



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF TROPICAL FRUIT PEELS ON *IN VITRO* RUMEN
FERMENTATION PROFILES AND GAS PRODUCTION IN CATTLE**

ATHIRA AMANINA OTHMAN

FP 2016 115

EFFECTS OF TROPICAL FRUIT PEELS ON *IN VITRO* RUMEN
FERMENTATION PROFILES AND GAS PRODUCTION IN CATTLE

BY

ATHIRA AMANINA BINTI OTHMAN

A project report submitted to Faculty of Agriculture, Universiti Putra
Malaysia, in fulfillment of the requirement of SHW4999 (Final Year Project)
for the award of the degree of Bachelor of Agriculture (Animal Science)

Faculty of Agriculture

Universiti Putra Malaysia

2015/2016

This project report entitled “**EFFECTS OF TROPICAL FRUIT PEELS ON *IN VITRO* RUMEN FERMENTATION PROFILES AND GAS PRODUCTION IN CATTLE**” is prepared by **Athira Amanina Binti Othman** and submitted to the Faculty of Agriculture in fulfillment of the requirement of SHW 4999 (Final Year Project) for the award of the degree of **BACHELOR OF AGRICULTURE (ANIMAL SCIENCE)**.

Student's name:

Student's signature:

ATHIRA AMANINA BINTI OTHMAN

Matric no : 170554

Certified by:

DR. ANJAS ASMARA BIN SAMSUDIN

Project Supervisor

Department of Animal Science

Faculty of Agriculture

Universiti Putra Malaysia

Date:

ACKNOWLEDGEMENTS

In the name of Allah, the most gracious and the most merciful. All praise to Allah S.W.T who has blessed me with patience and strength in finishing this final year project. First and foremost, I wish to express my gratitude to my family for being understanding and always stand by me through all the challenges and obstacles. Huge appreciation to my supervisor, Dr. Anjas Asmara as my supervisor, for all the guidance and advises throughout this study.

I wish to express my sincere appreciation and thanks to all postgraduate students, Sharmila Ahmad, Nurliyana Akmal, Diyana, Maisarah and laboratory assistance from Nutrition Lab, Pasture Lab and Microbe Lab Animal Science's Department, En. Saparin and En. Khairul Anuar who had been given a lot of assistance and also guideline to me while conducting the experiments.

In addition, special thanks to all of my classmates who have been helping and motivating me either directly or indirectly in completing this project. Last but not least, thank you to Prof Dr. Dahlan Ismail for all the guidelines in coordinating the project.

TABLE OF CONTENTS

TABLE OF CONTENT	iv
LIST OF FIGURE	vi
LIST OF TABLES	vii
ABSTRACT	viii
ABSTRAK	x
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Objective of Study	3
1.3 Hypothesis of Study	3
CHAPTER 2 LITERATURE REVIEW	4
2.1 Banana Peel	4
2.2 Pineapple Peel	5
2.3 Papaya Peels	6
2.4 Mangosteen Peel	6
2.5 <i>In vitro</i> Gas Production	8
CHAPTER 3 METHODOLOGY	9
3.1 Location of Study	9
3.2 Experimental of Design	9
3.3 Preparation of Sample	9
3.4 Proximate Analysis	10
3.4.1 DM and OM/Ash Determination	11
3.4.2 CP Determination	12
3.4.3 NDF Determination	13
3.4.4 ADF Determination	14
3.4.5 ADL Determination	15
3.5 Rumen Fluid Collection	15
3.6 <i>In vitro</i> Gas Production and IVDMD	16
3.7 Final pH Determination of Ruminal Fluid	18
3.8 Volatile Fatty Acid (VFA) Determination	19
3.9 Ammonia Determination	20
3.10 Statistical Analysis	21

CHAPTER 4 RESULT	22
4.1 Proximate Analysis	22
4.2 Cumulative Gas Production	24
4.3 <i>In vitro</i> Gas Production, IVDMD and Final pH of Ruminant Fluid	26
4.4 Volatile Fatty Acid (VFA) and Ammonia Production	27
CHAPTER 5 DISCUSSION	28
5.1 <i>In vitro</i> Gas Production, IVDMD and Final pH of Ruminant Fluid	28
5.2 Volatile Fatty Acid (VFA) and Ammonia Production	30
CHAPTER 6 CONCLUSION AND RECOMMENDATION	31
REFERENCES	32
APPENDIX	35

LIST OF FIGURES

Figure 4.1 Cumulative gas production of different feed samples

25



LIST OF TABLES

Table 3.1 Type of fruit peels used and total replicates used in this study	8
Table 4.1 Nutritive value of different feed samples (fruit peels)	23
Table 4.2 Cumulative gas production of different feed samples	26
Table 4.3 Volatile Fatty Acid (VFA) and ammonia production	27

ABSTRACT

Feed is one of major factor that plays important role in the animal production cost. Basic nutrition itself contributes in main expenses. There are various studies that have been done in order to reduce the feed cost by improving the nutritive value in the feedstuffs. In tropical countries, the abundance of tropical fruit peel is seen as an opportunity to explore new utilization of these waste products. Since most of tropical fruits are not seasonal, it becomes one of the advantages to run this study. There are four types of fruit peels chosen to be used in this study. Banana peels, pineapple peels, papaya peels and mangosteen peels are collected in the area near the UPM area. A study on nutritive value of banana peels, pineapple peels, papaya peels and mangosteen peels was conducted via *in vitro* rumen fermentation. Proximate analysis was also done to analyze the nutrient content in the samples. The general objective of this research was to determine the response of the rumen environment with different tropical fruits peel in cattle via *in vitro* rumen fermentation analyses. Diet 1 is banana peels sample, diet 2 is pineapple peels sample, and diet 3 is papaya peels sample while diet 4 is mangosteen peels sample. All these samples had 3 replicates. All these samples were added to basis diet as supplement. The basis diet consists of rice straw and concentrate. All the results were compared to the control diet's result. After 24 hours period of *in vitro* rumen fermentation, the gas production of all samples are not significant ($P < 0.05$) to the control's results. There are differences in cumulative gas production data, but there were no significant differences according to statistical analysis. After gas production

procedure, rumen fluid residues of samples were tested for pH reading. The pH readings of rumen fluid from all fruit peels supplement diets after *in vitro* procedure were also not significant ($P < 0.05$) when compared to pH value of rumen fluid for control's diet. The rumen fluid residues after the gas production procedure were collected for volatile fatty acid (VFA) analysis. The acetate, butyrate and propionate acid results were not affected ($P < 0.05$) when added with the fruit peels supplement diets when compared to control's result. Even though gas production, final rumen fluid's pH reading and VFAs production are not significant when compared to control diet, but ammonia production results of pineapple peels supplement diet and papaya peels supplement diet are significantly decreasing ($P < 0.05$) when compared to control diet. But the ammonia gas production was not affected ($P < 0.05$) when banana peels supplement diet and mangosteen peels supplement diet are used. For recommendation, further studies are needed in order to utilize this fruit waste. In future, some modification may be needed in this case for further study. For example, another type of fruit peels can be used. The percentage of fruit peels used can also be varied. Last but not least, the fruit peels used can be modified or treated. Thus, fruit peels can be used as a supplemental diet in ruminant as it has not significantly changes most at the crucial fermentation profiles.

ABSTRAK

Makanan adalah satu faktor utama yang memainkan peranan penting dalam kos produksi haiwan ternakan. Pemakanan asas sahaja telah menyumbang kepada perbelanjaan yang besar dalam produksi. Terdapat pelbagai kajian yang telah dilakukan bagi mengurangkan kos makanan dengan memperbaiki nilai nutrisi di dalam makanan haiwan. Di negara-negara tropikal, jumlah kulit buah-buahan tropikal yang banyak dilihat sebagai satu peluang untuk meneroka penggunaan produk buangan ini. Memandangkan kebanyakan buah-buahan tropikal adalah tidak bermusim, ia menjadi satu kelebihan dalam kajian ini. Terdapat empat jenis kulit buah-buahan yang telah dipilih di dalam kajian ini. Kulit pisang, kulit nenas, kulit betik dan kulit manggis dikumpul melalui kedai di sekitar kawasan UPM. Kajian nutrisi ke atas kulit pisang, kulit nenas, kulit betik dan kulit manggis dijalankan melalui pencernaan rumen '*in vitro*'. Diet 1 ialah sampel kulit pisang, diet 2 ialah sampel kulit nenas, diet 3 ialah sampel kulit betik dan diet 4 ialah sampel kulit manggis. Setiap sampel kulit buah ini mempunyai 3 replika. Semua sampel kulit buah ini dicampurkan dengan diet asas sebagai makanan tambahan. Diet asas terdiri daripada jerami padi dan konsentrat. Semua keputusan sampel dibandingkan dengan keputusan diet asas. Selepas 24 jam masa pencernaan rumen secara '*in vitro*', penghasilan gas oleh semua sampel adalah tidak memberi perbezaan ($P < 0.05$) setelah dibandingkan dengan keputusan diet asas. Terdapat perbezaan pada penghasilan gas tapi tidak ada perbezaan menurut pada analisis statistik. Selepas prosedur penghasilan gas, cecair rumen setiap sampel diuji bagi mengetahui

bacaan pH. Ternyata bacaan pH setiap cecair rumen dari semua sampel diet kulit buah-buahan tidak memberi perbezaan ($P < 0.05$) jika dibandingkan dengan diet asas. Cecair rumen selepas prosedur penghasilan gas dikumpul bagi analisis VFA. Penghasilan acetate, butyrate dan propionate dari sampel diet kulit buah-buahan tidak ada perbezaan ($P < 0.05$) jika dibandingkan dengan diet asas. Walaupun penghasilan gas, bacaan akhir pH cecair rumen dan penghasilan VFA tidak memberi perbezaan, namun penghasilan gas ammonia diet kulit nenas dan diet kulit betik memberi perbezaan ($P < 0.05$) yang rendah jika dibandingkan dengan diet asas. Manakala penghasilan gas ammonia oleh diet kulit pisang dan diet kulit manggis tidak memberi perbezaan ($P < 0.05$) jika dibandingkan kepada diet asas. Sebagai cadangan, kajian harus diteruskan bagi memaksimumkan penggunaan sisa kulit ini. Pada masa akan datang, sedikit pengubahsuaian boleh dilakukan. Seperti contoh, jenis kulit buah yang lain boleh digunakan. Peratusan kulit buah yang digunakan juga boleh dipelbagaikan. Akhir sekali, kulit buah yang digunakan boleh diubahsuai atau dirawat terlebih dahulu. Kesimpulannya, kulit buah boleh digunakan sebagai diet tambahan kerana profil fermentasi rumen tidak terganggu semasa proses penghadaman.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Locally available feed resources for ruminant production in the tropics are becoming increasingly important because of rising costs and limited supplies of conventional feedstuffs (Cherdthong and Wanapat, 2010). The highest expense in production cost is mainly from feedstuff cost that reaches more than half of the production cost. As the resource getting decreases, the price is getting higher. Thus, in order to reduce the cost, it is essential to find other alternative feed to overcome this situation.

The abundance of tropical fruit peel availability is seen as an initiative to overcome the wastage problem and to enhance the animal feed production. Tropical and subtropical fruit processing have considerably higher ratios of by-products than the temperate fruits (Schieber *et al.*, 2001). However, some of these tropical fruits peel contain condensed tannin, saponin, gossypol and other compound, which may limit their feeding quality and affect the ruminant digestibility and productivity (Pilajun and Wanapat, 2011). But on the bright side, there are few compounds in these tropical fruit peels that improve rumen fermentation and microbial population that could improve the feed digestion.

The *in vitro* gas production technique has been frequently used to assess initial biological values of feeds based on their pattern of accumulated gas when incubated with rumen fluid under anaerobic conditions. The technique was initially proposed by Menke *et al.*, (1979) to assess digestibility and metabolized energy (ME) content of feeds commonly fed to ruminants. This system is still used to determine fermentation dynamics, microbial biomass and short chain fatty acids.

Therefore, this study was aimed to determine the rumen fermentation profile and gas production of cattle with different tropical fruit peels, specifically banana (*Musa sapientum*) peel, pineapple (*Ananas comosus*) peel, papaya (*Carica papaya*) peel and mangosteen (*Garcinia mangostana*) peel via *in vitro* technique.

1.2.1 The general objective:

- To study the effect of rumen fermentation profile with different tropical fruit peels in cattle via *in vitro* rumen digestion

1.2.2 The specific objectives of the study are:

- To evaluate digestibility potentials of banana peels, pineapple peels, papaya peels and mangosteen peels as supplements in basal diet via *in vitro* digestion
- To determine the volatile fatty acid (VFA) production after *in vitro* digestion
- To determine the ammonia production after *in vitro* digestion

1.3 Research Hypothesis

Different types of tropical fruits peel have different effects on rumen fermentation profile, digestion kinetics and microbial population in cattle depending on the compound contains in the fruit peels.

REFERENCES

A. Jayanegara^{1,2}, G. Goel^{1,3}, H.P.S. Makkar¹ & K. Becker, 2010. Reduction in Methane Emissions from Ruminants by Plant Secondary Metabolites: Effects of Polyphenols and Saponins. *FAO Proc.indb* 152. 14:10:50

A.L Yusuf., M.Ebrahimi., Y.M. Goh., A.A. Samsudin, A.B Idris., A.R Alimon., A.Q Sazili., *In vitro* digestibility of diets containing different parts of *Andrographis paniculata* using rumen fluid from goats. A journal. *Journal of Animal and Veterinary Adnaces* 11 (21): 3921-3927, 2012

Cardozo PW., Calsamiglia S., Ferret A., & Kamel C. 2005. Screening for the effects of natural plant extracts at different pH on *in vitro* rumen microbial fermentation of a high-concentrate diet for beef cattle. A review. *J Anim Sci.* 83:2572–2579

Getachew, G., Makkar, H.P.S. & Becker, K. 1998. The *in vitro* gas coupled with ammonia measurement for evaluation of nitrogen degradability in low quality roughages using incubation medium of different buffering capacity. *J. Sci. Food Agric.* 77: 87–95.

Jayanegara, A., Togtokhbayar, N., Makkar, H.P.S. & Becker, K. 2009. Tannins determined by various methods as predictors of methane production reduction potential of plants by an *in vitro* rumen fermentation system. *Anim. Feed Sci. Technol.* 150: 230–237

K.A. Beauchemin, S.M. Mcginn, T.F. Martinez, T.A. Mcallister, 2007. Use of condensed tannin extract from quebracho trees to reduce methane emissions from cattle. *J. Anim. Sci.* 85:1990-1996.

M. Wanapat., P. Kongmun., O. Pongchompu., A. Cherdthong., P. Khejornsart., R. Pilajun., S. Kaenpakdee., Effects of plants containing secondary compounds and plant oil on rumen fermentation and ecology. A review article. *Trop Anim Health Prod* (2012) 44:399-405

Makkar, H. P. S., M. Blümmel, and K. Becker. 1995 In vitro effects and interactions of tannins and saponins and fate of tannins in rumen. *J. Sci. Food Agric.* 69:481-493

Menke K. H., L. Raab., A. Salewski., H. Steingass., D. Fritz., and W. Schneider., The estimation of digestibility and metabolizable energy content of ruminant's feedstuffs from gas production when they are incubated with rumen liquor in vitro, *Journal of Agricultural Science in Cambridge*, 93, (1979), 217-222

Menke K. H., and H. Steingass., Estimation of the energetic feed value obtained from chemical analysis and *in vitro* gas production using rumen fluid, *Animal Resources and Development*, 28, (1988), 7-55

Min, B. R., T. N. Barry, G. T. Attwood, and W. C. McNabb. 2003. The effect of condensed tannins on the nutrition and health of ruminants fed fresh temperate forages: a review. *Anim. Feed Sci. Technol.* 106:3-19

T. Norrapoke., M. Wanapat., S. Wanapat., Effects of Protein Level and Mangosteen Peel Pellets (Mago-pel) in Concentrate Diets on Rumen Fermentation and Milk Production in Lactating Dairy Crossbreds. *Asian Australas. J. Anim. Sci.* 2012;25(7):971-979

Wanapat M., S. Kang., P. Khejornsart., S. Wanapat., Effects of Plant Herb Combination Supplementation on Rumen Fermentation and Nutrient Digestibility in Beef Cattle, An article. *Asian-Australasian Journal of Animal Sciences (AJAS)* 2013; 26(8): 1127-1136

How Rumen Works: Tropical farming : feeding management for small holder dairy farmers in the humid tropics. By John Moran, 312 pp. Landlink Press, 2005

<http://www.feedipedia.org/>. Feedipedia - Animal Feed Resources Information System
INRA CIRAD AFZ and FAO © 2012-2015

