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## The effect of adding mung bean meal supplementation on Napier Pakchong 1 silage on fermentation quality and nutrient composition

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**Abstract** The effect of mung bean meal supplementation on Napier Pakchong 1 silage on fermentation quality and nutritional value was investigated. The results found that pH of all treatments of mung bean meals on Napier Pakchong 1 silage ranges from 4.17-4.73 was the lowest value found in the treatment 1 whereas highest value found in the treatment 6 ( $P<0.01$ ). When volatile basic nitrogen (VBN) in silage was recorded, the VBN in the silage of the treatment 5 had the highest value (35.56%) and followed by that of the treatment 6 (32.98%) while the lowest VBN found in the silage of the treatment 1 (8.57%) ( $P<0.01$ ). Moreover, the silage in the treatment 6 was the highest nutritional proportion by increasing dry matter (DM), crude protein (CP), ether extract (EE) and gross energy (GE), while decreasing ash, neutral detergent fiber (NDF) and acid detergent fiber (ADF) ( $P<0.01$ ). Thus, making silage by adding mung bean meals on Napier Pakchong 1 could improve nutritional value of silage in term of increasing DM, CP, EE and GE contents, but decreasing contents of ash, NDF and ADF. In addition, making silage from Napier Pakchong 1 grass by replacing mung bean meal at 10-20% could be applicable for preserving ruminant roughage.

**Keywords:** Mung bean meal, Napier Pakchong 1, Silage, Fermentation quality, Nutrient composition

### Introduction

The key factor and the main cost of livestock production (65-70%) is feed. If farmers can find good quality and cheap animal feeds for their livestock, this means that farmers can increase profitability in animal production. The livestock production in the tropical area is limited by acute shortages of good quality animal feed. (Hove *et al.*, 2001; Kanani *et al.*, 2006). Poor nutrition leads to low quantity and quality of the productivity from the animal. Profitable

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livestock production depends largely on the quality of animal feed. Therefore, the animals have to receive high quality animal feed during all produce period. Efficient utilization of crop residues available locally in appreciable quantum seems to be accomplished by the management to maximize advantage from feed in animal system. Currently, many researchers have been interested in studying and finding possible approaches to enhancing animal productivity. Hence, efforts are being directed forward assisting the animal to utilization of available feed resources, which is the key to enhance livestock productivity economically. The use of crop residues, agricultural by product and co-products from several industries for ruminant feeding is very common practice to ensure the feed supply for ruminant livestock production.

Silage served as a good choice for ruminant production, providing nutritive values for ruminant production in dry season. Silage is made of roughage such as grass for ruminants, beans and by-products kept in a container with an anaerobic condition. It may contain substances or components that promote the fermentation processes. In the processes of fermentation, there relies on lactic acid bacteria (LAB) to change the water-soluble carbohydrate (WSC) into organic acids. Fermentation processes will result in accumulation of lactic acid, making lower pH and then working with micro-organisms, such as yeast and fungi causing stopped working of spoilage from plant fermentation (Woolford, 1990). Consequently, silage would preserve nutritive value of food by minor change of nutritive contentd, when compared with dry grass. Ensiling is a traditional conservation method of fresh forages and grains, which aimed at supplying year-round availability of nutritious and palatable animal feed for livestock. However, it was reported that most tropical and subtropical grasses are very difficult to be ensiled due to relatively low DM and CP contents in raw feed materials. Thus, there should be added other animal feed materials for augmenting DM and nutritive value (McDonald *et al.*, 1991; Bureenok *et al.*, 2011).

Napier Pakchong 1 grass (*Pennisetum purpureum* × *Pennisetum americanum*) is a good quality roughage crops for ruminants as growing naturally in tropical and subtropical areas with fast growing and high yield. There are 10-12% CP, at the age of 45-60 days (Khiaotong, 2011). It is a major roughage source for ruminants. However, it is difficult to make good quality of silage due to low WSC and also low DM (Ohmomo *et al.*, 2003; Yahaya *et al.*, 2004), which affects the quality of the fermentation process. Bureenok *et al.* (2006) showed that it could be improved the fermentation quality of Napier Pakchong 1 grass by addition fermented juice epiphytic lactic acid bacteria (FJLB) or molasses (Yokota *et al.*, 1991; Yunus *et al.*, 2000; Van Niekerk *et al.*, 2007).

Mung bean meal is a by-product of vermicelli industries. After separating out the starch from mung bean seeds to do vermicelli, the rest are called mung bean meal or residue of vermicelli. Mung bean meal has a DM content of 88-91%, CP of about 15-21% (Jattupornpong *et al.*, 1988; Sitthigripong and Sethakul, 1991; Vijitrothai and Sitthigripong, 1993; Department of Livestock Development, 2008) and also contains essential amino acid in its entirety, especially lysine. It is an alternative feed source to be used as a substitute for protein source for animal feed, because it contains high protein and inexpensive (Suphadee *et al.*, 1995; Kanjanapruthipong *et al.*, 1992). Many researchers reported that mung bean meal addition could cost reduction in the production of animal feed (Vijitrothai *et al.*, 1997; Sitthigripong, 1994; Suphadee *et al.*, 1995; Kanjanapruthipong *et al.*, 1992), especially for adding nutritive contents into silage bases on Napier Pakchong 1 grass as low in DM, WSC and also CP.

The objectives of this study were to determine the effect of added mung bean meal on Napier Pakchong 1 silage quality and nutrient composition.

## **Materials and methods**

### ***Silage Making***

Napier Pakchong 1 grass was planted in experimental plots at Department of Animal Production Technology and Fisheries, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang. At the age of grasses 60 days, the grass was cut and then chopped into 1-2 cm length grass size by the use of grass chopper. The chopped grass was mixed with mung bean meal. The pre-silage material samples were 6 treatments as follows:- Treatment 1(T1); 100% Napier Pakchong 1 grass (without mung bean meal adding; control), T2; 90% Napier Pakchong 1 grass mixed with 10% mung bean meal, T3; 80% Napier Pakchong 1 grass mixed with 20% mung bean meal T4; 70% Napier Pakchong 1 grass mixed with 30% mung bean meal, T5; 60% Napier Pakchong 1 grass mixed with 40% mung bean meal and T6; 50% Napier Pakchong 1 grass mixed with 50% mung bean meal, as fresh weight basis. Then the pre-silage materials in all treatments were added with 1% molasses of the total fresh weight of pre-silage materials, then packed them into plastic 50-liter buckets with thick wall by tightly pressing until full of each plastic bucket, according to the method of Bureenok *et al.* (2005). Thick plastic cover for each bucket was brought to very tightly close the bucket with cover belt. Three replications for each treatment were done in this study. Until 21 days of fermentation to be ensilaging, silage was obtained and then samples of silage from all replications were taken analyze for measuring fermentation quality (pH,

volatile basic nitrogen; VBN and volatile fatty acid; VFA), gross energy (GE) and chemical composition (DM, CP, EE, ash, OM, ADF, NDF and ADL).

### ***Fermented quality evaluation***

After each plastic bucket of Napier Pakchong 1 was opened, the silage content was mixed thoroughly. Then, 20 g of the content was sampled from each plastic bucket and followed by adding 70-ml distilled water, shaking well and then macerating at 4°C for 12 hr. Each sample was filtered with Whatman no.1. Subsequently, all samples were measured of pH values by using a glass electrode pH meter, VBN by determining ammonia-nitrogen (NH<sub>3</sub>-N) with Kjeldahl method and VFA (lactic acid; LA, Acetic acid; AA, Propionic acid ; PA, Butyric acid; BA and total volatile fatty acid; VFAs) by the use of High Performance Liquid Chromatography (HPLC) (Bureenok *et al.*, 2007).

### ***Chemical analysis***

DM content of silage samples were determined by drying in a hot-air oven at 65°C for 48 hr, then ground to pass through a 1.0-mm screen and subsequently analyzed for chemical analyses. Total N was determined using the Kjeldahl method and CP was calculated by multiplying the N content by 6.25. EE and ash were quantified according to the method of Association of official Analytical Chemists guidelines (AOAC, 1995). Quantifying NDF, ADF and ADL contents were conducted as described by Goering and Van Soest (1991).

### ***Statistical analysis***

Data were statistically analyzed according to complete randomized design (CRD) by using the PROC GLM procedure (SAS, 1985). Significant differences (P<0.05) among treatments were determined using Duncan's New Multiple Range test according to Steel and Torrie (1980).

## **Results**

### ***Fermentation quality***

After 21 days of ensilage, the plastic bucket were opened and examined for fermentation quality. Fermentation quality of Napier Pakchong 1 grass fermented with mung bean meal silage has shown in Table 1. The pH values of silage in the treatment 5 and 6 was highly significant differences (P<0.01) from those in the treatment 1, 2, 3 and 4, where silage pH in the treatment 3, 2 and 1 had lower (P<0.01) than that in the treatment 4. The VBN level of silage in the

treatment 5 had significantly higher ( $P<0.01$ ) than that in the treatment 6, 4, 3, 2 and the lowest VBN level was found in the treatment 1.

For the VFA in the silage from all experiments, it was found that LA content in the treatment 4 and 5 was higher significant differences ( $P<0.01$ ) than those in the treatment 1, 2, 3 and 6, where LA content in the treatment 6 and 1 had lower ( $P<0.01$ ) than those in the treatment 3 and 2. The AA content in the treatment 1 was higher significant differences ( $P<0.01$ ) than that in the treatment 2, 3, 4, 5 and 6, where lowest AA content was found in the treatment 5 ( $P<0.01$ ). The PA content in the treatment 5 and 6 was higher significant differences ( $P<0.01$ ) than that in the treatment 1, 2, 3 and 4, where the PA content in the treatment 1 and 2 had lower ( $P<0.01$ ) than that in other treatments. The BA content in the treatment 6 was higher significant differences ( $P<0.01$ ) than that in the treatment 1, 2, 3, 4 and 5, where the PA content in the treatment 1 and 2 had lower ( $P<0.01$ ) than that in other treatments.

**Table 1.** Fermentation quality of Napier Pakchong 1 grass fermented with different levels of mung bean meal at 21 days of fermentation

Treatment	pH	VBN (%)	LA	AA	PA	BA
			(% of total VFA)			
1. N 100%	4.17 <sup>C</sup>	8.57 <sup>E</sup>	4.45 <sup>C</sup>	90.76 <sup>A</sup>	3.69 <sup>C</sup>	1.10 <sup>D</sup>
2. N 90% + M 10%	4.21 <sup>C</sup>	11.12 <sup>D</sup>	11.92 <sup>B</sup>	84.88 <sup>B</sup>	1.79 <sup>C</sup>	1.40 <sup>D</sup>
3. N 80% + M 20%	4.26 <sup>C</sup>	17.04 <sup>C</sup>	15.38 <sup>B</sup>	67.92 <sup>C</sup>	12.33 <sup>B</sup>	4.36 <sup>C</sup>
4. N 70% + M 30%	4.34 <sup>B</sup>	18.58 <sup>C</sup>	23.73 <sup>A</sup>	58.19 <sup>D</sup>	13.86 <sup>B</sup>	4.23 <sup>C</sup>
5. N 60% + M 40%	4.62 <sup>A</sup>	35.56 <sup>A</sup>	25.84 <sup>A</sup>	48.34 <sup>E</sup>	17.88 <sup>A</sup>	7.93 <sup>B</sup>
6. N 50% + M 50%	4.73 <sup>A</sup>	32.98 <sup>B</sup>	5.99 <sup>C</sup>	60.88 <sup>D</sup>	21.31 <sup>A</sup>	11.81 <sup>A</sup>
SEM	0.0185	0.2071	0.4682	0.5889	0.5247	0.1102
P-Value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

N = Napier Pakchong 1 grass, M = mung bean meal, VBN = volatile basic nitrogen, VFA = volatile fatty acid, AA = acetic acid, PA = propionic acid, BA = butyric acid, LA = lactic acid

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

### ***Chemical composition***

The chemical compositions of experimental silages were shown in Table 2. The DM content of the experimental silages varied ( $P<0.01$ ), in which the highest value was observed in the treatment 6 and followed by the treatment 5, 4, 3, 2 and 1. The CP and GE values in the treatment 6 were highly significantly higher ( $P<0.01$ ) than those in the treatment 1, 2, 3, 4 and 5, where CP and GE values in the treatment 1 had lowest ( $P<0.01$ ). The EE values in the treatment 5 and 6 were highly significantly higher ( $P<0.01$ ) than those in the treatment 1, 2, 3 and 4, where the treatment 1 had lowest ( $P<0.01$ ) EE value.

The OM values in the treatment 2, 3, 4, 5 and 6 were highly significantly higher ( $P<0.01$ ) than that in the treatment 1, whereas the ash content (inorganic matter) in the treatment 1 was highly significantly higher ( $P<0.01$ ) than that in the other treatments. Results of fiber analysis for the experimental silages were demonstrated in the table 3. The NDF, ADF and ADL content of experimental silages varied ( $P<0.01$ ), in which the highest value was observed in the treatment 1 and, followed by treatment 2, 3, 4, 5 and lowest ( $P<0.01$ ) in the treatment 6.

**Table 2.** Chemical composition of Napier Pakchong 1 grass fermented with different levels of mung bean meal at 21 days of fermentation

Treatment	DM (%)	CP (%)	EE (%)	Ash (%)	OM (%)	GE (kcal/g)
1. N 100%	22.14 <sup>E</sup>	7.40 <sup>F</sup>	1.69 <sup>D</sup>	11.08 <sup>A</sup>	88.92 <sup>B</sup>	3724.95 <sup>F</sup>
2. N 90% + M 10%	36.40 <sup>D</sup>	24.89 <sup>E</sup>	2.42 <sup>C</sup>	4.78 <sup>B</sup>	95.22 <sup>A</sup>	4216.80 <sup>E</sup>
3. N 80% + M 20%	40.70 <sup>C</sup>	38.69 <sup>D</sup>	2.62 <sup>C</sup>	4.35 <sup>B</sup>	95.65 <sup>A</sup>	4639.20 <sup>C</sup>
4. N 70% + M 30%	46.23 <sup>B</sup>	48.24 <sup>C</sup>	3.05 <sup>B</sup>	4.06 <sup>B</sup>	95.94 <sup>A</sup>	4439.60 <sup>D</sup>
5. N 60% + M 40%	46.50 <sup>B</sup>	51.57 <sup>B</sup>	3.43 <sup>A</sup>	3.91 <sup>B</sup>	96.09 <sup>A</sup>	4674.00 <sup>B</sup>
6. N 50% + M 50%	53.90 <sup>A</sup>	54.25 <sup>A</sup>	3.52 <sup>A</sup>	3.68 <sup>B</sup>	96.32 <sup>A</sup>	4796.60 <sup>A</sup>
SEM	0.0655	0.0364	0.0300	0.1350	0.1350	0.9454
P-Value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

N = Napier Pakchong 1 grass, M = mung bean meal, DM = dry matter, CP = crude protein, EE = ether extract, OM = organic matter, GE = gross energy

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

**Table 3.** Fiber analysis of Napier Pakchong 1 grass fermented with different levels of mung bean meal at 21 days of fermentation

Treatment	NDF (%)	ADF (%)	ADL (%)
1. N 100%	75.89 <sup>A</sup>	53.65 <sup>A</sup>	10.75 <sup>A</sup>
2. N 90% + M 10%	62.18 <sup>B</sup>	47.01 <sup>B</sup>	8.16 <sup>B</sup>
3. N 80% + M 20%	44.87 <sup>C</sup>	35.85 <sup>C</sup>	6.62 <sup>C</sup>
4. N 70% + M 30%	38.67 <sup>D</sup>	33.87 <sup>D</sup>	5.61 <sup>D</sup>
5. N 60% + M 40%	32.59 <sup>E</sup>	29.06 <sup>E</sup>	5.06 <sup>E</sup>
6. N 50% + M 50%	29.06 <sup>F</sup>	24.31 <sup>F</sup>	4.54 <sup>F</sup>
SEM	0.0713	0.0265	0.0542
P-Value	<.0001	<.0001	<.0001

N = Napier Pakchong 1 grass, M = mung bean meal, NDF = neutral detergent fiber, ADF = acid detergent fiber, ADL = acid detergent lignin

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

## Discussion

The significant changes on physical characteristics were noted in this experiment. The pH values of the silage in the treatment 2 and 3 were in the period of the acceptable range for good quality silage (Chinwaroj, 2016). This is consistent with the report of Nakdaeng (2014) found that leucaena quantity used as a source of protein inflated, resulting in higher pH value of silage, due to result of the more ability to resist change the pH (buffer-capacity) of leguminous plants, which is a feature that makes it more difficult to make silage by making the reduction of pH value in silages slow down (Bureau of Animal Nutrition Development, 2017). The pH of good quality silage was 3.5-4.2 (Karmearm *et al.*, 2005). If pH value of silage is lower than 4.2 will result in the inhibition of the function of microorganisms and contribute to the stability of silage. The silage with good quality should smell like the smell of fermented fruit, no pungent or rotten smell, and no mucus on the skin of the silage. The skin of the silage should be a yellowish green color with a slightly sour taste (Chanprecha, 2016). Levels of acidity in silage are important factors indicating the quality of silage.

The LA and BA concentrations were enhanced with the addition of mung bean meal in silage, because of high protein content in mung bean meal, most besides a high buffering capacity. There are also high CP and low sugar contents, causing high BA fermentation. (Bureau of Animal Nutrition Development, 2017). The AA concentration is also higher than LA for all treatments in this experiment. This finding is consistent with the report of Lukkananukool *et al.* (2018) who found AA as the main fermentation acid in silages made from tropical grass. The silage with good quality should have a amount of LA content of about 3-13%, BA not more than 0.2%, AA of about 0.5-0.8% and  $\text{NH}_3\text{-N}$  not more than 11% of the total nitrogen (Tudsri, 2005). The quantity of carbohydrate is a major factor in the anaerobic fermentation processes by the fact that LAB would change WSC into lactic acid, depending on the quantity of sugar. If a large amount of sugar and in anaerobic conditions, this will build up lactic acid faster (Tudsri, 2004). In general, bacteria creating LA and BA are scattered in the grass used to make silage. Variation of the type and quantity of bacteria in a silage depends on many factors, but if they can build lactic acid quickly, importantly resulting in control and prevent the creation of butyric acid. Silage containing with high BA proportion represents invalid fermentation process, which results in the decrease of nutritive value and palatability (Kung and Muck, 1997). Silage with high butyric acid proportion is classified as low quality of silage. The occurrence of BA is caused by the work of anaerobic bacteria. The bacteria causing fermentation and BA production arrange in groups of *Clostridium* found in the soil and the dung.

(Nakdaeng, 2015). AA is always found in silage, which is produced from the fermentation of LA and BA via microorganisms genera *Acetobacter* spp., which are large increase in the first few days of fermentation and caused by genera Coliform bacteria. These bacteria grow well in the early stages of fermentation, there is still some oxygen remaining in fermentation buckets with slightly or neutral pH condition. In addition, the Clostridia bacteria in genre Proteolytic Clostridia play a role in protein degradation and then producing AA (McDonald *et al.*, 1991).

When the included level of mung bean meal for making Napier Pakchong 1 grass silage were increased, the DM, CP and EE content of silage have increased in number while the NDF, ADF, and ash ADL content has decreased. The reason for this finding is due to the different mung bean meal contents of experimental silages. Plants with high moisture, together with incorreced fermentation cause the high volume of AA, making the loss of DM and energy in the silage (Nakdaeng, 2015). Plants suitable for fermentation should be high in yielding, sugar content and nutritional value (Chanprecha, 2016). Also, the good plants should have a DM quantity between the 30-40% or moisture between 60-70% of live plants weight (Nakdaeng, 2015). There is a WSC quantity not less than 18%. The Napier Pakchong 1 grasses have protein about 12.6-15.9% and WSC about 33.3-36.5% (Chanprecha, 2016). If the moisture content of animal feed less than 60% of fresh plants weight, it will result in compaction difficulty and promoting fungus growth easily. In the mean time, the fresh plants with more than 70 % moisture content probably make the liquid flow out of fermented food plants, causing the loss of LA and nutrient beneficial to animals, especially the carbohydrates in plants with high CP levels. In addition, suitable conditions for the growth of odor-causing bacteria may cause diseases to animals as well (McDonald *et al.*, 1991).

From results of this experiment, testing for fermentation quality and chemical composition of silage indicated that making silage from Napier Pakchong 1 grass by replacing mung bean meal at 10-20% could be applicable for preserving ruminant roughage.

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