RESEARCH ARTICLE

Advanced Science Letters
Vol. 23, 11972–11975, 2017

Effectiveness of Ruminant Feed Formula from the Fermented Water Hyacinth (*Eichhornia crassipes*) to Produce the High Level Protein of Goat Meat

Herlina Fitrihidajati* and Isnawati Evie Ratnasari

Department of Biology, Faculty of Mathematics and Science, Universitas Negeri Surabaya, Jl. Ketintang Wiyata No. 48, Ketintang, Gayungan 60231, Surabaya, East Java, Indonesia

The objectives of this research are to find the weight gain of the goat that was given this feed formulas and the protein content of goat meat after ten days application of the feed formulas. In this research we have applied three kinds of feed formulas to three groups of the goat. The nutritional value of the feed formulas was measured by proximate test. After ten days application of the feed fomulas, the weight gain of the goat biomass and protein content of goat muat was measured. The weight gain of goats that is given feed formula I and II was the same, 2,01 kg per month and the weight gain of goats with feed formula III is 2.13 kg per month. On the other hand, the weight gain of the goat with the conventional feed is 1.5 kg per month. In addition to this, the meat protein content of goat that is given three kinds feed formulas was made in this research were feed formula I = 17.0198%, feed formula II = 18.2870%, feed formula III = 18.8037%. The meat protein contains of goat with the conventional feed is 16.6%. Generally, all three types of feed formulas are made in this research have high nutritional value and can trigger weight gain better than that conventional feed. The feed formula III is the best feed formula to increase the goat body weight and the goat meat protein percentage increase about 1–1.5%.

Keywords: *Eichchornia crassipes*, The Ruminant Feed, High Level Protein of Goat Meat.

1. INTRODUCTION

Water hyacinth (*Eichhornia crassipes*) can grow so quickly in the water and disturb and damage the water environment.[1] Because of that, some efforts should be made to handle it to protect the negative effect of water environment disturbing. One kind of the solution is utilizing the plant as an animal feed so that weeds waters become something that have economic value. This is a possible item because of high nutrient content in the water hyacinth. The plant contain dry matter of about 7%; 11.2% crude protein; 18.3% crude fiber; BETN 57%; crude fat 0.9%; 12.6% ash; Ca 1.4%; and P of 0.3%.[2] The proximate analysis shows that the moisture content ranged from 92.13% in the roots to 85.15% in the leaves with a mean of 90.39%. The ash content ranged from 39.80% in the roots to 16.79% in the leaves. For the crude lipids, the least value of 1.2% came from the roots while the petioles had the highest value of 2.10%. The percentage of crude fibre ranged from 12.15% in the roots to 21.97% in the whole plant without the roots with a mean value of 14.41%. The percentage crude protein ranged from 7.11 in the petioles through 7.67% in the whole plant to 15.27% in the leaves.[3]

Recently a lot of research is done on the using of water hyacinth for animal feed. First, the research related to the using water hyacinth for the ducks feed,[4] and the duck is given the feed produced the high levels protein eggs.[4] Water hyacinth is also good fish feed especially Nila (*Cyprinus carpio*),[5] as well as feed ruminant animals such as goats because of high protein and carbohydrate content in the plant-fermented.[6] Biomass of goat that is given the feed of water hyacinth-fermented increased highly.[7] The protein content of the goat meat 1% higher than that is given with conventional feed.[8]

The fermentation process is very important to be applied to the plant in order to the plant can be used as the feed that has a higher nutritional value and better of level digesting. Some studies fermentation in water hyacinth was done. Mangisah used *Aspergillus niger* as a fermentation agent for water hyacinth.[9] In this case, the *Aspergillus niger* is a probiotic. The addition of probiotics increases the acceleration of the fermentation process. Probiotics are living microorganisms that can improve the health and physiological benefits when consumed.[10]

Several studies related to the using of probiotics was done. The research conducted by Isnawati has succeeded in developing a probiotic that can be used to decompose the materials is

*Author to whom correspondence should be addressed.

 1936-6612/2017/23/11972/004 doi:10.1166/asl.2017.10555

derived from plants quickly. The other researchers were successful to conducted the research related to rice straw, corn straw and soybean hay fermentation and implemented in ruminants.[11] The using of a mixture of various types probiotics such as of cellulolytic, proteolytic and lipolytic microorganisms produced high quality feed for the cattle from the raw material of corn straw,[12] from the raw materials of rice straw[13] and from the raw materials of soybean straw.[21] The using of a probiotic mixture of different types of microbes more advantageous than the using of a single microbial as the fermentation agents. In addition, the using of EM (Effective Microorganism) as the probiotics can also speed up the process of organic material decomposition. Therefore, in this study will be used the yeast tempeh (one kind of the yeast) as the fermentation agents of water hyacinth fermentation process. The yeast is a mixture of various microorganisms.

The fermentation process will improve digestibility, increase nutrient absorption, improve rumen microflora balance, increase endurance, and eliminate or decrease pathogenic microorganisms.[14] In the fermentation process, the protein will turn into peptides, amino acids, ammonia, the fats will turn into volatile fatty acids, and carbon dioxide.[2] There are several important points that must be had the probiotic bacteria that is normally present in the digestive tract. The bacteria must have a shorter regeneration time, produce substances to block the growth of pathogenic microorganisms and strong enough to with stand the packaging process (manufacturing) and distribution so that it can be moved into the intestine in a state live.[15]

As a support to obtain these properties, in the fermentation process is added molasses, according to the opinion which states that molasses are a major waste of sugar refining industry. Molasses has a crude protein content (PK) 3.1%, crude fiber (SK) 0.6%, extract materials without nitrogen (BETN) 83.5%, crude fat (LK) 0.9%, and ash 11.9% so as to improve the fermentation nutrients. Based on the nutritional content, there are two kinds of molasses:

(1) Cane-molasses, molasses has a sucrose content of 25–40% and 12–25% reducing sugar with a total sugar content 50–60% or more. Levels of crude protein (CP) approximately 3% and ash content of about 8–10%, which is largely made up of potassium, calcium, chloride, and sulfate salts;

(2) Beet-molasses a laxative feed which is normally given to cattle in small quantities of about 0.5%.[16]

We know the fresh feed of plants is given to the cows will be better, because the element of nutrients (carbohydrates, proteins, fats, vitamins, and minerals) will be more complete. Based on this study it was not good to apply the water hyacinth as the single animal feed. In this research, the plant was mixed with the other water plant namely green kangkong (*Ipomoea aquatic*). This plant contain some kinds of substances such as vitamin A, vitamin B1, vitamin C, protein, calcium, phosphorus, iron, with a protein content of 3% and energy 29 kcal.[17] Increasing the protein content of the feed is done by adding solid dreg of tofu factory to the feed. Solid dreg of tofu factory has a high nutritional content such as protein and carbohydrates to 17% to 67%. In addition to the substance of these nutrients, solid dreg of tofu factory also have another nutrient content is 3.79% fat, water 51.63% and ash 1, 21%, it is possible pulp to be added into animal feed.[7]

This study has been carried out by the manipulation of feed formulation levels of water hyacinth-fermented, dried green kangkong and solid dreg of tofu factory. Fermentation techniques were applied following the best results of previous studies so that the research will produce the best formula of ruminant feed that contains three ingredients as mentioned above. Furthermore, the feed formula is implemented to three groups of a goat. Each group has nine members of a goat. After ten days the biomass of goat and the protein level in it's meat is measured.

2. METHOD

The materials were used in this research include the feed formula I (solid dregs of tofu factory 30%, 35% water hyacinth-fermented, dried green kangkong 35%), the feed formula II (solid dregs of tofu factory 35%, 30% water hyacinth-fermented, dried green kangkong 35%) and the feed formula III (solid dregs of tofu factory 35%, 35% water hyacinth-fermented, dried green kangkong 30%), the three groups of goat (each group has nine members), balance and the tools and reagents for nutrient content analyze.

This study was an experimental study. Manipulation variables in this study were the percentage component of ruminant feed formula. There are three formulas, namely the formula I, II and III. The response variable in the research is biomass of goats and the level protein in the goat meat. Controle variable of this research is the age and condition of water hyacinth and green kangkong, types of probiotics, goats weighting 20–25 kg, and the probiotic inoculum as much as 0.15g for each treatment and conditions of solid dregs of tofu factory. Then, the feed is applied to three group of goat (each group has nine members of goat) for 10 days, then the goat's weight and protein content is measured. The data is analyzed with qualitative and quantitative descriptive analysis to obtain the findings or conclusions.

3. RESULT

The first result of this research is the nutritional value of fermented water hyacinth. The following table displayed this value.

Based on Tables I and II can be stated that the fermented water hyacinth is feasible to use the component of ruminant feed formulas. The protein contains of fermented water hyacinth high enough. Based on the data can be stated that the water hyacinth which ferment for ten days have the nutritional value higher than water hyacinth that ferment for five days.

The results that have been achieved in this research include application the feed to goat and measuring the goat weight and meat protein level of goat dafter 10 days application. The detailed description of each product is as follows. In this study, there are three kinds of feed formulas that contain three materials as mention in the materials and methods above.

The feed formulas then are applied as feed for goats for 10 days as an independent feed without any mixture or the addition of another feed. Each feed formula is given for nine goats with 2 times application daily at 09.00 and 17.00. The goat is maintained in Tegalrejo, Bareng, Jombang. Calculation of weight gain of sheep is done by reducing the weight of sheep after treatment with lamb weight prior to treatment.

After application of the feed formulas, the goats are slaughtered to get their meat and then is analyzed the nutritional content of the meat.

Ruminants abdomen consists of four parts, namely the rumen, reticulum, omasum, and abomasum with the size of which varies

Adv. Sci. Lett. 23, 11972–11975, 2017

Table I. Nutritional value of fermented water hyacinth for five days fermentation period.

No	Sample code	Analyze result (%)						
		Dried material	Dust	Crude protein	Crude lipid	Crude cellulosa	KH	ME (Kcal/kg)
1	V0.L5	32.4970	8.1681	4.6958	2.4114	10.9431	17.2217	85
2	V1.L5	23.8642	6.2166	4.5914	2.2253	6.2500	10.8309	496.66
3	V2.L5	25.9936	5.7981	5.1146	2.7824	6.4569	12.29	601.07
4	V3.L5	28.8609	6.4102	4.8301	2.4662	7.3903	15.1544	641.78
5	V4.L5	25.6951	5.8889	4.8843	2.2343	6.8651	12.6876	554.22

Table II. Nutritional value of fermented water hyacinth for ten days fermentation period.

No	Sample code	Analyze result (%)							
		Dried material	Dust	Crude protein	Crude lipid	Crude cellulosa	BETN	ME (Kcal/kg)	KH
1	V0L10	40.0630	9.4630	3.6525	1.7091	16.6299	8.6085	601.23	25.2384
2	V1L5 (C)	75.6872	17.5757	10.2941	5.8537	15.4093	26.5544	1778.08	41.9637
3	V1L10	42.4818	10.8233	6.9862	2.2918	12.7431	9.6374	782.82	22.3805
4	V2L10	40.4395	10.7599	7.1514	2.6139	10.0352	9.8791	813.92	19.9143
5	V3L10	42.6386	10.3097	6.6413	1.5904	13.0414	11.0558	773.74	24.0972
6	V4L10	44.0817	11.5536	6.9251	1.4271	12.3775	11.7984	797.17	24.1759

according to age and natural food. Feed rumen capacity to accommodate as much as 80%, 5% reticulum, omasum 7–8%, and abomasum 7–8%. This division can be seen from the shape muscle spincter during contraction. When considered from the food storage capacity can be known that the major ingestion of food occurred in the rumen. Saliva is also important to keep the amount of water in rumen fluid.[18] The process of digestion in the stomach depends on rumen temperature 37–39 °C and pH 6.0 to 6.7 and in the anaerobic state is the best condition for fermentation and the end of the fermentation process will be absorbed continuously by the reticulo rumen.[18] In the rumen, there are a large number of microorganisms, which are primarily anaerobic who do a symbiotic mutualism with the host animal.

In the digestive system of ruminant, there is a process called cud (rumination). Food that has been chewed by this animal in his mouth then is swallowed to enter into the rumen. In the rumen occurs destruction of the cell walls of forage, then the nutrients locked inside the walls of cellulose can be overhauled by enzymes that was produced by microorganisms. The first reform process is certainly not perfect, it will spew ruminant animals back food contained in the rumen back into the mouth. The animal will repeat to chew food for a few moments.[18]

Goat is one kind of ruminant that have fermentative digestion system. Fermentative digestion is done with the help of rumen microorganisms. Fermentation produces protein, peptides, amino acids, ammonia, volatile fatty acids, and carbon dioxide.[19]

Based on the food digestion process then will be greatly assisted if the food consumed by animals exist in the form of "partially digested" therefore the water hyacinth is used as one component of the feed formula should be fermented in advance to assist in the digestion of food is to mechanical or chemical, green kangkong should be made dry materials be more subtle (mechanical aids digestion of food) and the solid dregs of tofu factory as a third component, add the protein content in feed formula and bring a distinctive aroma that stimulates appetite goats.[8]

Provision of various types of feed formulas has created arole in this study have an impact on weight gain or animal biomass trials. Based on Table I on weight gain of goats, feed formula III gives the best average weight gain than that for formula I and II. Weight gain of goats with feed formula III is 0.71 kg within 10 days or 2.13 kg per month. While weight gain of goats that is given feed formula I and II 0.67 per 10 days or 2,01 kg per month. When compared to weight gain with conventional feed goats (1.5 Kg per month) are actually three types of rations were formulated in this study is better than conventional feed, but the formula III is the highest weight gain results.

Feed formula III consists of components solid dreg of tofu factory 35%, 35% water hyacinth-fermented, dried green kangkong 30%. When considered in the feed formula III the pulp out high

Table III. Weight Gain of the goat which is given feeds formula I, II and III for 10 days.

Treatment	Repeat	The prior goat weight (kg)	The last goat weight (kg)	The adding goat weight (kg)	The average adding goat weight (kg)
Feed formula I	1	24,5	25,17	0,67	0,67
	2	22	22,68	0,68	
	3	23,5	24,18	0,68	
	4	22	22,67	0,67	
	5	24	24,68	0,68	
	6	22	22,66	0,66	
	7	24	24,68	0,68	
	8	23	23,67	0,67	
	9	23,5	24,18	0,68	
Feed formula II	1	23	23,67	0,67	0,67
	2	23	23,67	0,67	
	3	22	22,66	0,66	
	4	24,5	25,18	0,68	
	5	22,5	23,16	0,66	
	6	24,5	25,17	0,67	
	7	23	23,67	0,67	
	8	24	24,67	0,67	
	9	23,5	24,16	0,66	
Feed formula III	1	24	24,7	0,7	0,71
	2	22,5	23,19	0,69	
	3	24	24,69	0,69	
	4	22	22,68	0,68	
	5	23,5	24,19	0,69	
	6	22	22,67	0,67	
	7	25	25,9	0,9	
	8	22,5	23,16	0,66	
	9	24,5	25,18	0,68	

Table IV. The nutritional value of goat meat.

No	Sample code	Nutritional value of (%)							
		Dried materia	Ash	Crude protein	Crude fat	Crude cellulose	Ca	BETN	ME (Kcal/Kg)
1	Ransum 1	22,9249	1,1415	17,0198	2,2518	1,8735	3,0041	0,6383	757,33
2	Ransum 2	30,6002	0,9665	18,2870	2,3878	1,7605	2,6529	7,1984	1050,39
3	Ransum 3	28,402	1,0629	18,8037	2,2833	1,2584	2,3251	4,9935	977,78

and high water hyacinth-fermented strongly supports the quality of feed. The solid dreg of tofu factory contains protein, Water hyacinth-fermented also highly nutritious and livestock are also high appetite with weight gain goat thus also the highest. The dried green kangkong high percentage less supportive of growth in weight because it has not become fodder "partially digested" so that undernutrition can be taken to the maximum.

Actually, all three types of feed formulas were made in this research have high nutritional value and can trigger weight gain better than conventional feed. High nutritional value of a feed can definitely trigger weight gain faster.

Weight gain, due to the dry ingredients in the feed requirements has been met, and also due to the results of protein and carbohydrate fermentation product which are higher than conventional feed so that the resulting growth is also better. The process of metabolism in ruminant was good, if the fermentation product in the form of amino acids, ammonia-N and volatile fatty acids in the rumen will be high.[20] As we know that for the growth of livestock amino acid required for the formation of the protein network while volatile fatty acids are used as a source of energy that the rest will be used as a fat or energy reserves.

Increasing in the rate of weight gain can be obtained by increasing the amount of feed composition, as is well known that the feed containing nutrients in sufficient quantities allowing livestock to grow. Therefore, the overall goat feed formulas in this study grew faster than those feed the conventional goat.

Based on Table IV above it can be seen that the protein content of goat meat that is given three kinds of feed formula was made in this research is higher (feed I = 17.0198%, ration II = 18.2870, ration III = 18.8037) than protein goat meat with the conventional feed (16.6%). In addition to increased protein content, the feed formulas was developed in this study also produce goat meat that low-fat content. Fat content of goat meat generally up to 9.2%, while based on the results of the analysis of goat meat with feed formula I was 2.2518%, formula II was 2.3878%, formula III was 2.2833%. Based on the results of the analysis of the data obtained can be stated that the feed formulas were developed in this study has the potential to produce goat meat with the low fat and high protein content.

Composition and nutritional value of feed are very important on the physical and physiological condition of the goat. Also, nutrient content of feed affects the quality of goat meat and goat hormonal conditions. Furthermore, the physiological processes that occur will affect the quality of meat especially level of protein and fat.

4. CONCLUSION

The fermented water hyacinth is feasible as the component of ruminant feed formulas. Feed formulas were developed in this study resulted in weight gain of goats is larger (2:07 kg per month) than that of goats with a conventional feed (1.5 kg per month). Feed formula III is the best formula to trigger weight gain goat (2.13 kg per month) is compared with feed formulas I and II (2:01 kg per month). While the protein content of goat meat with feed formulas are developed in this study increase of about 1% when is compared to the goat meat with the feed conventional feed. The level of fat in the goat meat with the feed formula are developed in this study experienced a decline of about 7%.

Acknowledgment: The researcher would like to thank all person especially Bayu Sandika and other students who have helped in this research.

References and Notes

1. Tham and H. Thanh, Water hyacinth (*Eichhornia crassipes)*-biomass production, ensilability and feeding value to growing cattle, Doctoral Thesis, Swedish University of Agricultural Sciences, Uppsala **(2012)**.
2. A. A. Mako, O. J. Babayemi, and A. O. Akinsoyinu, *Livestock Research for Rural Development* **(2011)**.
3. P. C. Okoye, F. Daddy, and B. D. Jlesanmj, The nutritive value of water hyacinth (*Eichhornia crassipes)* and its utilisation in fish feed, National Institute for Freshwater Research, P.M.B. 6606, New Bussa.
4. J. Lu, Z. Fu, and Z. Yin, *J. Environ. Sci. (China)* 20, 513 **(2008)**.
5. S. B. Mohapatra, *European Journal of Experimental Biology* 5, 31 **(2015)**.
6. H. Fitrihidajati, Isnawati, and G. Suparno, Using water hyacinth (*Eichornia crassipes*) as ruminant feed one kind of solution to handle the weed water, Research Report, LPPM Unesa, Surabaya **(2013)**.
7. H. Fitrihidajati, Isnawati, and G. Suparno, Using water hyacinth (*Eichornia crassipes*) as ruminant feed one kind of solution to handle the weed water, Research Report, LPPM Unesa, Surabaya **(2014)**.
8. G. Suparno, H. Fitrihidajati, and E. Ratnasari, Using feed fermented from water hyacinth, solid dreg waste of tofu factory and green kangkong as ruminant feed, Research Report, LPPM Unesa, Surabaya **(2015)**.
9. I. Mangisah, H. I. Wahyuni, Tristiarti, S. Sumarsih, and S. Setyaningrum, *Animal Production* 12, 100 **(2010)**.
10. K. S. Retta, *International Journal of Livestock Production* 7, 24 **(2016)**.
11. H. Fitrihidajati and E. Ratnasari, Pemanfaatan Limbah Blotong sebagai Pupuk Organik dengan Penambahan *Effektive Microorganism (EM4*), Laporan Penelitian Lemlit Unesa, Surabaya **2005**.
12. C. Qin, D. Bu, P. Sun, X. Zhao, P. Zhang, and J. Wang, *Animal Science Journal* 88, 259 **(2017)**.
13. S. N. O. Suwandyastuti and M. Bata, *Animal Production* 12, 82 **(2010)**.
14. J. A. M. Missotten, J. Michiels, J. Degroote, and S. D. Smet, *Jurnal of Animal Science and Biotechnology* 6, 1 **(2015)**.
15. Y. Zheng, Y. Lu, J. Wang, L. Yang, C. Pan, and Y. Huang, *Plos One* 8, 1 **(2013)**.
16. F. M. S. Pedro, I. A. D. Vara, J. L. Borguez, and M. G. Ronguillo, *Int. J. Recyel. Org. Waste Agricult.* 4, 273 **(2015)**.
17. I. Igwenyl, Ajah, Offor, and P. M. Aja, *International Journal of Pharma and Bio Sciences* 2, 593 **(2011)**.
18. L. M. Moriera, F. dep. Leonel, R. A. M. Vieira, and J. C. Pereira, *Rev. Bras. Saude Prod. Anim.* 14, 382 **(2013)**.
19. G. G. P. de Carvalho, R. Garcia, A. J. V. Pires, R. R. Silva, E. Detmann, R. L. Olivera, and L. S. O. Libeiro, *Asian-Aust. J. Anim. Sci.* 26, 65 **(2013)**.
20. H. B. Salem, *R. Bras. Zootec.* 39, 337 **(2010)**.
21. V. Mudgal, R. P. S. Baghel, and S. Srivastava, *Journal of Horticultural Letters* 1, 1 **(2010)**.

Received: 10 August 2016. Accepted: 15 May 2017.