**IMPROVING PHYSICO-CHEMICAL CHARACTERISTIC AND PALATABILITY OF KING GRASS (*Pennisetum* hybrid) SILAGE BY INOCULATION OF *Lactobacillus plantarum* - *Saccharomyces cerevisiae* CONSORTIA AND ADDITION OF RICE BRAN**

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**ABSTRACT**

This study was conducted to determine effectiveness of inoculants consisted of lactic acid bacteria *Lactobacillus plantarum* (Lp) and yeast *Saccharomyces cerevisiae* (Sc) combined with addition of rice bran on the physico-chemical characteristics and palatability of king grass (*Pennisetum* hybrid) silage. The experiment was arranged on the factorial randomized design (3x3) consisting of the inoculants treatments (control, Lp, Lp+Sc) and the addition level of rice bran (0, 5 and 10%). The measured variables were physico-chemical characteristics i.e. colour, odour, pH, lactic acid, Fleigh points, and palatability of silage. Inoculation of Lp and Lp+Sc improved silage odour and reduced fungal contamination. Silage was treated by Lp+Sc and rice bran (5-10%) showed reduction of pH and an increase of lactic acid and Fleigh points. However, interaction between inoculants and rice bran treatment was not significance. Either inoculation or addition of rice bran tended to enhance the palatability of silage in cattle. It concluded that the addition of inoculants *L. plantarum* and *S. cerevisiae* with/without addition of 5-10% rice bran could improve the physico-chemical characteristics of silage and its palatability to ruminant.

(Key words: King grass, *L. plantarum*, Palatability, *S. cerevisiae*, Silage)

**INTISARI**

Penelitian ini bertujuan untuk mengetahui efektivitas penambahan inokulum bakteri asam laktat *Lactobacillus plantarum* (Lp) dan khamir *Saccharomyces cerevisiae* (Sc) dengan taraf penambahan dedak padi terhadap karakteristik fisika, kimia dan palatabilitas pada silase rumput raja (*Pennisetum* hybrid). Perlakuan disusun dalam Rancangan Acak Lengkap Pola Faktorial (3x3) dengan faktor perlakuan jenis inokulum (kontrol, Lp, Lp+Sc) dan penambahan dedak padi (0, 5 dan 10%). Peubah yang diamati terdiri dari karakteristik fisik-kimia (warna, aroma, pH, asam laktat dan nilai Fleigh) dan tingkat palatabilitas silase. Hasil penelitian menunjukkan bahwa perlakuan inokulum memperbaiki aroma silase dan menurunkan kontaminasi jamur. Silase yang diberi perlakuan Lp+Sc dan penambahan dedak padi (5-10%) memiliki pH terendah seiring dengan peningkatan kadar asam laktat dan nilai Fleigh. Namun, tidak terdapat interaksi yang nyata antara perlakuan inokulum dan penambahan dedak padi terhadap kualitas silase. Silase dengan perlakuan inokulum atau penambahan dedak padi menunjukkan tingkat palatabilitas yang lebih tinggi terhadap ternak sapi. Dapat disimpulkan bahwa penambahan inokulum *L. plantarum* dan *S. cerevisiae* dan/atau penambahan dedak padi 5-10% mampu memperbaiki karakteristik fisik-kimia silase serta tingkat palatabilitasnya ke ternak ruminansia.

(Kata kunci: *L. plantarum*, Palatability,Rumput Raja, *S. cerevisiae*, Silase)

**INTRODUCTION**

The main factor leads to lower productivity in ruminant is a limited number of fresh forage, especially during dry season (in the tropics) and winter (in the sub-tropics). Production of forage such as King grass (*Pennisetum* hybrid) reaches around 150-160 tonnes per hectare annually (**ICAR, 2010**). King grass is easy to grow in the low- or high-lands and its production is higher than the elephant grass (*Pennisetum purpureum*) (**Budiman and Djamal, 1994**). Low production of forage in the dry season had implications for ~~the~~ declining availability of forage to supply animal needs. Implementation of preservation technology by making silage could be achieved to ensure the availability of forage. Although ensilage to be developed continuously, this technology has not been widely applied in the small-holder farmers. Implementation of the ensilage technology is facing with some limitations as follows; avalability of ensilage equipments, knowledge lack of farmers to adopt the technology, and high levels of rotten silage due to failuring anaerobic conditions.

The principle in making silage is to achieve anaerobic conditions and suppress growth of undesirable microorganisms such as *Clostridia* and *Enterobacteria* (**McDonald *et al*., 1991**). Maintaining quality of silage by addition of inoculant and soluble carbohydrate fraction were conducted to optimize production of lactic acid and minimize the nutrient lost of forage during ensilage (**Tabacco *et al*. 2011; Amer *et al*. 2012**). Lactic acid bacteria (LAB) are common inoculant that serve to convert soluble carbohydrates into organic acids or lactic acid. *Lactobacillus plantarum* is one of LAB species can be isolated from forage such as maize and tropical grasses (**Zhang *et al*., 2000; Santos *et al*., 2013**).

Producing lactic acid by LAB can be constrained with presence of oxygen during ensilage. These are caused by optimum density and anaerobic conditions in silage could not be achieved when raw materials was filled in silo. Efforts to improve the anaerobic condition is necessary so that the silage quality can be maintained. An effort may be performed to increase anaerobic conditions in the silage by adding *Saccharomyces cerevisiae*. Residual oxigen in the silage was possibly utilized by *S. cerevisiae*. Presence of *S. cerevisiae* in a growth medium of LAB showed no antagonist reaction, because the metabolic activity of *S. cerevisiae* ~~to~~ support the growth of LAB (**Gobetti *et al*. 1998**; **Sofyan *et al*. 2011b**). In recent study, addition of *S. cerevisiae* on silage has the potential to support the growth of LAB which has been used as a silage inoculant (**Duniere *et al*., 2015**).

Improving silage quality by addition of inoculant was suggested to positive response in animal acceptability and digestibility. Therefore, study of the use of *S. cerevisiae* and its interaction with the lactic acid bacteria as a silage inoculant needs to be conducted. This experiment was to eveluate effect of *L. plantarum* (Lp) and *S. cerevisiae* (Sc) inoculant consortia with addition of rice bran on the physico-chemical characteristics and palatability of king grass silage.

**MATERIALS AND METHODS**

**Preparation of Forage and Inoculant**

King grass (*Pennisetum* hybrid) for making silage was harvested at 60 days, which was planted in the forage collection field of the Research Unit for Natural Product Technology (BPTBA – LIPI). Inoculant consortia were used in this experiment consisting of *L. plantarum* and *S. cerevisiae* that had been isolated in the previous study (**Sofyan *et al*., 2011b**). Those isolates were grown on MRSB (deMann Rogossa Sharpe Broth, Oxoid®) and MEB (Malt Extract Broth, Merck®) for *L. plantarum* and *S. cerevisiae,* respectively. Total colony of *L. plantarum* and *S. cerevisiae* on each medium accounted for 108 cfu/mL and 107 cfu/mL, respectively.

**Inoculant Treatment in Silage**

Effectiveness of inoculants on silage characteristic was treated by addition of inoculants in combination with rice bran as water soluble carbohydrate (WSC). The experiment was arranged on factorial randomized design (3x3) consisting of inoculants treatments (type of inoculants; control, Lp, Lp+Sc) and rice bran addition (level; 0, 5 and 10%). Each treatment consisted of three replication was described in **Table 1**. Inoculant consortia was combination of *L. plantarum* and *S. cerevisiae* (3:1 v/v) which was optimized in the previous study (**Sofyan *et al*. 2011a**).

|  |  |  |  |
| --- | --- | --- | --- |
| Table 1. Inoculant treatment and rice bran addition in the king grass silage | | | |
| Inoculants | Level of rice bran addition | | |
| 0% (0) | 5% (5) | 10% (10) |
| Without Inoculant (A) | A0 | A5 | A10 |
| Lp (B) | B0 | B5 | B10 |
| Lp+Sc (C) | C0 | C5 | C10 |

Note: Lp (*L. plantarum*), Sc (*S. cerevisiae*)

Procedure of making silage consisted of several stages were; 1) preparing raw materials, 2) mixing according to the appropriate formula / treatment, 3) packaging and incubation (**Figure 1**). Prior to mix with concentrate, king grass was chopped in 1-3 cm length. In order to increase of dry matter, king grass was wilted for 24 hours.

Raw materials and silage additive

(king grass, rice bran and inoculants)

Formulating

Mixing

Silage

Packaging

Incubation

(Temperature: 25-35 ºC,

21 days)

Figure 1. Flow chart in making silage

Addition of inoculant 1% (v/w) and water was performed to adjust moisture content (approximately 75%) in ensilage mixture. After the ingredients mixed homogeneously, the mixtured silage was packed in a plastic bag (5 kg / pack) and incubated during 21 days at room temperature.

**Physical assesment of the silage**

Texture and flavour of silage were evlauated at the last incubation (day 21st). Briefly, silage bag was opened and immediately observed. Three person of the experienced panelists were previously trained in making silage to asses and evaluate texture and flavour of silage. Level of silage flavour was quantified by a scoring methods as was described; off-flavour (score: 0), less fragrant (score: 1), medium fragrant (score:2), and heavy fragrant (score: 3). Observations level of fungal contamination in silage was conducted by observing at the presence of mold. Estimated level of fungal contamination (LFC) percentage on the surface area with categories i.e. no contamination (0%), mild (<5%), medium (5-15%), and severe (> 15%).

**Measurement of pH, Fleigh points and lactic acid concentration**

Measurement of acidity degree (pH) by using a pH meter (type 8010, Hanna Instruments). Concentration of lactic acid was determined by acid titration method (**AOAC, 2005**). Briefly, silage sample (50 mg) was taken from each treatment, added by distilled water (50 ml), stirred homogeneously and allowed to stand for 5 minutes. The supernatant of samples were taken to measure pH and lactic acid concentration.

Fleigh points (Fp) was calculated according to **Kili**ç **(1984)** as previously reported by **Ozturk *et al*. (2006)** withthe following equation: Fp = 220 + [(2 x% DM) - 15] - [40 x pH], where DM denotes dry matter of silage. Silage quality is characterized as follow very good (85-100), good (60-85), moderate (55-60), satisfying (25-55) and bad quality/worthless (<25).

Concentration of lactic acid (crude) was measured by titimetry method according to **AOAC (2005)** as followed the equation:

|  |  |  |  |
| --- | --- | --- | --- |
| % LA | = | (Vts – Vto) x N x MW x Df | x 100% |
| Vs x 1000 |

Note:

[LA] = concentration of crude lactic acid

Vts = volume of sample titrant (mL)

Vto = volume of blank titrant (mL)

N = normality of titrant (NaOH) = 0,1 N

MW = molecular weight of lactic acid = 90,0 (g/mol)

Df = dilution factor = 10x

Vs = volume of sample (mL)

**Palatability test of silage**

Silage palatability test was carried out according to palatability test method as previous reported by **Scharenberg *et al*. (2007)** and **Sofyan *et al*. (2007).** Briefly,sample (500 gram each treatment) of the fresh silage which was harvested at 21 days of incubation, was taken and fed to animal. Each sample was freely fed by animal with the randomized sample position to minimize the bias of sample order (**Figure 2**). Three animals (Ongole crossbred cattle, BW = 224 ± 8.39 kg) that used in the palatability test were kept in the BPTBA-LIPI cattle barn. Prior to palatability test, animal was restricted by feeding until 2 hours in order to reduce a satiation effect from the previous feeding.

|  |  |  |
| --- | --- | --- |
| C5 | A5 | B0 |
| B5 | A10 | A0 |
| C0 | B10 | C10 |

|  |  |  |
| --- | --- | --- |
| B0 | A0 | C0 |
| C5 | B10 | B5 |
| A10 | C10 | A5 |

|  |  |  |
| --- | --- | --- |
| B5 | A5 | A0 |
| C10 | C5 | B0 |
| B10 | C0 | A10 |

Feeder#3

Feeder#2

Feeder#1

Figure 2. Illustration of randomized sample placed in silage feeder for evaluating palatability

Randomization place of silage samples for each treatment was carried out to reduce the bias of cow preference to certain samples. Silage palatability value was estimated from the percentage consumed cow silage samples for 10 minutes relative to amount of the initial silage samples. Palatability value was calculated following the equation:

|  |  |  |  |
| --- | --- | --- | --- |
| PVi (%) | = | Si | x 100% |
| (S1+ S2+S3 …+S9) |

Note:

PVi = Palatability value of silage at treatment-i (%)

Si = Consumed silage from treatment-i (gram)

i = Silage samples (i=1, 2, 3, …, 9). Code-i denote 1 (A0), 2 (A5), 3 (A10),

4 (B0), 5 (B5), 6 (B10), 7 (C0), 8 (C5), and 9 (C10).

**Data Analysis**

Data of physical characteristics of silage analyzed descriptively. Data of pH, Fleigh points, crude lactic acid concentration and palatability of silage were analyzed by ANOVA (analysis of variance / ANOVA). If among the treatments showed significant differences at least 5% (*P* <0.05), a post hoc of the orthogonal contrast test was applied (**Gomez and Gomez, 2007**). Interaction of silage characteristic and palatability was performed by linear regression. Raw data of *Clostridia* colonies that was reported by **Sofyan *et al*. (2011a)** were converted into logarithmic transformation then those were integrated in correlation analysis. A network analysis curve was applied to simplify the interaction of each parameter.

**RESULTS AND DISCUSSION**

**Physico-Chemical Characteristic of King Grass Silage**

Physical and chemical characteristic of king grass silage was evaluated to determine effect of *L. plantarum* and *S. cerevisiae* inoculants consortia in combination with rice bran addition during 21 days incubation. Physical characteristic of silage was evaluated by the texture-colour, flavour and fungal contamination. Contamination was indicated by fungus colonies grown on silage. Silage was treated inoculants with/without rice bran addition showed more fragrant flavour than that in control silage in parallel with addition of rice bran tended to improve silage flavour (**Table 2**).

Table 2. Physical characteristic of king grass silage treated by rice bran and inoculants consisting of *L. plantarum* (Lp) and *S. cerevisiae* (Sc)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Inoculants | Variables | Level of rice bran addition | | |
| 0% | 5% | 10% |
| Control | Colour | Green-browning | Green-browning | Green-browning |
| Flavour | Slightly fragrant | Fragrant | Fragrant |
| LFC | Not found | Slightly | Medium |
| Lp | Colour | Green-browning | Green-browning | Green-browning |
| Flavour | Heavily fragrant | Heavily fragrant | Heavily fragrant |
| LFC | Slightly | Slightly | Medium |
| Lp+Sc | Colour | Green-browning | Green-browning | Green-browning |
| Flavour | Heavily fragrant | Heavily fragrant | Heavily fragrant |
| LFC | Not found | Not found | Medium |

Note: LFC= Level of fungal contamination

Texture of all silage sample were similar in colour i.e. green-browning. Although no observed fungal contamination, silage without inoculation and rice bran addition (control) showed the worst flavour compared with others. Fungal contamination tended to higher in the silage was added by rice bran, except for the silage treated Lp+Sc with rice bran addition up to 5%.

Addition of rice bran up to 10% seem to be higher in fungal contamination. It might related to rice bran contained high soluble carbohydrate that was favourable for growing fungi and undesireable microorganism. However, the contamination can be reduced by adding Lp+Sc inoculants combined with 5% of rice bran. Both of microbes in inoculants were previously reported that those have ability to produce antibacterial subtances. In term, *L. plantarum* secretes bacteriocins subtances (**Thuault *et al*. 1991 ; Gollop *et al*., 2005 ; Valan-Arasu *et al*., 2013**) and *S. cerevisiae* generates oxylipins (**Strauss *et al*. 2005**) that those affect *Clostridia* and fungi inhibition.

Beside physical characteristics, it was also performed evaluation of chemical characteristics i.e. pH, crude lactic acid and Fleigh points in the silage that those were presented in **Table 3.**

Table 3. Degree of acidity and Fleigh points of king grass silage treated by rice bran and inoculants consisting of *L. plantarum* (Lp) and *S. cerevisiae* (Sc)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Inoculants | Level of rice bran addition | | | Average |
| 0% | 5% | 10% |  |
|  | --------------------------------- pH ------------------------------- | | | |
| Control | 4.34a | 4.28a | 4.34a | 4.32b |
| Lp | 4.31a | 4.24a | 4.24a | 4.26b |
| Lp+Sc | 4.24a | 4.10a | 4.12a | 4.15a |
| Average | 4.30a | 4.21a | 4.23a |  |
|  | -------------------- Crude lactic acid (% v/w) ---------------- | | | |
| Control | 8.85a | 10.03a | 13.40a | 10.76a |
| Lp | 7.59a | 9.17a | 12.33a | 9.70a |
| Lp+Sc | 9.48a | 12.96a | 12.33a | 11.59a |
| Average | 8.64a | 10.72b | 12.69c |  |
|  | ----------------------------- Fleigh points ------------------------- | | | |
| Control | 70.76a | 81.25a | 78.81a | 76.94a |
| Lp | 73.51a | 79.14a | 82.93a | 78.53a |
| Lp+Sc | 72.76a | 83.43a | 88.01a | 81.40a |
| Average | 72.35a | 81.27b | 83.25b |  |

Note. Different superscript in same column or row showed a significant difference (*P* < 0.05).

Addition of inoculants significantly (*P* < 0.05) decreased pH, and tended to increase concentration of crude lactic acid (*P* = 0.058) and Fleigh points (*P* = 0.081). The addition of rice bran showed significant increase of lactic acid and Fleigh points while pH seemed to decrease. Addition of silage with rice bran up to 10% increased concentration of lactic acid significantly (*P* <0.05). Silage treated with a combination of Lp+Sc showed the highest concentration of crude lactic acid (11.59%). High concentration of lactic acid was followed by reducing pH. An increase of lactic acid indicated that soluble carbohydrate might support microbial growth in inoculants. Based on proximate analysis, rice bran was used in this experiment contained soluble fraction (NFE, nitrogen free extract) accounted for 30-35% (DM).

Silage quality could be determined by indication of lactic acid concentration and pH values. Good quality of silage was determined if lactic acid content concentration reached 3-14% (**Hutton, 2008**) with pH was no higher than 4.2 (**McDonald *et al*., 1991**). Based on data from Table 3, Fleigh points was ranges of 78.9, in term the silage could be categorized as good quality. **Santoso *et al*. (2009)** revealed that king grass silage treated by inoculants had better quality than silage without inoculants (Fleigh points= 41.7 vs 14.2).

**Palatability of Silage**

Result of palatability test of silage to cattle are presented in **Table 4.** Silage treated with inoculation and rice bran addition was higher palatability than silage without inoculants (control).

Table 4. Palatability of silage inoculated by *L. plantarum* (Lp) and *S. cerevisiae* (Sc) with the addition of rice bran

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Inoculants | Level of rice bran addition | | | Average |
| 0% | 5% | 10% |
|  | ---------------------------------------- (%)----------------------------------------- | | | |
| Control | 0.00 | 1.67 | 18.33 | 6.67 |
| Lp | 26.67 | 18.33 | 33.33 | 26.11 |
| Lp+Sc | 33.33 | 33.33 | 33.33 | 33.33 |
| Average | 20.00 | 17.78 | 28.33 |  |

The highest palatability (about 33%) was observed in silage treated by Lp+Sc inculation with/without addition of rice bran. Addition of silage inoculants improved the physical quality by improving silage flavour. In accordance with the physical parameters in **Table 2,** silage treated by inoculants had a better flovour characteristic than others.

Palatability is a favorite response to the consumed raw materials or animal feed **(Grovum, 1988)**. Feed palatability involves feedstuffs characteristics that stimulate sensorial acceptance by olfactory, gustatory and tactile stimuli in animal (**Scharenberg *et al*., 2007**). The level of palatability of feedstuffs including silage was possibly influenced by taste, smell and texture of those materials. In previous study, **Sofyan *et al*. (2007)** revealed that silage treated by semi-aerobic inoculants (*Rhizopus* sp. and *S. cerevisiae*) was more palatable than silage without inoculants (93% vs 50%). High palatability of the inoculated silage was associated by their fragrant flavour that formed during ensilage. This volatile compound has contributed to fragrance formation in silage through involvement of enzymatic activity for synthesizing aromatic compound/flavouring substances in silage. **Carrau *et al*. (2008)** reported that aromatic compound i.e. esters, alcohols, acids and lactones as component of flavour in fermented products of grape juice can be produced by *S. cerevisiae.*

Parameter palatability affects consumption (intake) to meet dry matter and nutrients requirements. **Baumont (1996)** revealed that palatability was highly correlated with the amount of feed consumed and effected the flow rate of feed in the digestive tract. In this study, the silage that treated by either inoculants treatment or rice bran addition improved the quality parameters i.e. physical, chemical and palatability silage to animal. Although similar in palatablity with the incoulant treated silage with rice bran addition, the inoculated silage added by rice bran had a better physico-chemical characteristics. Inoculation without addition of soluble carbohydrate source affected degradation of substrate in forage. Dry matter loss reached 1-9% during ensilage was frequently caused by damage of aerobic conditions (oxidation) (**McDonald *et al*., 1991**). By addition of WSC substances, dry matter lost of forage can be minimized and lactic acid bacteria growth can be optimized. On the other hands, inoculants treatment without adequacy of WSC implied reducing in organic matter digestibility because most organic material degraded during ensilage although these physical quality i.e. flavour and palatability were still improved.

**General discussion: interelationship of silage characteristic and palatability**

In order to evaluate interdependency between parameters, regression analysis was performed to asses correlation of each parameters (**Figure 3**). In this study, palatability of king grass silage was directly influenced by *Clostridia* colony and pH, however, indirectly affected by Fleigh points and crude lactic acid concentration (**Figure 4**).



**Figure 3.** Interelationship of physico-chemical characteristics and palatablity of king grass silage.

An increase of clostridia colony number possibly affected decrease of palatability. *Clostridia* in silage caused the breakdown of protein fractions into ammonia by proteolytic enzymes produced by *Clostridia* (**McDonald *et al*., 1991**), and was able to convert lactic acid into butyric acid with the formation of hydrogen gas and carbon dioxide (**Stefanie *et al*., 2000**). **Lalou *et al.* (2013)** revealed that *S. cerevisiae* is used an inoculant to ferment sugar and generate volatile compound i.e. β-pinene, β-terpineol, and D-limonene etc. These volatile substances are known as bio-flavour compounds. Indeed, DM of silage has also associated with Fleigh points (**Ozturk *et al*., 2006**). On the other hands, moisture content of silage affects microbial activity during ensilage **(Weinberg and Muck, 1996)**. High moisture content in silage (more than 70%) has a challenge for *Clostridia* growth. Silage with bad flavour might be occurred as a consequence of clostridial deterioration (**Mathews, 1999**).

**Silage**

Palatability

pH

*Clostridia*

colony

Fleigh points

Lactic acid

**Figure 4.** Network analysis chart visualized physico-chemical characteristics that influenced palatablity of king grass silage. Arrow connectors denote a significant correlation at least *P* < 0.05.

In addition, deterioration in silage was indicated by fungal contamination and bad- silage flavour. Fungi and *clostridia* are easily growing on silage when anaerobic condition can not be achieved. Butyric acid producing bacteria such as clostridia in silage affected deterioration and off-flavour silage (**Vissers *et al*., 2007**). In order to inhibit fungi growth, LAB could be used as bio-preservative agent. **Valan-Arasu *et al*. (2013)** observed antifungal compound from *Lactobacillus plantarum* KCC‐10. Bacteriocins can be functioned as antifungal compound, which are secondary metabolites and serve to inhibit pathogenic bacteria such as *Clostridia*.

The increase in the inhibition of the growth of *Clostridia*, fungi and other undesirable microbes in silage, combination of inoculants consisted of *L. plantarum* and *S. cerevisiae* is more due to the ability of *S. cerevisiae* to produce antibacterial substances. Yeast S. cerevisiae can produce oxylipin as antifungal substance which has a role in *Clostridia* inhibition (**Strauss *et al*., 2005**). The existence of an active compound supporting functions of bacteriocins produced by *L. plantarum*. Synergism of *L. plantarum* and *S. cerevisiae* in inhibiting the growth of *Clostridia* are indicated on the number of these colonies in the treated silage Lp+Sc which tend to be lower than control and the Lp-treatment. The number of *Clostridia* colonies were lower in treated silage indicated that inoculated silage maintained the low level of deterioration.

Interestingly, in the recent study (**Zakariah *et al*., 2016**) reported that quality cocoa pod silage could be improved by addition of Lp+Sc inoculant. Effectivity of yeast was also contributed to increase rumen microbe population and short chain fatty acids (**Riyanti *et al*. 2016**). Improving nitrogen utilization and fiber digestion in the rumen of cattle by yeast *S. cerevisiae* supplementation were also reported by **Chaucheyras‐Durand *et al*. (2016)** and **Ouellet *et al*. (2016).**

Overall, the use of *L. plantarum* and *S. cerevisiae* in combination with soluble carbohydrate (such as rice bran) had mutual effect to improve silage quality. Furthermore, aerobic deterioration and rotten silage caused by fungi and clostridial contamination can be presumbly prevented by applying those inoculation methods. Consequently, those ensilage method ensure continuity of forage preservation and econimically advantage in ruminant production. Perhaps, further implementation of these ensilage technology could easly adopted by either in small-holder farmers or livestock industrial scale.

**CONCLUSION**

The use of lactic acid bacteria inoculant (100% of *L. plantarum*) or in combination with *S. cerevisiae* (75% of *L. plantarum* and 25% of *S.cerevisiae*) by adding a source of soluble carbohydrate (rice bran) improved the physico-chemical quality and palatability of king grass silage.

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