72	24.96	25.90	17.90
Ash	15.83	11.95	16.09	7.39
Crude Protein	8.17	12.35	14.84	6.97
Crude Fat	14.15	1.98	5.03	6.97
Crude Fibre	9.39	30.00	20.92	8.25
NFE	53.46	43.72	43.09	5.12
TDN	66.16	56.20	60.00	72.27
				82.00

Notes : Results of proximate analysis by Laboratory of Ruminant Nutrition and Feed Chemistry, Faculty of Animal Science, Padjadjaran University, 2008

Diet treatments consist of equal forages (native grass and carrot waste) and concentrate, prepared based on 100% DM. Diet treatment is

R0 = 66% native grass + 34% concentrate
R1 = 60% native grass + 40% concentrate
R2 = 33% native grass + 33% carrot leaf + 34% concentrate
R3 = 33% native grass + 16.5% carrot leaf + 16.5% carrot tuber + 34% concentrate

Tables 2. Chemical composition of the experimental Diets (dry matter basis)

Nutrient	R0	R1	R2	R3
		%.		
Dry matter	46.43	50.31	46.49	46.64
Ash	13.26	13.49	14.65	13.49
Crude Protein	10.94	10.69	11.80	10.66
Crude Fat	6.08	6.82	7.06	7.58
Crude Fibre	23.06	21.80	20.06	18.05
NFE	47.13	47.75	46.88	50.70
TDN	59.55	60.16	60.80	63.57

Calculation Result bases Table 1.

Twenty Holstein lactating dairy cows were randomly allocated to dietary treatments according to Randomized Block Design (RBD) four treatments and five groups as the replicating. Subdividing is relied on daily milk production, that is group 1 (production 10.0-12.36 kg/day), group 2 (production 12.37-14.72 kg/day), group 3 (production 14.73-17.08 kg/day), group 4 (production 17.09-19.44 kg/day) and group 5 (production 19.45-21.80 kg/day). Each cow is placed in individual pen that equipped with feeder and drinking water.

Variables observed

1. Bacteria and protozoa population in rumen fluid (*in vitro*)

Bacteria population is calculated using method of counting colony, wich only count living bacteria. The principle of calculation with serial delution, anf propagation of bacteria breeder in hungate tube for 7 day. Cultivation of bacteria is carried out at pH 7 for an-aerobe atmosphere at a temperature of 39°C. Protozoa population is calculated based on coloring with solution Methylgreen Formalin Salin (MFS) solution in physiological NaCl solution and then fixated with formaline (Ogimoto and Imai, 1981).

2. Feed Efficiency

Usage Feed Efficiency is to the number of diet that consumed to produce one set of production. Feed Efficiency is calculated by using formula :

$$EPR = \frac{\text{Milk production based on 4\% FCM (kg)}}{\text{Dry Matter feed Consumption (kg)}}$$

Milk production was measured by deliberate water of result milking morning and evening (gram). Measurement of milk production is conducted everyday during perception. Milk Production based 4% FCM are calculated with formula: (0,4) (kg Milk) + 15 (kg fat milk)

3. Value Income over Feed Cost (IOFC) calculated base difference between price sell milk and feed expense that consumed during research.

Data that obtained tested with Analysis of varians and continues test with Multiple Range Test Duncan (Steel and Torrie, 1980).

Research was conducted in the dairy cow farm belongs to group of Mekar Mukti, Ciharus village, Margajaya countryside, district of Cikajang, sub-province Garut in January to February 2008. Execution time for 7 week, the first three week is for adaptation period and the next four week of data collecting.

RESULT AND DISCUSSION

Population of rumen bacteria and protozoa, and feed efficiency and the value of economic feed efficiency each of them treats presented at Table 3.

Table 3. Amount of Rumen Bacterium and Protozoa, Feed Efficiency and value of Economic Feed Efficiency at Dairy Cow Treatment

	Variable	Treatment			
		R0	R1	R2	R3
1	Total bacteria ($x10^{10}$ cell/ml)	2,83a	2,23a	3,61a	2,27a
2	Total protozoa ($x10^{6}$ cell/ml)	4,65c	12,45a	6,00bc	9,45ab
3	Feed Efficiency, %	55,30ab	53,19b	57,99ab	61,51a
4	IOFC (Rp/head/day)	11.125	7.019	13.136	8.824

R0 = 66% native grass+34% concentrate, R1 = 60% native grass + 40% concentrate
R2 = 33% native grass+33% carrot leaf+34% concentrate, R3 = 33% native grass+16.5% carrot leaf + 16.5% carrot tuber + 34% concentrate
Different Superscript on the same row, indicating significantly differ (P<0.05)

In the experiment, type of ration used which is replacement of native grass by leaf and carrot tubers does not affect the population of rumen bacteria, but has effect on the protozoa population of rumen fluid. Population of rumen fluid bacteria treatment ranged from 2.23-3.61 x1010 cells / ml, the bacteria population in general is on a normal range.

Treatment R1, namely ration containing 40% concentrate resulted the population of protozoa rumen higher than (P <0.05) treatment R0, namely the ration containing 34% concentrate. The high population of protozoa in treatment R1 allegedly related to the type of non-structural carbohydrate found in R1 higher than the R0 and R2, whereas treatment between R3 and R1 is not significantly different (P> 0.05). This shows that the addition of carrot tubers in the ration have the same function in the carbohydrate supply non-structural treatment such as R1.

Interactions that occur between the rumen microbes are complex. Microbe population and the proportion of species are not fixed, but always changing. Lloyd *et al.*, (1978) states that the rumen microorganisms cause some issues, namely the fermentation process occurs that can digest fibrous food, amino acid needs for nutrition does not depend much on the quality of food, able to change the non-protein nitrogen (NPN) to high quality protein, the products of fermentation in the rumen to the intestine can be presented in the form of a more easily digested. Rumen microbes in addition to a role in the fermentation process, also play a role as a source of protein microbial for its surrogate livestock. According to Sniffen *et al.*, (1987), contribution made by microbial protein towards amino acid needs of the livestock ruminant can reach 40-80% and is a quality protein needed by the livestock. According to Clark *et al.*, (1992), 59% pure protein obtained into the duodenum of dairy cow come from rumen microbes. This analysis is based on the analysis that amino acid in the duodenum is similar to the amino acid contents in the rumen microbes.

Ration efficiency value is calculated based on the number of milk production for each kg of ration dry matter intake consumed. Ration efficiency value define the quantity of ration nutrient content that can be converted into livestock products, namely milk. On this research, efficiency ration highest value obtained in the treatment R3 is 61.51% and lowest in treatment R1 is 53.19%. The efficiency of ration R3 is higher (P <0.05) than R1 treatment (61.52% vs 53.19%), whereas treatments between R3, R2 and R0 are not different.

Ration efficiency value is strongly influenced by the amount of ration dry matter intake consumed and the amount of milk produced. Based on Tanuwiria *et al.*, (2008), milk production in each treatment did not differ significantly, while consumption in the dry ration treatment R3 is lower (P <0.05) than treatment R0, R1, and R2. This shows that the addition of carrot tubers in the ration can reduce consumption without reducing milk production. Or in other words, the addition of carrot tubers can improve the overall quality of the ration. This in line with the statement of Suryahadi *et al.*, (1997) which says that the high digested ration , will impact on the milk production and high ration efficiency

In general, a farm has the purpose of profit (profit oriented). Gross income from a dairy farm can be estimated from the sale price after feed price (income over feed cost). On this research, the lowest IOFC value obtained in the R1 and the highest is in R2. These facts indicate that either waste carrot leaves or tubers and both carrot leaves and tubers addition resulted in high ration efficiency, but when examined from the economic side of the waste, carrot leaves addition is more profitable.

CONCLUSION

Carrot waste (leaves and tubers) can be used to replace 50% native grass in the diet for productive dairy cow. Replacement of up to 50% native grass by carrot leaves generate the highest income over feed cost if compared with a mixture of leaves and tubers from carrot waste.

SUGGESTION

Carrot waste such as leaves and carrot tubers are feasible for component for dairy cow ration not more than 35% in the ration.

ACKNOWLEDGE

This research is fully funded by the Program of PHK A3 Department of Livestock Production. Faculty of Animal Science UNPAD in the Fiscal Year 2007. We say thank you to all PHK A3 for your trust, support and the opportunity, also to Ai Neni Nurhayati, Ratna Puspitasari, Roman Ruhiyanto, and Ira Suryanawati involved in this research.

REFERENCES

Arora, S.P. 1989. Pencernaan mikroba pada ruminansia. Gadjah Mada University Press. Yogyakarta

Clark, J.H., T.H. Klusmeyer, and M.R. Cameron. 1992. Microbial Protein Synthetis and Flows of Nitrogen Fractions to the Duodenum of Dairy Cattle. Symposium : Nitrogen metabolism and amino acid nutrition in dairy cattle. J. Dairy Sci. 2304-2323

Lloyd, L.E., BE. McDonald, and E.W. Crampton. 1978. Fundamentals of Nutrition. Freeman and Company San Francisco.

Ogimoto K., and S. Imai. 1981. Atlas of Rumen Microbiology. Japan Scientific Societies Press. Tokyo.

Sniffen, C.J and P.H. Robinson. 1987. Microbial Growth and Flow as Influenced by Dietary Manipulations. J. Dairy Sci. 70:425-432

Steel, R.G., and J.H. Torrie. 1980. Principle of Procedure of Statistics. 2nd Edition. McGraw-Hill. International Book Co., Singapore

Suryahadi, T. Toharmat, Nahrowi, Hadianto, I. G. Permana, dan L. Abdullah. 1997. Manajemen Pakan Sapi Perah. Kerjasama Fakultas Peternakan IPB dan GKSI-CCA Kanada. Bogor.

Tanuwiria, U.H., A.Rochana, Mansyur, dan L.Budimulyati. 2008. Pemanfaatan Limbah Wortel dalam Ransum dan Pengaruhnya terhadap Metabolisme Rumen dan Performan Produksi Sapi Perah. Proceeding. Seminar Nasional. Pengembangan Agroindustri Usaha Persusuan Nasional untuk Perbaikan Gizi Masyarakat dan Kesejahteraan Peternak. Fakultas Peternakan UGM Yogyakarta. Hal : 107-113