Quality of water hyacinth (*Eichhornia crassipes*) silage with different level of rice bran

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Abstract. This study aimed to determine the effect different levels of rice bran with on the quality of Water hyacinth (*Eichhornia crassipes*) silage, know the nutrient content of water hyacinth before and after fermentation and determine the effect of adding a dose of bran with a different level of the quality of water hyacinth silage (pH, moisture content, carbohydrate and nutrient contents). This research was conducted in the Subdistrict Rasau Jaya, District Kubu Raya, West Kalimantan. The research design used was completely randomized design (CRD) with 5 treatments and 4 replications. There are P0 = Control (0% of rice bran), P1 = 5% of rice bran, P2 = 7.5% of rice bran, P3 = 10% of rice bran, P4 = 12.5% of rice bran. The parameters of this research are crude protein, crude fibre, crude lipid, pH, moisture content and carbohydrate. The results showed that treatment with the addition of rice bran was highly significant on water content, but no significant effect on crude protein, crude lipid, and crude fibre.

1. Introduction

The availability of land forage feed crops increasingly limited as a result of the transfer of land for housing, industry, agriculture. The quality and quality of forage is low, it would require an alternative source processing of new feed ingredients. Today many studies that utilize waste and weeds so that it becomes more useful while helping to reduce the negative impact on the environment.

Water hyacinth (*Eichhornia crassipes*) is a floating plant that can cover the surface of the water. The plant can adapt to extreme changes in the rate of the water, changes in levels of nutrients, pH (soil acidity), temperature and water level. High water hyacinth around 0.4-0.8 m. The leaves single oval, tapered tip, and base, the base of the petiole bubble. The flowers including compound interest, grain-shaped, tubular petals. The seeds are round and black. Its roots are fibrous. Water hyacinth, which is known as aquatic weeds disturbing and difficult to eradicate turned out to have a fairly high protein content of between 12-18%. Water hyacinth can thrive in conditions of high water containing nutrients, especially in regions where the nitrogen content of 1.02%, Potassium 22.40%, and Phosphate 0.7%. Silage with good quality is obtained by tapping various undesired enzyme activity and encouraged the development of lactic acid bacteria that already exists in the material [1]. The carbohydrates that are easy to digest such as fine bran and cassava can improve the quality of silage so that silage can serve as a preservative. Retain nutrients in the forage and provide fodder in the dry season long.
Water hyacinth silage research has not been done and silage made to forage into a durable, yet decrease the nutrient content of feed due to the overhaul of feed nutrients, especially protein made by the bacteria proteolysis. The decline in the nutrient content of the feed is associated with long ripening. The longer it is fermented, the more nutrients are lost. One effort that can be done to overcome this is by adding lactic acid bacterial inoculant. Lactic acid bacteria can thrive with foods containing glucose so that the starter can be used is rice bran.

2. Materials and methods

2.1. Preparation of samples
This study used 60 kg *Eichhornia crassipes* was collected from rivers in Raya Jaya districts with each treatment as much as 3 kg. The starter used in this study is the brown sugar with the amount used for each treatment is 30 g/kg. Used fine rice bran obtained directly from the milling rice. The rice brain amount needed for each treatment varies depending on the concentration of each treatment, so for all treatments was ± 1200 grams. The water was spraying to the amount needed for each treatment is 50 ml and the amount for all treatments was 1000 ml.

2.2. Ensilage method and design
*Eichhornia crassipes* collected of the river using sacks. Sorting and selecting a good weed water hyacinth and discard the bad. Water hyacinth cut the size of 3 cm. Considering freshwater hyacinth that has been cut size of 3 cm to withered as much as ± 60 kg. Shrivelled water hyacinth that has been cut and then drying under sunlight using tarpaulin mat until the moisture content of 60-70%. *Eichhornia crassipes* that have withered weighed on digital scales. Additional material in the process of making silage and silage-making tools for preparation. Counting and weighing the materials used such as bran and brown sugar for each treatment. Mix the ingredients according to the concentration that will be done every treatment. Once well blended, then put into plastic cans of size 5 kg, and pressing until no air / anaerobic conditions. Close the lid and solace cans with the can lid and store it for 30 days. After 30 days to observe the quality of silage conducted at the Laboratory of Animal Husbandry Faculty of Agriculture and silage proximate analysis in the laboratory of Agricultural Product Technology, Faculty of Agriculture, Tanjungpura University.

The design used in this study was completely randomized design (CRD) with 5 treatments and 4 replications. Taraf treatment is given by the study as follows:
P0: *Eichhornia crassipes* without rice bran (Control); P1: *Eichhornia crassipes* + 5% Rice Bran; P2: *Eichhornia crassipes* + 7.5% Rice Bran; P3: *Eichhornia crassipes* + 10% Rice Bran; P4: *Eichhornia crassipes* + 12.5% Rice Bran

Variables observed in this study are (1) The pH measured by mashing silage using mortar mixed with distilled water and then measured using a pH meter, (2) The water content was measured by using the proximate analysis before fermentation and after fermentation, (3) Carbohydrates are measured by dividing the content of water, protein, fat, and ash by 100, (4) Crude protein measure using proximate analysis before fermentation and after fermentation, (5) Ether extract measure using proximate analysis before fermentation and after fermentation, (6) Fibre measure using proximate analysis before fermentation and after fermentation.

All the data obtained was subjected to a one-way analysis of variance (ANOVA), and the mean differences were compared by a least significant differences (LSD) test.
3. Result and discussion

3.1. Chemical composition of silage

3.1.1. Crude protein analysis. The observation of nutrient intake during the study can be seen in Figure 1. The treatment did not significantly affect the consumption of nutrients (P > 0.05). Based on Figure 1 that the crude protein content is highest in the treatment of P2, while the lowest for the treatment P4. Each treatment decreased with the increasing length of fermentation from 6.936% to 4.433%, a decrease in each treatment is relatively stable, because decrease not much different, it is similar to previous research in respect of crude protein in the silage total mixed ration hyacinth down from 5.56% (long ripening 4 days) to 2.15 (long ripening 20 days) [2]. It is anticipated by the degradation of proteins by bacteria. Previous research reported that the addition of cassava flour from 15% lower levels of crude protein vegetable waste silage. The decline in crude protein levels due to the work of bacteria [3]. The decline in crude protein due to reduced content of nitrogen (N) on the leaves because of the aging process, it is well known that proteins are composed of a series of amino acids containing nitrogen, with the increasing age of the leaves marked by a change of colour in the leaves showed that the chlorophyll content of substances of leaves is reduced along with a reduction of nitrogen in the leaves. The decrease is due to the protein content is also because of a fungus in each treatment, so that the protein to be down, but it is also caused by a decrease in protein nitrogen taken spoilage bacteria and converted to ammonia. The existence of proteases in silage cause breakdown proteins into simpler molecules, so that the levels of protein to be down.

![Figure 1. Crude protein (CP), ether extract (EE), crude fibre (CF) from water hyacinth silage different levels of rice bran](image)

According to previous research, the addition of describe level of more than 15% to lower crude protein silage compared with controls of 0%, whereas the addition of accelerators 15% have not lowered the crude protein content [4]. This is due to the crude protein content of cassava is very low. Cassava waste an energy source feed material having a crude protein content is very low, only 1.13%. This proves that the addition of cassava flour can reduce the crude protein content of vegetable waste silage.

The decrease was caused by the transfer of nitrogen accumulation of vegetative parts of the plant to the cobs for the seed formation process. It has been reported that before filling the seed result of assimilation is mostly used by the components of vegetative growth, whereas during seed filling most of the results of assimilation used for generative production. In line with the previous research that when plants grow old then there was a transfer of the protein from the vegetative to the seed for seed development [5].
Decreased levels of crude protein vegetable waste silage. This occurs because of the addition of cassava flour which is an extract without nitrogen source material. It has been reported that the higher the addition of the accelerator, causing the greater the reduction in the levels of crude protein [6]. This is due to the higher accelerator added will increase the levels of extract material without nitrogen, given accelerator is potential as a source of extract without nitrogen. Cassava flour is a source of extract material without nitrogen when added to vegetable waste silage will cause a decrease in crude protein. According to previous research that the mixing of two different feed ingredients or more will cause changes in nutrient content [7].

3.1.2. Ether extract analysis. Based on Figure 1. that ether extract levels highest in P2 treatment, while the lowest for the treatment P4. Each treatment has decreased from 5.258% to 4.786%, a decrease in fat content rough due to the fat component rude easily fermented and because of the work of bacteria that break down fat, so fat to be down, it is similar to the previous research that the average value fat content in cassava waste silage decreased in the treatment of inoculum addition of lactic acid bacteria and the combination of lactic acid bacteria inoculum and cassava flour, for allegedly crude lipid component enzymatically easily fermented by lactic acid bacteria [8]. Fat loss is caused by lipolytic processes that lead to the disintegration of fat into short-chain fatty acids, carbonyls and volatile compounds as free fatty acids, other than that caused by damage to the fat component due ensilage process as it happens in other nutrient content.

According to previous research, fat content decreased due to the occurrence of lipolytic processes that lead to the disintegration of fat into short-chain fatty acids, carbonyls, and volatile compounds as free fatty acids [9]. It has been reported that ensilage ration complete waste raw material market. Rough fat dropped from 5.15% to 4.07% [10]. The decline in crude lipid allegedly because of rough fat component is fermented so degraded enzymatically by lactic acid bacteria. It has been reported that the fat content of the coarse feed material consisting of glycerol esters, fatty acids and vitamins are fat-soluble volatile [11]. Laboratory and Nutrition Faculty of Agriculture, University of Lampung reported that the increase in crude lipid levels highest in the addition of rice bran may be caused by rough fat content owned rice bran highest compared with other treatments in the amount of 16.63% Laboratory of Animal Nutrition and Feed Faculty of Agriculture, University of Lampung [12].

Lipolytic bacteria are bacteria that can do the breakdown of fat into fatty acids or glycerol. Bacteria that thrive will utilize fat on cassava flour for growth so that the fat content will decrease. According to another research, bacteria need fat to grow. These bacteria belong to the lipolytic bacteria that can do the breakdown of fat into fatty acids or glycerol. Examples of types of bacteria are Pseudomonas, Alcaligenes, Serratia, and Micrococcus. The grow of bacteria population can hydrolyse starch and cellulose and cause fermentation of sugar, while other bacteria can hydrolyse fat so that the fat content is generated is lower.

3.1.3. Crude fibre analysis. Based on Figure 1 that the fibre content is highest at treatment was lowest for the P4 and P2 treatment. Each treatment increased from 23.035% to 24.836%, an increase in fibre content due process ensilage that occurs when the closure process silage, before the phase of aerobic, occur phase ensilage affecting crude fibre content of silage and increased crude fibre due to lack of work activity of bacteria, other than that caused by the use of bran in each treatment. Crude fibre bran is higher than water hyacinth, so crude fibre brand affect water hyacinth silage. The increase in crude fibre caused enough glucose, alcohol forming microbes become active, so that the alcohol content increases, the high alcohol content, which hydrolyse microbial silage is not active, consequently the amount of carbohydrates is not reduced. Meanwhile, microbial biomass formed since the beginning of accumulating, so the increase in crude fibre no longer occurs because carbohydrates hydrolysed, and microbial biomass continues to grow, in addition to the lactic acid process can also increase the crude fibre.

The longer ripening ensilage treated a complete feed with vegetable protein sources increased crude fibre content. However, the increase in crude fibre does not occur significantly. According to another
research, proteolytic clostrium will hydrolyse amino acids into a variety of products including ammonia, amines, and volatile organic acids [13]. Meanwhile, the crude fibre content will increase, and this is because during the fermentation of microorganisms degrade carbohydrate and protein much so that at the end of silage proportion of coarse fibres will be higher because not degraded. It has been reported that the principle of making silage is to stop breathing and evaporation plant cells, convert carbohydrates into lactic acid by fermentation airtight and resist the activity of bacteria. The length of time did not happen ensilage crude fibre digestion, but digestion of crude fibre occurs when the feed is located in the rumen [14]. The process ensilage lactic acid bacteria require a pH of 3.8 to 4.0 to grow, while the coarse fibre splitting bacteria require a pH of 6.2 to grow [15].

3.2. Quality of silage

3.2.1. pH. Based on Table 1, the lowest pH treatment contained in the P1, P2, P3, and P4, while the pH is highest at P0 treatment. pH P0 higher than P1, P2, P3 and P4, this is due to carbohydrate in treatment P0 lower than P1, P2, P3 and P4 so that spoilage bacteria on P0 lot, so that the pH at P0 is still high and the process ensilage longstanding resulting bacterial Clostridiagrowth. P0 treatment did not experience ensilage perfect process so that the pH of the resulting high, it is similar to the another research in the treatment without the addition of additives produces a high pH [16]. This is because the carbohydrates in the water hyacinth low that the lactic acid bacteria in the water hyacinth is not sufficiently energized to produce lactic acid and ensilage process lasts longer, resulting in the growth of Clostridia bacteria.

This study had the highest pH of 7.54 at E0 and the lowest was 5.09 in E2. This study included an ugly pH for > 5.0 so that spoilage bacteria are easy to grow, it is consistent with the study, when pH > 5.0 and a dry matter content of 50%, the toxic bacteria Clostridia will grow, while the value of too low pH < 4.1 and 15% dry matter will enable microbial contaminants [17]. This means that the silage produced has the possibility of toxic bacteria are Clostridia. According another study reported that when lactic acid is insufficient to lower the pH of the second fermentation will occur namely lactic acid will be degraded further into acetic acid, CO2, butyric acid so that the pH is high [18]. The degree of acidity (pH) in the treatment of urea 2% addition of 4.07 and 2% urea treatment plus EM4 8% at 3.65 indicates that a decrease in pH compared to treatment without the addition of urea. It is caused due to the addition of EM-4 and molasses as a carbohydrate source for the bacteria.

This study had the highest pH of 7.54 at E0 and the lowest was 5.09 in E2. This study included an ugly pH for > 5.0, it is not the same as another research reported that the complete feed silage with silage pH of 4.4-4.5 is still relatively good [19]. This suggests a process of anaerobic fermentation microbial activity involving one Lactobacillus sp., Which revolutionized carbohydrates into lactic acid so that the pH in the ingredients down to become more acidic than the initial condition. It has been reported that the addition of molasses as a source of carbohydrate can also speed up the atmosphere and indirectly acid pH to drop [20].

The rapid decrease in pH which inhibits the action of microbial spoilage so that degradation of nutrients can be pressed [21]. The pH value of silage by cassava that is in the optimal range by another study is pH < 4.2, while cassava silage belongs to the moderate quality silage with a pH ranging from 4.5 to 5.2 [22]. The degree of acidity owned lactic acid bacteria can inhibit the attack of rotten bacteria. Silage pH decrease is largely determined by the amount of lactic acid is formed. Good silage quality is achieved when lactic acid as the predominant acid produced. Fermented very efficient when silage pH decrease occurred rapidly. It has been reported that the silage pH associated with the production of lactic acid in the process ensilage, reflecting the low pH lactic acid production is high, while high pH reflecting lower production of lactic acid [23].
which causes soft texture than carbohydrates with increased levels of water caused by a respiration phase and loss of dry matter greatest for their oxidation during the silage process, anaerobic fermentation stage 2 where glucose is converted to lactic acid, ethanol, and CO2.

The water content of silage on the treatment given to the treatment given cassava bran produces water content values is almost the same. This is because the water content of the two materials is almost the same as the water content of 11.62% cassava and rice bran water content of 12.3%. The second difference in the moisture content of materials 0.68. The addition of additives significant effect on water content, it is appropriate with another study that in his research showed that adding additional material effect on the moisture content of the silage. In another study showed that molasses, rice bran amount additive levels (0%, 2.5%, and 5%) effect on water content [26]. One of the factors that affect the silage is the moisture content of forage and materials. This is in accordance opinions another study that quality of silage produced is influenced by three factors in making silage, among others: forage is used, the additive (an additive used to increase the levels of protein and carbohydrates in the material feed) and water content material inside the forage due to high water levels encourage the growth of mould and produce butyric acid, while low water levels cause the temperature inside the silo is higher so as to have a high risk of the occurrence of fire [27].

High moisture content material produced any result silage moisture content and high water and vice versa if the moisture content of the materials used to produce silage is low, the low water levels. This opinion is also reported that the wet material/forage ensilage the more heat is required to raise the temperature and the more speed silage dry matter loss or increase in water content [28].

During the ongoing ensilage increased levels of water caused by a respiration phase that converts glucose into H2O, during the ongoing ensilage then decreased dry matter content and organic ingredients [25]. This happens in stages ensilage, as follows: Phase 1 where respiration is still ongoing, glucose is converted to CO2, H2O, and heat, so there is some fraction of glucose which is a fraction of the dry matter loss and loss of dry matter greatest for their oxidation during the silage process, anaerobic fermentation stage 2 where glucose is converted to lactic acid, ethanol, and CO2.

### Table 1. Measurement of pH, moisture, and water hyacinth silage carbohydrates with Addition of rice bran on different level

| Variable Response | Treatment | P0 | P1 | P2 | P3 | P4 |
|-------------------|-----------|----|----|----|----|----|
| pH                |           | 7.54±0.78 a | 5.81±0.80 b | 5.09±0.11 a | 5.24±0.23 a | 5.16±0.38 a |
| Moisture content  |           | 0.7±0.56 a | 9.25±0.54 b | 10.34±0.53 b | 10.4±0.42 b | 10.26±0.55 b |
| Carbohydrate      |           | 1.59±1.74 a | 4.96±1.64 b | 5.19±0.96 c | 5.14±1.11 c | 6.12±0.55 c |

Description: a, b, c of different superscripts in the same row showed no difference in (P <0.05), P0=Eichhornia crassipes without rice bran (control); P1=Eichhornia crassipes rice bran + 5%; P2=Eichhornia crassipes rice bran + 7.5%; P3=Eichhornia crassipes rice bran + 10%; P4=Eichhornia crassipes rice bran + 12.5%

3.2.2. Water content. Based on Table 1 that the water content is highest at P0 treatment, while the lowest was in P1, P2, P3, and P4. In the treatment of P1, P2, P3, and P4 are not significantly different, but P1, P2, P3 and P4 significantly different from P0. Moisture difference P0 lower than P1, P2, P3, and P4, this is due to the growing P0 many spoilage bacteria, foul odour and texture of the clot and cans less sterile conditions. The high water levels caused by spoilage bacteria that convert glucose into water, process ensilage first is where respiration is still ongoing, glucose is converted to CO2, H2O, and heat, in addition to high levels of water caused by the water content of the materials used to make silage high so that the moisture content of the silage produced is high which causes soft texture than other grasses, it is similar to another research that the treatment using lactic acid bacteria 60 ml more than produce more water, because the lactic acid bacteria can be converting glucose into the water [24]. At high water levels when no spoilage bacteria cause very rapid growth of spoilage bacteria, it is affecting silage moisture content is high. The study reported that during the ongoing ensilage decreased dry matter content (DM) and an increase in water levels caused by ensilage first stage is where respiration is still ongoing, glucose is converted to CO2, H2O, and heat [25].

The water content of silage on the treatment given to the treatment given cassava bran produces water content values is almost the same. This is because the water content of the two materials is almost the same as the water content of 11.62% cassava and rice bran water content of 12.3%. The second difference in the moisture content of materials 0.68. The addition of additives significant effect on water content, it is appropriate with another study that in his research showed that adding additional material effect on the moisture content of the silage. In another study showed that molasses, rice bran amount additive levels (0%, 2.5%, and 5%) effect on water content [26]. One of the factors that affect the silage is the moisture content of forage and materials. This is in accordance opinions another study that quality of silage produced is influenced by three factors in making silage, among others: forage is used, the additive (an additive used to increase the levels of protein and carbohydrates in the material feed) and water content material inside the forage due to high water levels encourage the growth of mould and produce butyric acid, while low water levels cause the temperature inside the silo is higher so as to have a high risk of the occurrence of fire [27].
3.2.3. Carbohydrate. Based on Table 1. Carbohydrates highest in P4 by 6.12%, while the lowest was at P0 of 1.59%. Between P0 and P1 significantly different, P0, P1, P2, P3 and P4 significantly different, but the P2, P3 and P4 are not significantly different, it is because the concentration of bran between P0 and P1, P2, P3 and P4 is different but the concentration of bran P2, P3 and P4 are not significantly different. Carbohydrates in silage decreased, due to the carbohydrate content of the additive is lower than the main ingredient of making silage water hyacinth, so that the carbohydrate content to be decreased, in addition to the presence of fungi, bacteria spoilage in silage also affect carbohydrate of silage, because carbohydrates are converted into ammonia and mildew, this is not the same as the results of the study [30] that the water soluble carbohydrate content of hemp leaves (3.08%) classified as very low as most of the tropical forage.

Water soluble carbohydrate content of a low coefficient lower fermentative. Water soluble carbohydrate content varied plant and influenced by the types and varieties of plants age of the plant and cropping patterns. According to McDonald [25], water soluble carbohydrate content in the forage for silage making of a good quality range of 3-5%. Carbohydrate sources used in this experiment has a water soluble carbohydrate content higher than the leaves of hemp, which is expected to provide water soluble carbohydrates to improve the performance of BAL. Silage by cassava, there is a water soluble carbohydrate content of silage that is lower than the water soluble carbohydrate content of the starting material.

Decreased levels of water soluble carbohydrates in silage can be understood because it is used by BAL during ensilage to produce acid and lowering the pH silage [30]. But the increased water soluble carbohydrates such as silage by cassava is not commonly found. This can be caused by many water-soluble carbohydrates used by BAL is lower than the bound carbohydrate occupational dissolving microbes and the acid produced.

The addition of a nutrient source (molasses, rice bran, and coconut cake) can increase the availability of soluble carbohydrate [31]. The carbohydrate is hydrophilic and can draw water to increase the water content in the forage being converted into silage. Digestible carbohydrate content, the more the number of microbes that can evolve so that the production of lactic acid as a result of carbohydrate fermentation will also increase. Treatment without an additive amount of carbohydrate available only from Eichhornia crassipes so that the levels of lactic acid produced less.

The addition of rice bran as a source of carbohydrate is expected to easily soluble and can be rapidly used by lactic acid bacteria as nutrients for growth [32]. Nutrient content of silage can be maintained with the addition of additives such as bacterial cultures (lactic acid bacteria), the source of water-soluble carbohydrates, organic acids, enzymes, and nutrients.

The content of WSC (water-soluble carbohydrate) was higher in rice bran can affect the quality of silage following the recommendation of another study that the soluble carbohydrate in each accelerator affects the quality of silage produced [33]. Soluble carbohydrates through fermentation by microorganisms reformed into organic acids especially lactic acid and acetic acid fraction and butyric acid, hence the presence of soluble carbohydrates is very important in ensilage.

4. Conclusions

Chemical composition of water hyacinth silage such as crude protein, crude fat and moisture content decreased. The dose of 12.5% rice bran showed significant differences in water, carbohydrate and pH levels, but did not show significant differences in crude protein, ether extract, crude fibre.

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