MINISTRY OF EDUCATION AND TRAINING
MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT
NATIONAL INSTITUTE OF ANIMAL SCIENCE

LE VAN HA

USING PASSION FRUIT PEEL (*Passiflora Edulis)* FOR DAIRY COWS IN SON LA PROVINCE

Major: Animal nutrition and feed
Code: 9 62 01 07

SUMMARY OF THE DOCTOTAL THESIS

Hanoi – 2022

This thesis was completed at: National Institute of Animal Science

Advisor 1: Prof. Dr. Nguyen Xuan Trach

Advisor 2: Dr. Nguyen Van Quang

Reviewer 1: Assoc Prof. Dr. Pham Kim Dang

Reviewer 2: Assoc Prof. Dr. Mai Thi Thom

Reviewer 3: Assoc Prof. Dr. Le Thi Thanh Huyen

This thesis will be defended at: National Institute of Animal Sciences.

Time: Date Month 9 Year 2022

The dissertation can be found at:

1. The National Library of Vietnam
2. The Library of the NIAS

LIST OF THE AUTHOR'S PUBLICATIONS

1. Le Van Ha, Nguyen Hung Son, Nguyen Xuan Trach, Bui Quang Tuan and Tran Hiep. 2020. Potential of using passion fruit peel as ruminant feed. Journal of Livestock Science and Technology, No 107 January 2020, 49 – 58.

2. Le Van Ha, Nguyen Van Quang and Nguyen Xuan Trach. 2020. Passion fruit peel as feed for dairy cows raising in Moc Chau District – Son La Province. Journal of Livestock Science and Technology, No 118 December 2020, 24 – 34.

3. Tran Hiep, Bui Quang Tuan, Nguyen Hung Son, Le Van Ha and Nguyen Xuan Trach, 2020. Passion fruit (*Passiflora edulis*) peel as feed for ruminants in Vietnam: use of passion fruit peel silage in the diet of dairy cattle. *Livestock Research for Rural Development. Volume 32 (4), Article #35.* Retrieved April 1, 2020.

1. Introduction

Son La is a province with the potential to develop herbivorous cattle. By 2020, there have been 25,400 cows, 343,723 beef cattle, and 130,095 buffaloes. To meet the demand for ruminant cattle, it is vital to have a a stable raw food source throughout the year. However, at present, there is a shortage of raw food sources in Son La, especially in winter, in the context that the area of grassland has been gradually narrowed due to the increasing need to use land for other more profitable purposes. Therefore, the solution to utilize the available agricultural by-products as animal feed is being concerned by the leaders of Son La province and scientists.

Passiflora edulis has recently been grown in many places in Vietnam, including Son La province, and they are being developed at a fast rate thanks to having a good export market. However, the Passiflora edulis processing for export has left a large amount of by-products, which leads to a very high risk of environmental pollution. Some studies have shown that Passiflora edulis peel can be used as good forage for cows (Alves et al., 2015; Figueiredo et al., 2019), for sheep (Santos-Cruz et al., 2013; Sena et al., 2013). ., 2015). However, there has not been any researches on using Passiflora edulis peel as animal feed so far in Vietnam.

Passiflora edulis peel has high fiber and water content while low protein content (He et al., 2020). In order that cattle can effectively use fresh Passiflora edulis peel, it is necessary to have measures to process, process and store them appropriately. Therefore, the research on processing and preserving these by-products will create a cheap source of food, contributing to lowering the cost of products, as well as reducing environmental pollution, which create sustainable development in the livestock industry.

2. Objectives of the project

- To determine the weight, chemical composition and nutritional value of Passiflora edulis peel as feed for dairy cows.
- To identify silage formula to preserve Passiflora edulis rind as feed for ruminants.

- To aim to use effectively Passiflora edulis peel in the diet of heifers and milking cows.

3. New contributions of the thesis

- Successful evaluation of the potential, composition and nutritional value of *Passiflora edulis* peel as animal feed as the first time in Vietnam.

- Creating the silage formula to preserve Passiflora edulis rind.

- Providing the effective way of Passiflora edulis peel in diets for dairy cows.

4. Scientific and practical significance of the thesis

a. Scientific significance

- Giving equation to estimate the reserve of Passiflora edulis peel.

- Document the nutritional value of Passiflora edulis peel.

- Finding out ways to preserve and appropriately use Passiflora edulis rind to replace some other foods in the diet for dairy cows.

- Opening a direction to exploit and use Passiflora edulis rind effectively and sustainably as cattle and buffalo feed.

b. Practical significance

- Opening the possibility of using *Passiflora edulis* peels in Son La as feed for dairy cows, helping to create cheaper feed sources, contributing to lower product costs and increase income for farmers.

- Reducing cost of environmental treatment and minimize environmental pollution caused by Passiflora edulis processing enterprises.

- The thesis is a reference for research institutions, universities and colleges as well as for dairy farms.

5. Structure of the thesis

The thesis consists of 5 parts: Introduction (3 pages); Chapter 1: Literature review (38 pages); Chapter 2: Research content and methods (9 pages); Chapter 3: Results and discussion (46 pages); Conclusions and Recommendations (1 page). There are 28 tables of data, 10 figures, 135 references, and 1 page of list of author's publications.

Chapter 1
LITERATURE REVIEW

1.1. Scientific evidence of research

The thesis presents the digestive characteristics of ruminant cattle, methods of processing and using by-products as feed for ruminants, factors affecting the quality of silage (especially the harvesting, the temperature of the silage pit, the degree of mincing of crude materials), the situation of using by-products as feed for ruminant cattle domestically and abroad.

1.2. Status of research and use of passion fruit by-products as feed for ruminants

First of all, this section introduces passion fruit trees, varieties, characteristics and distribution in the world, current situation of passion fruit cultivation in Vietnam. Next it mentions the chemical composition and value of passion fruit. Passion fruit peel is mixed into ruminant rations for different purposes, such as improving growth, feed utilization, improving ruminant product quality, and reducing feed costs, improve livestock efficiency.

For the above purposes, Passiflora edulis rind is added to the diet as a supplement or a source of food instead of traditional food. There have been a number of studies using fresh Passiflora edulis rind in goats, sheep, and beef cattle. On that basis, the recommended levels of using Passiflora edulis peel in the diet for dairy cows are considered as the basis for the research of the thesis.

Chapter 2
RESEARCH CONTENTS AND METHODS

2.1. Materials, study sites and time period of study

2.1.1. Materials:

- Feed: purple Passiflora edulis peel and other feeds including: cob, bagasse, molasses, maize, Pennisetum purpureum, bran, tapioca meal, soybean meal, mineral premix.
- Livestock: dairy cows and HF milking cows (Holstein Friesian).

2.1.2. Study sites

- Field works (silage, experiment on cow raising) at Son La province,
- Analysis of feed samples, brewing materials and chemical composition of Passiflora edulis peels and processing formulas at the Vietnam Academy of Agriculture;
- Assessment of nutritional value and metabolic energy of dairy cow diets by in vitro gas production method at the Institute of Livestock Production.

***2.1.3. Time period* of study**: 2017 - 2021.

2.2. Contents of study

- Determining weight, chemical composition and nutritional value of Passiflora edulis by-products in Son La province.
- Studying on silage formula to preserve passion fruit peel as feed for dairy cows.
- Studying on diets using *Passiflora edulis* peel for dairy cows.

2.3. Methods

2.3.1. Evaluation of potential by-products of passiflora edulis

Secondary survey: Surveying the whole province on the area and yield of Passiflora edulis based on reports from the People's Committees of communes, districts, departments, companies and cooperatives growing passiflora edulis

Primary survey: Directly survey through interview questionnaires with farmer households, cooperatives, companies, district and city departments. Identify the main products, by-products of Passiflora edulis such as: fresh rind, dried rind and seeds.

Chemical component analysis of *Passiflora edulis* peel: Dry matter, total minerals; crude fiber, lipid, crude protein; Non-nitrogen derivatives and ME (energy exchange) according to Vietnamese standards and National Research council (2016).

2.3.2. Studying recipe for silage of passion fruit rind as feed for cows

**** Experiment 1: Processing and preserving Passiflora edulis rind by silage method in the laboratory***

After scooping fruit juice, Passiflora edulis peel is brought to the laboratory for silage. The experiment is shown in the diagram Table

2.1.

Table 2.1. Layout diagram of the experiment for silage of *Passiflora edulis* rind

No	Experiment	Formula	Model number
1	100% of Passiflora edulis rind	CT1	3
2	98% of Passiflora edulis rind + 2% of molasses (according to usage form)	CT2	3
3	75% of Passiflora edulis rind + 20% of dry cob + 5% of molasses (according to usage)	CT3	3
4	75% of Passiflora edulis rind + 20% of sugarcane bagasse + 5% of molasses (according to usage form)	CT4	3
5	75% of Passiflora edulis rind + 10% of sugarcane bagasse + 10% of dried cob + 5% of molasses (according to usage).	CT5	3

Passiflora edulis peel is chopped into 1-2cm in length, dried corn cob is crushed by machine with 0.5 cm sieve, then mix the experimental ingredients according to the ratio of each brewing formulae.

Place the mixture into a glass flask, firmly compress the mixture layer by layer to remove all air from the incubator, maintain the laboratory temperature. Total number of incubation flasks: 5 CT x 3 incubation time x 3 flasks/CT = 45 flasks. Evaluation times: 0; 30; 60 and 90 days after incubation.

* Targets to track

Sensory: color, smell, state, musty.

Chemistry: pH, content of organic acids and NH3–N.

* Method of determining the criteria: pH according to Hartlay and Jones (1978); organic acids by high performance liquid chromatography (HPLC); NH3–N according to Kjeldahl.

**** Experiment 2:* Fermentation of complete mixed feed (FTMR) with *Passiflora edulis* peel in the laboratory***

Table 2.2a. Formula for mixing FTMR (% DM)

Material	FTMR1	FTMR2	FTMR3	FTMR4
Passiflora edulis peel	12,50	25,00	25,00	25,00
Dry cob	-	-	-	10,00
Dry sugarcane bagasse	-	-	10,00	-
Dough-stage maize	25,00	25,00	30,00	30,00
Pennisetum purpureum	12,50	-	-	-
Corn powder	12,50	12,50	12,00	12,00
Cassava powder	12,50	12,50	-	-
Molasses	10,00	10,00	10,00	10,00
Dried soybeans	15,00	15,00	13,00	13,00
Total	**100,00**	**100,00**	**100,00**	**100,00**

Notes: FTMR: Fermented Complete Feed; VCK: Dry matter

Table 2.2b. Formula for mixing FTMR (% as fed)

Formulae	FTMR1	FTMR2	FTMR3	FTMR4
Material				
Passiflora edulis peel	28,5	54,5	51,4	52,7
Dry cob	-	-	-	3,4
Dry sugarcane bagasse	-	-	5,8	-
Dough-stage maize	27,8	26,5	30,0	30,7
Pennisetum purpureum	23,7	-	-	-
Corn powder	5,0	4,8	4,4	4,5
Cassava powder	4,8	4,6	-	-
Molasses	4,4	4,2	3,9	4,0
Dried soybeans	5,8	5,5	4,5	4,6
Total	**100**	**100**	**100**	**100**
Nutritional composition				
DM (%)	34,16	32,59	30,75	31,54
ME (MJ/kg DM)	10,56	10,47	9,95	9,91
Crude protein(% DM)	15,66	15,92	15,10	15,09
Crude fiber (% DM)	17,35	16,79	21,37	21,23

Notes: FTMR: Fermented Complete Feed; VCK: Dry material

Total number of flasks: 4 Formula x 2 incubation time x 3 flasks/CT = 24 flasks.

* Monitoring indicators: the same to the criteria of the experiment

1.

**** Experiment 3: Incubation of sour fermentation of Passiflora edulis peel and complete mixed feed (FTMR) in the field***

Based on the laboratory research results in section 2.4.2.1, select 03 passion fruit zest silage formulas and 02 FTMR silage formulas with good results for preservation silage in field to evaluate the suitability of incubation method and the palatability of processed feed

* The indicators and methods of monitoring the indicators are the same as experiments 1 and 2.

** Determination of the amount of processed Passiflora edulis peel obtained from cows*

Exploring the palatability of silage feed to dairy cows: 10 heifers are fed 05 types of feed (03 CT silage and 02 CT FTMR in the field) to assess the palatability of the feed made of Passiflora edulis rind.

Evaluation criteria:

Feed intake by cows per unit time (60 min).

2.3.3. Research on diets using Passiflora edulis peels for dairy cows

**** Experiment 4: Research on diets using passion fruit rind to raise heifers***

Table 2.3a. Layout diagram of the experiment on heifers

Indicator	Control	TN1	TN2
n (head)	5	5	5
Age (month)	6-7	6-7	6-7
Average weight (kg)	171,7	172,7	169,6
Adaptation time (day)	15	15	15
Follow-up period (month)	3	3	3
Cow feed	Control	KP 1	KP 2
Water	Free	Free	free

Note: ĐC: Maize silage accounted for 65% of the VCK ration; TN1: silage Passiflora edulis rind replaced 50% of silage maize; TN2: Passiflora edulis silage replaced for 100% of corn silage; Fermented Passiflora edulis peel according to the formulae: 75% of Passiflora edulis peel + 20% of dried corn cobs + 5% of molasses)

Table 2.3b. Formula of experimental feed on heifers

Target	Control	TN1 (KP 1)	TN2 (KP2)
Material (kg/100kg DM)			
Silage Passiflora edulis rind	-	32.5	65.0
Silage maize	65.0	32.5	-
Pennisetum purpureum	15.0	15.0	15.0
Mixed food	20.0	20.0	20.0
Nutritional composition			
Dry matter (%)	31.3	32.0	32.7
ME (MJ/kg DM)	9.25	9.17	9.09
Crude protein (% DM)	11.5	11.7	11.9
Crude fiber (% DM)	25.5	25.6	25.6

Table 2.3c. Formula of experimental feed on heifers

Chỉ tiêu	ĐC	TN1 (KP 1)	TN2 (KP2)
Material (% as fed)			
Silage Passiflora edulis rind	-	31.5	64.9
Silage maize	66.8	34.3	-
Pennisetum purpureum	26.0	26.8	27.5
Mixed food	7.2	7.4	7.6
Tổng	**100**	**100**	**100**

Note: ĐC: Maize silage accounted for 65% of the DM ration; TN1: Passiflora edulis rind silage replaced 50% of silage maize; TN2: Passiflora edulis silage replaced 100% of corn silage; Fermented Passiflora edulis peel according to the formulae: 75% of Passiflora edulis peel + 20% of dried corn cobs + 5% of molasses)

The feed is used as a control instead of corn silage. Experimental food is the diet using silage Passiflora edulis peel. Mixed feed for cows produced by Moc Chau Dairy Cow Breeding Joint Stock Company. A total of 15 HF heifers average age 6-7 months

A total of 15 HF heifers aged 6-7 months on average, with average weight of 172 ± 3.42 kg randomly assigned (CRD) to feed 3 different diets (Table 2.3a).

** Monitoring metrics:*

Laboratory evaluation criteria:

- Calculate the amount of gas generated at the time: 3; 6; 12; 24; 48 and 72h based on the in vitro gasproduction method of Menke and Steingass (1988).

- Determine metabolic energy (ME); Estimate organic matter digestibility (OMD) according to Menke and Steingass (1988). short-chain fatty acids (SCFA) according to Getachew et al. (1999).

Indicators for monitoring on cattle: Daily intake of feed; increase in weight and feed efficiency

**** Experiment 5: Research on diets using Passiflora edulis peels for dairy cows***

* *Experimental diet:* Experimenting with milking cows on 2 nutritional diets and 01 control diet is showed at the table 2.4a and 2.4b.

Table 2.4a. Layout diagram of the experiment on dairy cows

Indicator	Control	TN3	TN4
n (head)	5	5	5
Cow weight (kg)	532.3	530.3	532.2
NSS before the experiment (kg/day)	22.3	22.6	23
Period (month)	2-5	2-5	2-5
Follow-up period(month)	3	3	3
Cow feed	Control	Ration 3	Ration 4
Water	Free	Free	free

Note: ĐC (Control): The rations of the farm's silage maize; KL: Volume; NSS: Milk yield; TN: Experiment

Table 2.4b. Experimental feed formulae on milking cows according

	Control	TN3 (KP3)	TN4 (KP4)
Material (kg/100kg DM)			
Silage Passiflora edulis rind	-	20.0	40.0
Silage maize	40.0	20.0	-
Pennisetum purpureum	15.0	15.0	15.0
Mixed food	45.0	45.0	45.0
Nutritional composition			
Dry matter (% as fed)	37.8	38.4	39.1
ME (MJ/kg DM)	9.97	9.92	9.87
Crude protein (% DM)	13.6	13.7	13.9
Crude fiber (% DM)	19.5	19.6	19.6

Table 2.4c. Experimental feed formulae on milking cows according

Items	ĐC	TN1 (KP1)	TN2 (KP2)
Material (% as fed)			
Silage Passiflora edulis rind	-	23.1	47.2
Silage maize	49.3	25.2	-
Pennisetum purpureum	31.3	31.9	32.6
Mixed food	19.4	19.8	20.2
Total	**100**	**100**	**100**

Note: ĐC: maize Silage accounted for 40% of the VCK ration; TN3: Passiflora edulis rind silage replaced 50% of silage maize; TN4: Passiflora edulis rind silage replaced 100% of maize Silage; Fermented Passiflora edulis peel according to the formulae: 75% of Passiflora edulis peel + 20% of dried corn cob + 5% of molasses) ME: Metabolic Energy; TMR: Complete compound feed; TN: Experiment; DM: Dry matter

** Tracking indicators*

- Laboratory evaluation criteria:

Total amount of gas generated at all of the time; determination of metabolic energy (ME) and short-chain fatty acids (SCFA) the same as experiment 4.

- Monitoring indicators on cattle

+ Daily intake of food: The same to the experimental 4.

+ Milk yield (kg/head/day):

FCMY (kg) = milk fat productivity (kg) x (0,4 + 0,15 x % Actual milk fat)

+ Milk quality: Analysis of milk fat %; % milk protein; % Fat-free VCK

(SNF) using an ECOMILK M90 analyzer.

+ Determination of body condition score of cows: according to the method of Ferguson et al. (1994).

+ Feed conversion ratio (FCR): the number of kg of feed consumed for 1 kg of milk.

2.4. Data processing methods

* Data processing of experiment 3 (testing palatability of cows to silage feed in the field), experiment 4 and 5 are analyzed by one-way ANOVA using Minitab 16 software. The ANOVA model is as follows:

$$y_{ij} = \mu + a_i + e_{ij}$$

In there: μ is average value

a_i is the effect of experimental batch i (i = 1, 2, 3)

e_{ij} is random error of the cow j (j = 1, 2, 3, 4, 5) of experimental batch i.

Average values are compared in pairs method to Tukey's standard at $P<0.05$.

* Data processing of experiment 1, 2 and 3 (field incubation) is analyzed by two-way ANOVA using Minitab 16 software. The ANOVA model is as follows:

$$y_{ij} = \mu + a_i + b_{ij} + e_{ijk}$$

In there: μ is average value

a_i is the difference due to the influence of the formula silage/FTMR i (i = 1, 2, 3, 4, 5)

b_{ij} is the difference due to the effect of incubation time j (j = 1, 2, 3)

e_{ijk} is random error of the sample k (k = 1, 2, 3) of formula silage/FTMR i at incubation time j.

Average values are compared in pairs method to Tukey's standard at $P<0.05$.

Chapter 3

RESULTS AND DISCUSSION

3.1. Volume of passion fruit by-products of Son La province

The area of Passiflora edulis in Son La increased by 2,023 ha from 2017 to 2019; productivity reached 19,746 tons of fruit (2019). The percentage of fresh pods was determined to be 41.07%; fruit juice accounted for 38.21%; grain accounted for 18.96%; From that, the volume of by-products of Passiflora edulis in 2019 was estimated to reach 8,656 tons.

3.2. Chemical component and energy value of Passiflora edulis by-products

The results of chemical composition analysis and determination of

energy (ME) value of Passiflora edulis peel are presented in Table 3.1.

Table 3.1. Chemical component and energy value of Passiflora edulis by-products from Son La Province

Material	DM (%)	Composition (% DM)					ME (MJ/kg VCK)
		CP	CF	EE	Ash	ND	
Passion fruit peel	14.96	14.11	29.83	0.98	7.55	47.53	7.98
Passion fruit seed	91.00	13.48	23.37	25.13	1.32	36.70	13.85

Notes: DM: Dry matter, Ash: Total ash, ND: Non-nitrogen derivatives; ME: Metabolizable Enegry, CF: Crude fiber; CP: Crude Protein; EE: Ether extract..

Passiflora edulis peel has a low percentage of dry matter (14.96%) so it is difficult to dry. Thanks to the relatively high content of raw protein (14.11%) and non-nitrogen derivatives (47.53%) fresh Passiflora edulis rind can be used as a fermentable feed for ruminants.

The ME value of Passiflora edulis peel (7.98MJ/kg DM) is equivalent to the ME value of some good herbaceous plants in Vietnam.

3.3. Fermentation in the laboratory

3.3.1 Fermentation of Passiflora edulis rind

a. Sensory evaluation of silage quality

After 30 days of incubation, the silage in all formulas is light yellow, soft, with a slight sour smell and not moldy. Particularly, the formulae brewed with 20% sugar cane bagasse has a slight alcohol smell, with hard pieces from the sugarcane bark.

When incubating for 60 and 90 days, the food turns darker yellow-brown, soft, has a slight sour smell and appears moldy on 1/3 of the surface. In particular, in the brewing formulae with only Passiflora edulis peel (CT1) or Passiflora edulis rind and 2% molasses (CT2), the product becomes sour, soft and slightly crushed, indicating poor quality.

b. Evaluation of the quality of silage by chemical composition

The pH of most of the formulas in this experiment drops below 4.2, except for the silage with suage cane bagasse (CT1) and remain stable until 90 days of incubation.

The results of chemical component determination of silage are presented in Table 3.2.

Table 3.2. Nutritional component of fermenting Passiflora edulis peel according to different formula

Silage	DM (%)	CP (%DM)	CF (%DM)	EE *(%DM)*	Ash *(%DM)*	ND *(%DM)*	ME (MJ/kg DM)
Before incubation							
CT1	14.96^{d}	14.11^{a}	29.83	0.98^{a}	7.55^{a}	47.53^{c}	7.98
CT2	16.22^{d}	13.81^{a}	26.96	0.88^{a}	7.55^{a}	50.80^{b}	8.09
CT3	33.50^{a}	7.42^{b}	29.37	0.45^{b}	4.29^{b}	58.47^{a}	8.25
CT4	25.71^{c}	8.93^{b}	28.08	0.51^{ab}	5.28^{ab}	57.20^{a}	8.34
CT5	29.58^{b}	8.08^{b}	28.83	0.48^{b}	4.72^{ab}	57.89^{a}	8.29
SEM	0.40	0.74	0.81	0.13	0.68	0.68	0.54
P	0.001	0.001	0.178	0.046	0.015	0.001	0.988
After 30 days of incubation							
CT1	14.47^{d}	13.82^{a}	31.80^{a}	1.19^{a}	7.45	45.74^{b}	8.37
CT2	15.72^{d}	13.44^{a}	28.88^{b}	1.12^{a}	8.42	47.22^{b}	8.29
CT3	33.05^{a}	7.07^{b}	31.32^{ab}	0.72^{b}	6.43	54.46^{a}	8.33
CT4	25.32^{c}	8.62^{b}	30.00^{ab}	0.78^{b}	6.92	53.68^{a}	8.40
CT5	29.08^{b}	7.81^{b}	30.76^{ab}	0.74^{b}	6.57	54.12^{a}	8.37
SEM	0.74	0.59	0.73	0.11	0.69	0.54	0.80
P	0.001	0.001	0.110	0.033	0.317	0.001	0.999
After 60 days of incubation							
CT1	14.16^{d}	13.556^{a}	31.82^{a}	1.22	8.85	44.55^{b}	8.17
CT2	15.41^{d}	13.07^{a}	28.86^{b}	1.18	8.65	46.24^{b}	8.11
CT3	32.82^{a}	6.85^{b}	31.35^{ab}	0.85	6.53	54.42^{a}	8.35
CT4	25.05^{c}	8.34^{b}	30.12^{ab}	0.84	7.08	53.62^{a}	8.38
CT5	28.88^{b}	7.52^{b}	30.74^{ab}	0.88	6.42	54.44^{a}	8.43
SEM	0.52	0.46	0.54	0.11	0.64	0.48	0.67
P	0.001	0.001	0.022	0.077	0.058	0.001	0.996
After 90 days of incubation							
CT1	13.82^{d}	13.45^{a}	31.80^{a}	1.34	9.26	44.15^{b}	8.14
CT2	15.04^{d}	13.01^{a}	28.81^{b}	1.24	9.90	47.04^{b}	8.25
CT3	32.42^{a}	6.45^{b}	31.38^{ab}	0.88	8.17	53.12^{a}	8.11
CT4	24.85^{c}	8.04^{b}	30.02^{ab}	0.92	7.78	53.24^{a}	8.31
CT5	28.54^{b}	7.41^{b}	30.70^{ab}	0.98	6.78	54.13^{a}	8.41
SEM	0.35	0.81	0.61	0.19	0.70	0.72	0.49
P	0.001	0.001	0.042	0.387	0.077	0.001	0.992
P*	0.020	0.265	0.001	0.001	0.001	0.001	0.981

*Notes: In each indicator and in each time period, the mean values have statistically significant diferences (p<0,05); *: value of probability comparison between incubation times of research criteria. CT1 (Passiflora edulis rind); CT2 (Passiflora*

edulis rind + 2% of molasses); CT3 (75% of Passiflora edulis peel + 20% of dried corn cob + 5% of molasses); CT4 (75% of Passiflora edulis peel + 20% of sugar cane bagasse + 5% of molasses); CT5 (75% of Passiflora edulis peel + 10% of dried corn cob + 10% of sugar cane bagasse + 5% of molasses); ND: Non-nitrogen derivatives; Ash: Total ash; DM: Dry matter

The addition of dried bagasse and/or dried corn cobs increases the VCK content in the silage formulations, for which the food can be preserved for a longer period of time. As a result, CT3, CT4 and CT5 have a higher percentage of lactic acid than CT1 and CT2.

Good silage food has an amount of lactic acid concentration in the range of 1.2 % -1.5% (depending on feed form). The above silage formula (except CT1) all have relatively high concentrations of lactic acid and low concentrations of butyric acid.

3.3.2. ***Fermentation complete mix (FTMR) containing Passiflora edulis rind***

a. Sensory evaluation of quality FTMR

After 5 weeks of incubation, on the surface of the FTMR feed, slight mold appeared (about 1/3 of the surface).

b. Evaluation of the quality of silage by chemical composition

The pH of the FTMR formulations was lowered to approximately 4.5 and remained stable up to 5th week after incubation.

The results of chemical component of FTMR feed are presented in Table 3.3.

Table 3.3. Nutritional component of FTMR feed

Formula	DM (%)	CP (%DM)	CF (%DM)	EE (%DM)	Ash (%DM)	ND (%DM)	ME (MJ/kg DM)
Before incubation							
FTMR1	34.94	15.48	17.35^{b}	2.12	6.21	58.84	10.56
FTMR2	33.98	15.82	16.80^{b}	1.77	5.92	59.69	10.47
FTMR3	32.68	14.83	21.37^{a}	1.43	5.97	56.40	9.95
FTMR4	33.47	14.81	21.23^{a}	1.43	5.92	56.61	9.91
SEM	0.50	0.68	0.66	0.39	0.94	1.02	1.00
P	0.67	0.673	0.002	0.565	0.995	0.129	0.948
After 3 weeks of incubation							
FTMR1	34.85	15.01	17.52^{b}	2.42	6.35	58.70	10.03
FTMR2	33.91	15.05	17.16^{b}	2.10	6.04	59.65	10.02
FTMR3	32.56	14.46	21.54^{a}	1.85	6.02	56.13	9.62
FTMR4	33.44	14.89	21.44^{a}	1.82	6.05	55.80	9.62

SEM	0.74	0.51	0.79	0.45	0.75	1.34	0.94
P	0.250	0.841	0.006	0.768	0.987	0.193	0.978
After 5 weeks of incubation							
FTMR1	34.78	14.44	17.65[b]	2.59	6.46	58.86	10.05
FTMR2	33.88	14.78	17.24[b]	2.34	6.08	59.56	10.07
FTMR3	32.58	14.04	21.66[a]	2.07	6.14	56.09	9.62
FTMR4	33.41	14.27	21.62[a]	2.08	6.21	55.83	9.62
SEM	0.82	0.45	0.68	0.50	0.57	1.05	1.06
P	0.356	0.703	0.002	0.862	0.966	0.081	0.981
P*	0.977	0.118	0.775	0.199	0.923	0.909	0.816

*Notes: In each indicator and in each time period, the mean values have statistically significant diferences (p<0,05); *: value of probability comparison between incubation times of research criteria. FTMR1: Fermented complete feed with 12.5% of Passiflora edulis rind; FTMR2: Fermented complete feed with 25.0% of Passiflora edulis rind; FTMR3: Fermented complete feed with 25.0% of Passiflora edulis rind and 10% of sugar cane bagasse; FTMR4: Fermented complete feed with 25.0% of Passiflora edulis rind and 10% of dried cob; ND: Non-nitrogen derivatives; Ash: Total ash; DM: Dry matter*

With the above pH value, the nutrients of FTMR feed are well preserved and not spoiled.

FTMR feed is only incubated for a short period of time (3-5 weeks), so the chemical composition and nutritional value do not change much compared to the feed before incubation. The raw protein rate of all FTMR formula is slightly reduced, which is due to the activity of the enzyme in proteolytic plant cells that produces NH3. Raw protein rate, raw fiber rate and ME density of the FTMR formula after 3-5 weeks of incubation remain within the appropriate level for dairy cows.

3.4 Fermenting Passiflora edulis rind in the field

3.4.1. Fermentation of Passiflora edulis rind with other by-products

From 5 formula for silage of Passiflora edulis peel in the laboratory, 3 formula including CT3, CT4 and CT5 showing the best results are selected for further research to incubate in the field and test on animals.

a. Sensory evaluation of silage quality

The silage in all formula is light yellow-brown, soft with a slight sour smell and is not moldy after 30 days of incubation. When incubating for 60 and 90 days, the food turns darker yellow-brown, soft with a slight sour smell and appears moldy on 1/3 of the surface. Particularly, the brewing formula with sugar bagasse (CT4 and CT5) has slight alcohol smell, and there is a hard bagasse pieces from the

sugarcane bark.

b. Evaluation of silage quality by pH and organic acid content

The pH value of the silage after 30 days of incubation drops below 4.2; then decreases slightly and remains stable at around 3.9.

The chemical composition of silage according to the formula and incubation time is presented in Table 3.4 and Table 3.5.

Table 3.4. Contents of organic acids and NH3-N of fermenting Passiflora edulis peel according to different formula in the field

Ensiling time (days)	**Silage**	**NH3 -N** (g/kg N)	**Organic acids profile** (g/kgDM)		
			Lactic acid	**Acetic Acid**	**Butyric Acid**
30	CT3	62.54	89.16	23.13	0.88
	CT4	63.58	91.55	22.08	0.74
	CT5	63.66	91.18	23.86	0.62
	SEM	1.72	1.28	0.93	0.12
	P	0.762	0.421	0.443	0.391
60	CT3	64.20	93.50	25.06	0.80
	CT4	68.08	92.79	24.50	0.70
	CT5	68.25	95.11	24.08	0.80
	SEM	1.42	1.32	1.07	0.09
	P	0.153	0.488	0.817	0.702
90	CT3	70.86	93.05	25.28	0.90
	CT4	72.77	92.20	24.27	0.90
	CT5	73.19	9.00	24.80	0.92
	SEM	1.25	1.75	1.03	0.01
	P	0.426	0.929	0.794	0.422
P*		0.001	0.047	0.097	0.087

*Notes: In each indicator and in each time period, the mean values have statistically significant diferences (p<0,05); *: value of probability comparison between incubation times of research criteria. CT3: 75% of Passiflora edulis peel + 20% of dried corn cobs + 5% of molasses; CT4: 75% of Passiflora edulis peel + 20% of bagasse + 5% of molasses; CT5: 75% of Passiflora edulis peel*

+ 10% of bagasse + 10% of dried corn cobs + 5% of molasses.

c. Assessment of quality fermentation feed in the field by their chemical component.

Chemical component and nutrition of fermentation feed in the field by their different mixing fomulars and fermentation time are showed in Table 3.5.

Table 3.5. Nutritional component of silage Passiflora edulis peel and by-products by different formulas in the field

Silage	**DM** (%)	**CP** (%DM)	**CF** (%DM)	**EE** *(%DM)*	**Ash** *(%DM)*	**ND** *(%DM)*	**ME** (MJ/kg DM)
Before incubation							
CT3	33.50[a]	7.42	29.37	0.45	4.29	58.47	8.25
CT4	25.71[b]	8.93	28.08	0.51	5.28	57.20	8.34
CT5	29.58[ab]	8.08	28.83	0.48	4.72	57.89	8.29
SEM	1.39	1.00	1.10	0.04	0.53	0.55	0.52
P	0.021	0.591	0.721	0.586	0.469	0.330	0.992
After 30 days of incubation							
CT3	33.05[a]	7.12	31.30	0.68	6.45	54.45	8.32
CT4	25.32[b]	8.75	29.55	0.72	6.98	54.00	8.41
CT5	29.08[ab]	7.88	29.88	0.69	6.62	54.93	8.42
SEM	1.22	0.92	0.87	0.09	0.77	0.98	0.53
P	0.012	0.495	0.379	0.946	0.886	0.803	0.990
After 60 days of incubation							
CT3	32.82[a]	6.88	31.31	0.80	6.65	54.36	8.32
CT4	25.05[b]	8.42	30.16	0.85	7.12	53.45	8.38
CT5	28.88[ab]	7.54	30.90	0.90	6.55	54.11	8.41
SEM	1.20	0.64	1.07	0.04	0.70	0.46	0.48
P	0.011	0.309	0.755	0.941	0.835	0.409	0.989
After 90 days of incubation							
CT3	32.42[a]	6.49	31.40	0.86[b]	8.22	53.03	8.10
CT4	24.85[b]	8.14	30.16	0.90[ab]	7.74	53.06	8.30
CT5	28.54[ab]	7.65	30.77	0.97[a]	6.82	53.79	8.40
SEM	0.99	0.71	0.46	0.02	0.51	0.53	0.46
P	0.005	0.309	0.241	0.029	0.204	0.092	0.896
P*	0.781	0.726	0.038	0.001	0.001	0.001	0.992

*Notes: In each indicator and in each time period, the mean values have statistically significant diferences (p<0,05); *: value of probability comparison between incubation times of research criteria. CT3 (75% of passion fruit rind + 20% of dried corn cob + 5% of molasses), CT4 (75% of Passiflora edulis rind + 20% of bagasse + 5% molasses), CT5 (75% of Passiflora edulis rind + 10% of dried cob + 10% of bagasse + 5% of molasses); DXKN: Non-nitrogen derivatives; KTS: Total Minerals; VCK: Dry matter*

Silage in laboratory conditions can be better controlled, and can reduce the bad effects of adverse weather conditions. However, silage on a smaller scale is more difficult to conduct except using a vacuum cleaner to remove all the air from the silage. Incubation in the field is implemented on a larger scale, so it is easier to silage, but the preservation of food will be affected by surrounding environmental factors.

d. Collecting passion fruit rind to incubate according to different formula of dairy cows

The amount of silage collected in the first day is very low, especially silage CT4 because there are hard pieces of bagasse in the feed that pierce the cow's gums, so the cows are cautious when eating, and the feed has the smell of alcohol, which makes dairy cows uninterested

Thus, silage formula CT3 gives good results according to sensory evaluation, pH, chemical analysis criteria as well as feed intake of dairy cows, so silage formula CT3 can be used for feeding on dairy calves. and dairy cows.

3.4.2. Fermentation of complete mixed feed containing Passiflora edulis rind

Based on 4 FTMR incubation formula in the laboratory, the formular 2 which is the most suitable formula was selected for field incubation and animal testing.

a. Sensory evaluation of the quality of FTMR containing Passiflora edulis rind

After 21 days, FTMR4 shows good results, with the color of a light yellow-brown state, a slight sour smell, soft food, not crushed, no mold phenomenon.

b. Evaluation of FTMR quality by pH and organic acid content

The content of organic acids and nutritional values of FTMR are presented in Table 3.6 and Table 3.7.

Table 3.6. Contents of organic acids and NH3-N of FTMR containing Passiflora edulis rind silage in the field by different formulas

Time of incubation (day)	Formula	NH_3 -N (g/kg N)	Organic acids (g/kg VCK)		
			Lactic Acid	Acetic Acid	Butyric Acid
21	FTMR3	58.45	79.78	24.32	patch
	FTMR4	60.34	77.40	23.70	patch

Notes: FTMR3: Fermented complete feed with 25.0% Passiflora edulis rind and 10% suager cane bagasse; FTMR4: Fermented complete feed with 25.0% of Passiflora edulis rind and 10% of dried corn cob; VCK: Dry matter

Compared with the above silage formula, the two FTMR formula have higher pH values, perhaps because the evaluation time is on the 21st day of incubation, the formation of organic acids are still happening.

The component of organic acids in both FTMR formula is relatively high, butyric acid content is low, and there are signs of mold that make the quality of FTMR better.

Table 3.7. Nutritional component of FTMR containing Passiflora edulis rind silage in the field by different formulas

Silage	DM (%)	CP (%DM)	CF (%DM)	EE *(%DM)*	Ash *(%DM)*	ND *(%DM)*	ME (MJ/kg DM)
Before incubation							
FTMR3	32.68	14.83	21.37	1.43	5.97	56.40	9.95
FTMR4	33.47	14.81	21.23	1.43	5.92	56.61	9.91
SEM	0.43	0.87	0.81	0.30	1.14	1.19	0.90
P	0.266	0.988	0.909	1.00	0.994	0.907	0.976
After 3 weeks of incubation							
FTMR3	32.56	14.55	21.62	1.78	6.13	55.92	9.53
FTMR4	33.44	14.72	21.65	1.70	6.12	55.81	9.51
SEM	0.73	0.46	0.75	0.46	0.82	1.24	0.68
P	0.444	0.808	0.979	0.907	0.907	0.953	0.984
P*	0.906	0.797	0.679	0.447	0.860	0.613	0.621

*Notes: In each indicator and each time period, the mean values with diferente letters shows significant statistics difference ($p<0.05$); *: p-value*

of comparison between incubation time and research criteria.

FTMR3: Fermented complete feed with 25.0% of Passiflora edulis rind and 10% of sugar cane bagasse; FTMR4: Fermented complete feed with 25.0% Passiflora edulis rind and 10% of dried corn cob; DXKN: Non-nitrogen derivatives; KTS: Total Minerals; VCK: Dry matter

Due to FTMR feed is only incubated for a short period of time (3 weeks), the chemical composition and nutritional value do not change much compared to the feed before incubation. Crude protein percentages of all FTMR formula are slightly reduced. Crude protein ratio, crude fiber ratio and ME density of the FTMR formula after 3 weeks of incubation remain stable within the appropriate level for dairy cows.

c. Intake of FTMR of dairy cows

Unlike passion fruit rind silage, fermented complete compound feed is eaten by cows from the first day of feeding. However, the storage time is short, so the silage formula is used as an experiment on dairy cows.

3.5. Studying diets using Passiflora edulis peel for dairy cows

3.5.1. Studying diets for heifers

a. Gas production of experimental diets

The amount of gas increases sharply after from 3 hour to 48 hours, then the amount of gas decreases gradually after from 48 hours to 72 hours. At most of the incubation times, the gas production in the TN1 and TN2 diets is higher than those of the control diets.

b. Effect of diferente suppliment levels of passion fruit peel to digestibility under in vitro conditions

Table 3.8. The digestibility of organic matter, ME, SCFA of the diet supplemented with Passiflora edulis peel used for heifers

Samples (n=3)	**OMD** *(%)*	**ME** *(MJ/kg DM)*	**SCFA** *(mmol/200mg DM)*
Control	63.9	9.9	1.1
TN 1	64.5	10.0	1.1
TN 2	64.4	10.0	1.1
SEM	0.7	0.09	0.02
P	0.01	0.04	0.03

Note: ĐC (control): Maize silage accounted for 65% of the DM; TN1: silage Passiflora edulis rind replaced for 50% of maize silage; TN2: : Passiflora edulis rind silage replaced for 100% of corn silage; Passiflora edulis rind silage according to the formula: 75% of

Passiflora edulis rind + 20% of dry corn cob + 5% of molasses; OMD: Organic matter digestibility; SCFA: short-chain volatile fatty acids (mmol/200mg dry matter); ME: Exchange energy.

The results of Table 3.8 show that all the experimental samples are not different from the control samples in terms of OMD, ME and SCFA (P>0.05). This shows that the addition of passion fruit peel silage to the diet of heifers does not adversely affect the digestibility of organic matter, metabolic energy and short-chain fatty acids.

c. body weights and weight gains of heifers

Body weight and weight gains of heifers were similar among the three rayions. As can be seen in table 3.9.

Table 3.9. Changes in body weight (BW) of heifers during the feedinh trial

Indicator	ĐC	TN1	TN2	SEM	P
Initial BW (kg)	171.7	172.7	169.7	1.38	0.318
Final BW(kg)	247.6	248.2	246.0	1.67	0.628
Total BW gain (kg)	76.00	75.50	76.30	1.07	0.852
Average daily gain (kg/day)	0.84	0.84	0.85	0.01	0.852
ME receive(MJ/days)	44.6	43.5	44.5	0.31	0.062
Pr receive (g/days)	554	570	568	3.93	0.058
FCR	5.72	5.65	5.79	0.07	0.427
Consumes ME (MJ/kg BW)	52.9	51.3	53.1	0.67	0.168
Consumes Pr (g/kg BW)	673	673	677	8.52	0.252

Note: ĐC(Control): Maize silage accounted for 65% of the DM; TN1: silage Passiflora edulis rind replaced for 50% of silage maize; TN2: : Passiflora edulis rind silage replaced for 100% of corn silage; : Passiflora edulis rind silage according to the formula: 75% of Passiflora edulis rind + 20% of dried corn cob + 5% of molasses; KL: Mass; TKL: Mass Increase

Heifers grow and develop well in all feed formula. The level of dietary protein (approximately 12% of the VC), and ME (>9MJ/kg of VC) ensures good growth and development of heifers. Weight gain of calves reaches 0.84 kg/day. Replacing 50% and 100% of silage corn with silage Passiflora edulis rind still ensures an appropriate need of dietary nutrition of heifers, thus their weight reamain increasing

Experimental results show that there is a very small difference in the weight gain, feed intake, and feed FCR of calves in 3 formula. The amount of DM (dry material) collected by heifers varies from 4.79 kg to 4.85 kg/head/day.

3.5.2. Studying diets using silage Passiflora edulis rind to raise dairy cows

3.5.2.1. Evaluation of experimental diets by in vitro gas prodution

a. Gas production of experimental diets

The amount of gas increases sharply after from 3 hours to 48 hours, then after from 48 hours to 72 hours, the amount of gas gradually decreased. At most of the incubation times, the gas production of the diets in TN3 and TN4 is higher than that of the control diets.

b. The effect of replacing silage corn with silage Passiflora edulis rind in the diet of dairy cows on digestibility under in vitro conditions

The values of OMD, ME and SCFA calculated by the amount of gas produced 24 h under in vitro conditions are presented in Table 3.10.

Table 3.10. The digestibility of organic matter, ME, SCFA of dairy cow diets when replacing silage corn with silage Passiflora edulis rind

Sample (n=3)	OMD *(%)*	ME *(MJ/kg VCK)*	SCFA *(mmol/200mg VCK)*
ĐC	83.2	10.0	1.1
TN 3	85.1	10.2	1.1
TN 4	84.3	10.2	1.1

Note: ĐC(Control): Maize silage accounted for 40% of the VCK; TN3: Passiflora edulis rind silage replaced for 50% of silage maize; TN4: :Passiflora edulis rind silage replaced for 100% of corn silage; OMD: Organic matter digestibility; SCFA: short-chain volatile fatty acids (mmol/200g dry matter); ME: Exchange energy

ME and SCFA are 10,2 (MJ/kg VCK) and 1,1 (mmol/200mg VCK) respectively.

Addition of different amount of Passiflora edulis rind, there is little change in OMD (P>0.05). There is no difference in ME and SCFA value among amounts of Passiflora edulis rind in the diet (P>0.05). The ME and corresponding SCFA value are 10.2 (MJ/kg VC) and 1.1 (mmol/200mg VC).

In summary, There are no effects on OMD, ME and SCFA under in vitro conditions when replacing silage corn stalks with silage

Passiflora edulis rind with different amount. In other words, silage Passiflora edulis rind has the same nutritional value as silage corn.

3.3.2.2. Milk yield, quality and feed conversion of cows

a. Milk yield and quality

The results of monitoring milk yield and quality are presented in Table 3.11.

Table 3.11. Milk yield and quality of dairy cows when replacing silage corn in the diet with silage Passiflora edulis rind

	ĐC	TN 3	TN4	SEM	P
NSS before TN (kg/day)	22.3	22.6	23.0	2.40	0.783
NSS within 12 weeks TN (kg/day)	20.8	21.0	21.4	0.60	0.793
NSS TC within 12 weeks TN (kg/day)	19.3	19.6	19.9	0.55	0.726
Fat-free solids (%)	8.55	8.59	8.62	0.18	0.980
Milk protein (%)	3.45	3.51	3.48	0.08	0.913
Milk fat (%)	3.52	3.54	3.55	0.09	0.897

Note: ĐC(Control): Maize silage accounted for 40% of the VCK; TN3: Passiflora edulis rind silage replaced for 50% of maize silage; TN4: :Passiflora edulis rind silage replaced for 100% of corn silage; : Passiflora edulis rind silage according to the formula: 75% of Passiflora edulis rind + 20% of dry corn cob + 5% of molasses; ME: Exchange energy; TC: Standard; TN: Experiment

The average actual milk yield/day and the average standard milk yield/day of cows after the experiment according to the formula ĐC, TN3 and TN4 reaches from 20.8-21.4 kg/day and 19.3- 19.9 kg/day. This proves that the formula of using silage Passiflora edulis rind meet the nutritional needs of dairy cows.

b. Feed intake and feed efficiency

Feed intake of dairy cows when using silage Passiflora edulis rind to replace silage corn in the diet is presented in Table 3.12.

Table 3.12. Feed intake and feed efficiency of dairy cows when replacing silage corn in the diet with silage Passiflora edulis rind

	ĐC	TN 3	TN4	SEM	P
Food intake (kg VCK/day)	17.80	17.90	18.00	1.99	0.682
% Body weight	3.33	3.34	3.36	0.02	0.627
ME intake (MJ/day)	177	178	177	19.8	0.784
Crude Protein intake (kg/day)	2.41	2.46	2.49	0.27	0.476
FCR (kg DM/kg milk TC)	0.85	0.85	0.84	0.01	0.351
TTME (MJ/kg milk TC)	8.50	8.46	8.30	0.06	0.103
TTPr. (g/kg milk TC)	116	117	116	0.88	0.613

Note: ĐC(Control): Maize silage accounted for 40% of the VCK; TN3: silage Passiflora edulis rind is replaced for 50% of silage maize; TN4: : Passiflora edulis rind silage is replaced for 100% of corn silage; : Passiflora edulis rind silage according to the formula: 75% of Passiflora edulis rind + 20% of dried corn cob + 5% of molasses; ME: Exchange energy; TC: Standard; TN: Experiment; FCR: Consumption of food; TTME: Exchange energy consumption; TTPr.: Protein consumption

The amount of dry material collected by cows varies from 17.80 to 18.00 kg/cow/day. The diets have ME concentrations which are not significantly different, so the difference in feed energy intake of cows is not much. The amount of dry material obtained from experimental dairy cows accounts for from 3.33% to 3.36% of body weight. Consumption of VCK, ME and protein for the production of 1kg milk in the cow groups is not much different.

Thus, the results of the experiment on dairy cows shows that the silage of Passiflora edulis rind (75% of Passiflora edulis rind + 20% of dried cob + 5% of molasses) is as good as silage corn. The chemical composition and ME value are similar to those of maize silage.

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

1. Fresh Passiflora edulis rind accounts for 41.07% of the total weight of passiflora edulis. There is an abundant supply of by-products of Passiflora edulis rind in Son La province. (8,542 tons of fresh peels and 4,950 tons of fresh seeds in 2019).

2. The chemical composition of Passiflora edulis rind has a dry matter ratio of 14.96%; raw protein accounts for 14.11%; non-nitrogen derivatives accounts for 47.53%; Dried Passiflora edulis seeds have a high percentage of lipids (25.13%). The metabolic energy (ME) value of Passiflora edulis peel is 7.98 MJ/kg VCK, and the metabolic energy of Passiflora edulis seeds is 13.85 MJ/kg finals.

3. The silage formulae which consists of 75% of Passiflora edulis rind + 20% of dried corn cobs + 5% of molasses is the most suitable. Storage time of Passiflora edulis rind according to this silage formulae lasts at least 60 days.

4. 100% of corn silage can be replaced with silage Passiflora edulis rind according to the above formula to feed heifers and milking cows without adversely affecting cow performance.

2. Recommendations

1. Implement the research results into commercial manufacture.

2. Should conduct a trial on FTMR with Passiflora edulis rind for dairy cows.

3. Carry out a research to evaluate of pesticide residues in fresh and post-silage Passiflora edulis rind.