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Using Leucaena to Improve the Quality of Pineapple Plant Silage

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The objective of this study was to improve the quality of pineapple plant silage by leucaena supplementation and using it as roughage during the shortage of green forages. There were 5 treatments as follows :- 1. Pineapple plant 100%, 2. pineapple plants mixed with leucaena 5%, 3. pineapple plants mixed with leucaena 10%, 4. Pineapple plants mixed with leucaena 15% and 5. grass 100%. The Completely Randomized Design (CRD) with four replications each was used in this experiment. All treatments were put in 1%$NaCL_2$ and tightly sealed in plastic containers. They were stored at room temperature for 21 days. The silage treatments were evaluated on physical characteristics, chemical composition and fibre analysis. The physical characteristic showed that the color of treatment 1 was a yellow green color, a good characteristic of silage. For treatments 2, 3 and 4 there was a light brown color. Treatment 5 was a dark brown in color. The aromas of all silage treatments were aromatic and acidic like pickled fruit. The evaluation of chemical composition showed a highly significant difference among the treatment groups ($p < 0.01$). Treatment 4 was the highest in protein and metabolizable energy percentage with the averages of 8.19% and 3,697.17 kcal/k, respectively. The percentage of crude fibre was reduced with the increase of leucaena in the silage. Treatment 5 was the highest in crude fibre. The pineapple plant silage mixed with leucaena could improve the quality of silage for ruminants.
Keywords**:** pineapple plant, leucaena, pineapple plant silage, ruminant feed

1. Introduction

Pineapple is one of the economic fruits of Thailand. This product is mostly used for fresh fruit consumption and processing products within the country and exported in terms of canned fruits and frozen fruits. There are large amounts of pineapple plant which are harvested fresh for fruit consumption and processing products such as canned pineapple (Gowda, 2015). Thus the farmer must dispose of this large amount of pineapple plant waste to alleviates this problem for a green environment. Now they try to make a value added aspect of pineapple and their by-products. Also, the use of pineapple plants contributes to useful material for the industrial sector such as textile, pineapple fibre cloth, enzyme, combustible material, etc.

Pineapple is a component of the trunk. Farmers cut off the plants after harvesting. Pineapple leaves are waste or by – product of agriculture. There are almost all year long and will be much in range November – June because it is period when most farmers collect the yield delivered factory, which meet the drought season, where farmers shortage of fresh grass for ruminant. The analysis of pineapple leaves showed that the protein 8.47 %, fibre 17.89 %, ADF 25.87% and NDF 42.28 % (Warunee and Walaikhan, 1998). Pineapple leaves can be used as a component in total mixed ration for dairy feed, without any effect on milk production.

The most important aspect of animal husbandry is to reduce the costs of production or the costs of animal feed in order to maintain the livestock business. The reduction in production costs that can be achieved is the feed efficiency. Ruminants are animals that use both concentrate and roughage. Roughage include forage crop such as grass and legume. But roughage is usually of low quality and insufficient for the needs of ruminants. Because the farmers have limited space in the preparation of forage crop or pasture and often lacking, especially during the dry season. There are various by – products in agriculture instead such as pineapple leaves or pineapple plant can be used to feed dairy cattle (Prachya et al., 2001). Pineapple leaves or pineapple plant can be a source of roughage for ruminants, but lack of knowledge and understanding of the proper use, the opportunity to be used to maximum benefit. Because of this, it is necessary to develop

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appropriate knowledge for farmer to increase farmers' incomes. Suchat et al. (2011) was to determine the effect of ensiled pineapple waste compared with pangola hay as roughage source on rumen fermentation and feed utilization of native cattle. The apparent digestibility of dry matter, organic matter, crude protein, NDF and ADF in cattle fed only pineapple waste as roughage source was higher than in cattle fed only pangola hay. The pineapple waste have several benefit in terms of increasing caloric density, digestibility and feed utilization as compared to pangola hay. Moreover, it also enhances populations of dominant cellulolytic bacteria in the rumen.

The chemical composition of the pineapple plant is high in fibre which makes it is a good source of fibre for ruminant feed. Pine apple plants could be used as ruminant feed in silage forms to preserves the quality of its nutrient (Sayan, 2004). Furthermore, it can be kept for a long time. Pineapple plant silage can alleviate a malnutrition in ruminants during the dry season or flooding time. It is a high quality silage because it is good in digestibility and palatability. It is easy for animal raisers to make pineapple plant silage for their animals by themselves. This can help reduces animal feed cost and increase the quality of feed which is reflected in the high production performance of their animal. However, the quality of silage is depends on feed additive uses during the making processes. This research is aimed at selecting the suitability of leucaena level to apply to pineapple plant silage making for ruminant feed.

2. Materials and Method

2.1 Silage preparation

The harvested material was 3 samples of para grass, leucaena and pineapple plants randomly taken and chopped to 2-3 cm. (Figure 1) The pre-silage material samples were 5 treatments as follows:- 1. pineapple plant 100%, 2. pine apple plant mixed with leucaena 5%, 3. pine apple plant mixed with leucaena 10%, 4. pine apple plant mixed with leucaena 15% and 5. grass 100%. All treatments were put into 1%$NaCL_2$ and tightly sealed in plastic containers. They were stored at room temperature for 21 days. A total of 25 g sample was dissolved in 100 ml sterile water and stirred for 10 min. The pH values were measured for acidity changes using the pH meter (Polan et al., 1998). After 21 days fermentation, the color and aroma of the silages were evaluated according to the indices score of Muhammad et al. (2008). For the color description the silage was scored as 1 = dark brown, 2 = light brown, 3 = pale yellow and 4 = yellowish green. For the aroma description the silage was scored as 1 = putrid or rancid, 2 = pleasant, 3 = sweet and 4 = very sweet.

Figure 1 The Fresh samples of pineapple plant

2.2 Proximate composition analysis of silage

Fresh samples of 1,000 g were randomly by collected to determine nutrient composition. The samples were done by oven drying at 60^{o} C for 48 h prior to proximate analysis. Dry matter (DM), ash, crude protein (CP), crude fibre (CF), ether extract (EE), nitrogen free extract (NFE) and organic matter (OM) were determined according to the methods of AOAC (1995). Neutral detergent fibre (NDF) and Acid detergent fibre (ADF) were determined according to the method of Van Soest and Robertson (1979). Proximate analysis was done before and after fermentation. The experiment was repeated two times. Data were then computed using analysis of variance and treatment means were compared with Duncan's Multiple Range Test (DMRT) at P = 0.05 and P = 0.01.

3. Results

3.1 Physical characteristic of silage

After 21 days of ensilage, the plastic containers were opened and examined for gross characteristics. The physical characteristic (Table 1.) showed that the color of treatment 1 was a yellowish green color which was a good characteristic of silage (Figure 2). For treatment 2,.3 and 4 they were light brown color. Treatment 5 was a dark brown color, with quality being lower than treatment 1, 2, 3 and 4 (Muhammad et al., 2008). Generally, the silage should have a darker color than fresh forage because the color of chlorophyll reacted with acid from fermentation. These changed them to become a magnesium free pigment phaeophytin. However, the carotene was a provitamin A which was suffered from oxidation at high temperature (Azim et al.,2000 ; Wanapat, 1986). The aroma of silage treatment 1, 2, 3 and 4 were aromatic and acidic like pickled fruit (sweet smell). The sweet smell was caused by lactic acid bacteria which utilized sugar in the forage to produce lactic acid and volatile acid (McDonald et al.,1991; Merry et al., 2000). For treatment 5 the aroma of silage was very sour and may have occurred by the activity of proteolytic bacteria change protein to ammonia, volatile acid, amine and amide which dissatisfied in silage (Sayan, 2004). The pH values of silage treatment 1, 2, 3, 4 and 5 were 3.45, 3.43, 3.72, 3.52 and 4.27 respectively. Overall, treatments showed highly significant differences at a low level ($P < 0.01$). The pH values of silage was indicated that bacteria to produced lactic acid (Schroeder, 2004). The pH of good quality silage was 3.5 – 4.5, if pH increases more than 5.1 it was low quality (church, 1991). The moisture value of silage showed that highly significant differences ($P < 0.01$). Treatment 1 gave significantly higher moisture (81.83%) than treatment 4 (80.95%), treatment 2 (79.77%), treatment 3 (79.10%) and was lower in treatment 5 (72.93%). The silage making had high moisture and lowered dry matter during raining season may have coursed risk for the silage to spoil. In cases where the silage had lower moisture and higher of dry matter it may have been more fibre difficult to compact the silage in the silo (Saranya W. and Jantakarn, A., 1997).

Table 1 The Physical Characteristics of Silage

silage		character	
		Colour of silage	Aroma of silage
1	Pineapple plant 100%	Yellowish green	Aromatic and acidic
2	Pineapple plant mixed with leucaena 5%,	Light brown	Aromatic and acidic
3	Pineapple plant mixed with leucaena 10%,	Light brown	Aromatic and acidic
4	Pineapple plant mixed with leucaena 15%,	Light brown	Aromatic and acidic
5	Grass silage 100%	Dark brown	Very sour

Figure 2 The physical characteristics of pineapple plant silage

3.2 Nutritive values of silage

The proximate composition of the examined silage is shown in Table 2. Results revealed that highly significant differences ($P < 0.01$). Treatment 5 gave significantly higher dry matter (27.08%) than treatment 3 (20.90%), treatment 2 (20.23%), treatment 4 (19.05%) and was lower in treatment 1 (18.17%). For the good fermentation process and fast originate, dry matter had a loss of approximately 1 – 2 % from respiratory of forage during first stage (McDonald et al., 1991). The value of ash showed that Treatment 5 gave significantly higher ash (16.02%) than treatment 3 (9.71%), treatment 1 (9.38%), treatment 2 and lower ash in treatment 4 respectively. The increased of ash occurred by the utilization of plant organic substance and change to inorganic substance by microorganism during fermentation (Frame, 1994). The calcium value of silage showed that treatment 4 gave significantly higher calcium (0.48%) than treatment 3 (0.35%), treatment 5 (0.34%), Treatment 2 (0.32%) and lower calcium in treatment 1 (0.26%) respectively. For the phosphorus treatment 1 gave significantly higher phosphorus (0.38%) than treatment 4 (0.36%), treatment 2-3 (0.29%) and lower phosphorus in treatment 5 (0.19%) respectively. Treatment 4 gave significantly higher protein (8.19%) than treatment 5 (7.39%), treatment 3 (6.99%), treatment 2 (6.39%) and lower in treatment 1 (6.13%) respectively. Leucaena had condensed tannin 4 – 6 % of dry matter which could be caught protein and protect the digestion by microorganisms. McDonald et al. (1991) reported that usually decreases in protein was due to the initially digestion by microorganism, while the increased of protein may occurs by the influence of salt, which it prevents clostridium sp. to not destroy protein. There were not significantly differences in protein, ether extract, calcium, and phosphorus. Pineapple plant mixed with leucaena 5% gave significantly lower fibre (21.76%) than pineapple plant mixed with leucaena 10% (22.51%), pineapple plant mixed with leucaena 15% (23.15), pineapple plant 100% (24.18%) and grass silage 100% respectively, but it was not significantly different in the pineapple plant mixed with leucaena. However, fibre decreased during fermentation which may occurred have happened due to *lactobacillus* sp. which could have digested the cell wall (Mc Donald et al., 1991)

Table 2 Proximate composition analysis of pine apple plant silage.

Treatment	Nutritive value of pine apple plant silage								
	pH	Moist.	DM	Ash	CP	CF	Ca	P	Energy
1	3.45^{d}	81.83^{a}	18.17^{c}	9.38^{b}	6.13^{d}	24.18^{ab}	0.26^{c}	0.38^{a}	$3,620.99^{a}$
2	3.43^{c}	79.77^{ab}	20.23^{bc}	9.05^{bc}	6.39^{cd}	21.76^{c}	0.32^{b}	0.29^{b}	$3,471.06^{b}$
3	3.72^{b}	79.10^{b}	20.90^{b}	9.71^{b}	$6.99b^{c}$	22.51^{c}	0.35^{b}	0.29b	$3,475.86^{b}$
4	3.52^{c}	80.95^{ab}	19.05^{bc}	8.14^{c}	8.19^{a}	23.15^{bc}	0.48^{a}	0.36^{a}	$3,697.17^{a}$
5	4.27^{a}	72.93^{c}	27.08^{a}	16.02^{a}	7.39^{b}	25.42^{ab}	0.34^{b}	0.19^{c}	$3,029.80^{c}$

Means followed by a common letter in each column are not significantly different ($p<0.01$)

Results showed that fibre analysis by using Van Soest demonstrated the fibre digestion of pineapple plants mixed with leucaena silage could be degraded (Table 3). Pineapple plant mixed with leucaena 15% gave significantly lower NDF (42.19%) than pineapple plant mixed with leucaena 5% (43.30%), pineapple plant mixed with leucaena 10% (43.71%), pineapple plant 100% (47.10%) and grass silage 100% (48.76%), but it was not significantly different in pineapple plant mixed with leucaena. For NDF the decreased in may be due to the part of cell wall and carbohydrate structure being utilized as an energy source for microorganism growth during fermentation (O'Kiely and Muck, 1998). Pineapple plant mixed with leucaena 5% gave significantly lower ADF (29.85) than grass silage 100% (29.88%), pineapple plant mixed with leucaena 15% (30.46%), pineapple plant mixed with leucaena 10% (30.90%) and pineapple plant 100% (31.94%) respectively. The acid detergent fibre of silage trend were perhaps increased by the sugar structured in the plant cell with the microorganism being utilized and causing ADF increase (Campbell and Bruchanan-Smith, 1991). Generally, a good range of ADF in dairy cattle' feed should be around 40 – 60 % to produces butterfat in milk (Somjit, 2006; Jantakarn, 2009). Grass silage 100% gave significantly lower ADL (3.98%) than pineapple plant mixed with leucaena 15% (5.66%), pineapple plant mixed with leucaena 5% (5.99%), pineapple plant 100% (6.19%) and pineapple plant mixed with leucaena 10% (6.23%) respectively. It was not significantly different in ADL of pineapple plant 100% and pineapple plant mixed with leucaena. The quantity of lignin, cellulose, and hemicellulose in feed are important for the forage crop of ruminants. A good quality of forage crop should be low in lignin (Flores, 1991). In this study, pineapple plant mixed with leucaena 15% gave significantly higher metabolizable energy (3,697.17 kcal/k) than pineapple plant 100% (3,620.99 kcal/k), pineapple plant mixed with leucaena 10% (3,475.86 kcal/k), pineapple plant mixed with leucaena 5% (3,471.06 kcal/k) and grass silage 100% (3,029.80 kcal/k) respectively. The leucaena was completed in nutrient and when mixed with the pineapple plant the metabolizable energy was increased (Piliwan et al., 1989).

Table 3 Fibre analysis of pineapple plant silage.

Treatment	NDF	ADF	ADL
1	47.10[a]	31.94[a]	6.19[a]
2	43.30[b]	29.85[b]	5.99[a]
3	43.71[b]	30.90[ab]	6.23[a]
4	42.91[b]	30.46[ab]	5.66[a]
5	48.76[a]	29.88[b]	3.98[b]

Means followed by a common letter in each column are not significantly different ($p<0.01$)

Treatment 1. = pineapple plant 100%
Treatment 2. = pine apple plant mixed with leucaena 5%
Treatment 3. = pine apple plant mixed with leucaena 10%
Treatment 4. = pine apple plant mixed with leucaena 15%
Treatment 5. = grass 100%.

4. Conclusion

The uses of leucaena to improve nutritive value in pineapple plant silage were determined. This study was to improve the quality of pineapple plant silage by leucaena supplementation for using as roughage during the shortage of green forages. There were 5 treatments as follows:- 1. pineapple plant 100%, 2. pineapple plant mixed with leucaena 5%, 3. pineapple plant mixed with leucaena 10%, 4. pineapple plant mixed with leucaena 15% and 5. grass 100%. The silage samples were mixed with $NaCl_2$ all formula and kept tightly sealed in plastic containers and stored at room temperature for 21 days. The results of physical characteristics, chemical composition and fibre analysis of pineapple plant silage were indicated that the color appearance of formula 1 was yellowish green color, formula 2,3,4 were light brown color and formula 5 dark brown color. The aroma of the pineapple plant silage was aromatic and acidic like pickled fruit. The chemical composition analysis of silage found that highly significantly difference ($p< 0.01$). Which this pH value in rang 3.43 – 4.27, Dry matter 18.17 – 27.08%, ash 8.14 – 16.02%, protein 6.13 -8.19%, fibre 21.76 – 25.42, NDF 42.91 – 48.76, ADF 29.85 – 31.94, lignin 3.98 – 6.23, Ca 0.26 – 0.48, P 0.20 – 0.38 and energy 3,029.80 – 3,697.17. Pineapple plant silage mixed with leucaena could improve the quality of nutritive value for ruminants.

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