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Nutrient Value of Pineapple Peel Silage with the Addition of Various Carbohydrate Sources

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Abstract
This study aimed to evaluate the nutritional quality of pineapple peel silage with the addition of various carbohydrate sources, namely corn flour, cassava waste, and rice bran. The research used a completely randomized design method with 5 treatments and 4 replications. The treatments are (P0 = 100% pineapple peel; P1 = 70% pineapple peel + 30% corn flour; P2 = 70% pineapple peel + 30% cassava waste; P3 = 70% pineapple peel + 30% rice bran; P4 = 70% pineapple peel + 10% corn flour + 10% rice bran + 10% cassava waste) with the addition of molasses for each treatment as much as 5%. Parameters observed were the nutritional quality of pineapple peel silage including CP, CF, DM, ash, and CFat, levels of NDF, and ADF percentage. The results showed that the difference in carbohydrate source material had a significant effect (P<0.05) on the nutrient content of the pineapple peel silage produced. It can be concluded that adding corn flour at a 30% level to pineapple peel silage improves the overall nutritional quality as seen from the increase in crude protein and crude fat as well as a decrease in crude fiber, NDF, and ADF content.
Keywords: Pineapple Peel, Nutrient, Silage, Carbohydrate

Nilai Nutrien Silase Kulit Buah Nanas dengan Penambahan Berbagai Sumber Karbohidrat

Abstrak
Penelitian ini bertujuan untuk mengevaluasi kualitas nutrien silase kulit nanas dengan penambahan berbagai sumber karbohidrat yaitu tepung jagung, onggok dan dedak padi. Metode penelitian menggunakan rancangan acak lengkap dengan 5 perlakuan dan 4 ulangan. Adapun perlakuan yaitu (P0 = 100% kulit nanas; P1 = 70% kulit nanas + 30% tepung jagung; P2 = 70% kulit nanas + 30% onggok; P3 = 70% kulit nanas + 30% dedak padi; P4 = 70% kulit nanas + 10% tepung jagung + 10% dedak padi + 10% onggok) dengan penambahan molases masing-masing perlakuan sebanyak 5%. Parameter yang diamati yaitu kualitas nutrien silase kulit nanas meliputi persentasi PK, SK, BK, Abu dan LK, kadar NDF dan ADF. Hasil penelitian menunjukkan perbedaan bahan sumber karbohidrat berpengaruh nyata (P<0,05) terhadap kandungan nutrien silase kulit nanas yang dihasilkan. Kesimpulan penelitian bahwa penambahan tepung jagung pada taraf 30% pada silase kulit nanas dapat memperbaiki kualitas nutrien secara keseluruhan dilihat dari peningkatan protein kasar, lemak kasar serta penurunan kandungan serat kasar, NDF dan ADF.
Kata kunci: Kulit Nanas, Nutrien, Silase, Karbohidrat

Introduction

Riau Province has high pineapple productivity. In 2020 alone, Riau produced 1,343,076 tons of pineapples (BPS, 2021). The high potential of pineapple fruit is directly proportional to the amount of pineapple peel produced. Pineapple fruit can produce 27 % pineapple peel waste (Nurhayati & Berliana, 2014). If not handled properly, the wasted pineapple peel can result in environmental pollution, and the peel's high water and crude fiber content makes it easily decompose if not processed. Wijaya *et al*., (1991) reported that pineapple peel contains 81.72% water, 20.87% crude fiber (CF), 17.53% carbohydrates, 4.41 % crude protein (CP), 0.02% crude fat (Cfat), 0.48% ash, 1.66% crude fiber. Therefore. it is necessary to have a technology that can make pineapple skin waste can be stored by the fermentation method so that it has high use value as feed, one of which is silage. The silage process involves the work of lactic acid bacteria's ability to utilize non-structural carbohydrate substrates by producing various fermented products, such as lactic, propionic, and acetic acids. The production of those organic acids accelerates the condition of low pH in the silo.

Lactic acid bacteria candidates will continue to survive, grow and develop due to the support of the substrate availability. The substrate can come from a class of carbohydrate-source feedstuffs with simpler components of the sugar group (water soluble carbohydrates), so lactic acid bacteria can optimally utilize them. Some feed ingredients are sources of carbohydrates, such as corn flour, tapioca/cassava waste, and rice bran. Corn flour contains arabinoxylan which can increase the *Lactobacillus* population (Chen *et al*., 2015). One of them, cassava waste is a source of carbohydrates consisting of 87% starch whereas the rest is fiber, fat, and ash (Emmanuel *et al*., 2012). This research was carried out and focused on making pineapple peel waste silage with the addition of carbohydrate source feed ingredients in the form of corn flour, cassava waste, and rice bran. The resulting silage product is then subjected to overall nutritional analysis.

Materials and Methods

The main materials used in silage making were pineapple peel waste, corn flour, cassava waste, rice bran carbohydrate sources, and molasses. Nutritional and silage fiber fraction analysis including dry matter (DM), crude protein (CP), crude fat (CFat), crude fiber (CF), ash, NDF (neutral detergent fiber), and ADF (acid detergent fiber). Analysis was done using NIRS (Near Infrared Reflectance Spectroscopy) analysis using a Buchi NIRFlex N500 Fourier Transform near-infrared (FR-NIR) connected to a computer, petri dish, transflactance cover, and NIRWare software. NIRS analyzes samples quickly by utilizing fired infrared light and not into a data matrix that forms a spectrum graph.

Research Methods

This study used a completely randomized design with 5 treatments and 4 replications. The treatments were as follows:

P0 = 100 % pineapple peel (KN)
P1 = 70% pineapple peel (KN) + 30% corn flour (TJ)
P2 = 70% pineapple peel (KN) + 30% cassava waste (O)
P3 = 70% pineapple peel (KN) + 30% rice bran (DP)
P4 = 70% pineapple peel (KN) + 10% corn flour (TJ) + 10% rice bran (DP) + 10% cassava (O)

The addition of molasses for each treatment was 5%

Research Procedure

Pineapple peel wastes were chopped in 3-5 cm lengths, then withered for 18 hours to reduce their water content to 60 - 70 % (Harahap *et al.*, 2018; Superianto *et al.*, 2018). Withered peel waste was then mixed with the silage material with various carbohydrate ingredients: corn flour, rice bran, and cassava waste, and adding 5% molasses to each treatment. After the ingredients were mixed evenly, they were put into a 10-liter silo, compacted and tightly closed (*anaerobic),* and fermented for 21 days. After 21 days of silage fermentation, the silos were opened and the silage content (in percentage) of CP, CF, DM, Ash, CFat, NDF, and ADF were analyzed.

Research Parameter

The nutrient quality of pineapple peel silage including CP, CF, DM, Ash, CFat, NDF, and ADF were observed as research parameters.

Data Analysis

Data were analyzed using SPSS 20 software. If there is a significant difference, Duncan's Multiple Range Test (DMRT) was performed.

Results and Discussion

The nutritional value of pineapple peel silage was analyzed after the silage-making process until dry silage flour was produced. The results of the nutritional analysis of various carbohydrate sources used as additional ingredients for the silage process are shown below.

Table 1 shows that corn flour has a relatively good nutrient component compared to other carbohydrate sources. This can be seen from the high nutrient value of crude protein and supported by data on the low content of crude fiber and NDF (neutral detergent fiber*)*.

Dry Matter (%)

Dry matter is an important measure of the nutritional value of a feed ingredient, dry matter usually reflects several other components of nutritional value. The dry matter contents of pineapple peel silage with the addition of various carbohydrate feed ingredients are shown below.

Table 2 shows that adding various carbohydrate source feed ingredients to the pineapple peel silage affected (P<0.05) its dry matter content. Treatments P3 and P4 produced the same dry matter content (P>0.05) with values of 91.53% and 91.49% and were higher than treatments P3, P2, and P1 with sequential values of 91.28, 90.17 and 89.92 %. The high dry matter in treatments P3 and P4 was due to the relatively high dry matter value of rice bran before silage with a value of 91.47% which resulted in lactic acid bacteria being free to utilize WSC (*water soluble carbohydrates*), causing higher dry matter value. Pahlow *et al*., (2003) reported that the ideal fermentation is that lactic acid bacteria can use WSC for their growth and are characterized by increasing dry matter content. The dry matter content in this study ranged from 89.82 - 91.53%, higher than the results of research by Kusuma *et al*., (2019) using pineapple peel silage with the addition of *Aspergillus niger* with dry matter values ranging from 31.73 – 40.15%.

Crude Protein (%)

Crude protein is a component of organic matter containing nitrogen and part of the substrate needed by lactic acid bacteria in the silage process. The crude protein value of pineapple peel silage with the addition of carbohydrate source feed ingredients is presented in Table 3.

The silage analysis results showed that the crude protein content was affected (P<0.05) by the silage treatment of pineapple peels added with various carbohydrate sources. The highest crude protein content was in treatment P1 (70% KN + 30% TJ) with a value of 9.16 % and the lowest crude protein value was in treatment P4 (70 % KN + 10% TJ + 10% O + 10% DP) with a value of 6.62%. The high crude protein in the P1 treatment was caused by corn flour providing substrate materials in the form of non-structural carbohydrates in a stable manner, causing lactic acid bacteria to produce various fermentation products. These fermentation products can stop the reaction of microorganisms, especially bacteria capable of reducing the quality of silage products by reducing the crude protein percentage. Unlike the P4 treatment, it produced the lowest crude protein value due to the limited adequacy of the substrate, although the types of carbon source feed used varied but were unable to maintain protein value during the silage process. Cao *et al.*, (2016) stated that the silage process is stable if lactic acid bacteria with adequate non-structural carbohydrate support can slow down protein degradation, enabling the crude protein content during ensilaging to remain high. The results of this study ranged from 6.62 - 9.16 % higher than those obtained by Faisal *et al*. (2021) on fermented pineapple peel and crown silage with values ranging from 5.98 - 8.46%.

Crude Fat (%)

Crude fat is a structural component of organic matter nutrients without nitrogen needed in the feed fermentation process. The crude fat content of pineapple peel silage with the addition of various carbohydrate source feed ingredients is presented in Table 4.

The table above shows that the pineapple peel silage treatment with the addition of various carbohydrate ingredients had significantly different (P<0.05) crude fat content. The highest treatment was in the P1 treatment (70% KN + 30% TJ) with a crude fat value of 3.21% and the lowest was in the P2 treatment (70% KN + 30% O) with a crude fat value of 0.83%. The high crude fat in treatment P1 was caused by the high crude fat content of corn starch with a value of 8.85% (Table 1) and the lowest crude fat was in the cassava carbohydrate with a value of 0.43%. This condition was directly proportional to the value of crude fat during and after the silage process. The silage process is an activity of lactic acid bacteria with an anaerobic mechanism through the utilization of existing substrate nutrients, one of which is crude fat. The activity of lactic acid bacteria aims to reduce the loss of crude fat components due to the silage process. Borreani *et al.*, (2018) stated that the silage process is a microbiological activity that aims to anticipate the loss of dry matter, one of which is crude fat. The results of this study produced crude fat ranging from 0.83 - 3.21% lower than the results of research by Kesuma *et al.*, (2021) using crown silage and pineapple peel and different proportions with an average crude fat ranging from 2.08 – 3.87%.

Ash (%)

The ash content is a component of inorganic material that has gone through the ashing process from the dry matter of the feed.

The results of the research on the ash content of pineapple peel silage with the addition of various carbohydrate sources can be seen in Table 5.

Table 5 shows that the ash content in pineapple peels silage was affected ($P<0.05$) by the silage treatment of pineapple peels added with various carbohydrate sources. The highest ash value was found in the P3 treatment (70% KN + 30% DP) compared to the P0 treatment; P1 and P2 with a value of 5.30% compared to 3.01; 3.57; and 3.81% and the same as the P4 treatment (70 % KN + 10% TJ + 10% O + 10% DP) with a value of 3.95%. The high ash in the P3 treatment indicated that the predominance of the production of mineral elements was also high and the possibility of this production had occurred during the silage process due to microbiological processes which were mostly reduced mainly from dry matter components. This is supported by the ash content before the silage process (Table 1) in rice bran material reaching 9.85%.

Crude Fiber (%)

Crude fiber content is part of the carbohydrates derived from components of organic matter without nitrogen. The average value of the crude fiber content of pineapple peel silage with the addition of various carbohydrate sources can be seen in Table 6.

Table 6 shows that adding various carbohydrate sources of feed ingredients influenced the crude fiber content of pineapple peel silage. The P3 treatment (70% KN + 30% DP) was different ($P< 0.05$) with the P0, P1, and P4 treatments but not different ($P>0.05$) with the P2 treatment. The highest crude fiber value was in treatment P3 (addition of rice bran) with a crude fiber value of 21.20% and the lowest was in treatment P1 (addition of corn flour) with a value of 14.70 %. It is possible that the WSC substrate was not optimally available so that the activity of lactic acid bacteria was not able to optimally degrade crude fiber, in contrast to the P4 treatment where the distribution of portions of carbohydrate source feed was more varied so that the production of lactic acid was more varied. This condition makes it easier for bacteria to degrade crude fiber. Colombatto *et al*., (2003) stated that the WSC substance as a substrate for lactic acid bacteria can be converted into lactic acid, increasing the fiber's digestibility. The results of this study are also in accordance with what was conveyed by Nastiti *et al.*, (2013) that the use of *Actinobacillus sp. ML-08* up to a level of 10% significantly reduce the crude fiber content of pineapple peel silage. The results of this study were higher than those obtained by Kusuma *et al*., (2019) using pineapple peel silage with the addition of *Aspergillus niger* resulting in an average crude fiber value of 13.23 - 16.85%

NDF (%)

The NDF content is part of the crude fiber component found in the part of the plant cell wall that is difficult to digest. The average value of the NDF content of pineapple peel silage with the addition of various carbohydrate sources can be seen in Table 7.

Table 7 shows that adding various carbohydrate source feed ingredients had a significant effect ($P<0.05$) on changes in the NDF content of pineapple peel silage. P2 (70% KN + 30% O) produces a different value ($P< 0.05$) with P0, P1, P3, and P4 then P3 (70% KN + 30% DP) obtains the same value ($P>0.05$) with P4 treatment. The highest value of silage NDF content was found in the addition of 30% cassava with a value of 48.35%, not different from the addition of 30% rice bran with a value of 43.12%. Furthermore, the lowest NDF was found in adding corn flour with a crude fiber value of 36.25 %. This result is in line with the results (Table 6) which showed that the highest crude fiber was found in the addition of rice bran and the lowest was in the addition of corn flour. This proves that the silage process is closely related to the performance of lactic acid bacteria in utilizing the substrate. The substrate on corn flour is easier to use for growth and development because it probably has a high enough WSC content to consistently degrade the silage material as indicated by a significant decrease in the NDF component. Hua *et al*. (2016) described that adding *Lactobacillus plantarum* and fibrolytic enzymes can reduce the silage's NDF content.

ADF (%)

The ADF content is a part of the constituent components of plant cell walls with high digestibility. The value of the ADF content of pineapple peel waste silage with the addition of various carbohydrate sources is presented in Table 8.

Table 8 shows that adding various carbohydrate ingredients had a significant effect (P<0.05) on the ADF value of pineapple peel silage. Treatment P4 (addition of rice bran) had the highest crude fiber value of 20.83% and treatment P1 (addition of corn flour) produced the lowest crude fiber value with a value of 14.98. This result also aligns with the crude fiber value (Table 6) that the highest and lowest silage treatments were the addition of rice bran and corn flour. This proves that in the silage process, lactic acid bacteria have a good ability to decompose ADF components when supported with substrate materials suitable for the growth conditions, one of which is corn flour because it is part of the non-structural carbohydrate component which is easily digested during the silage process. Sarong *et al*. (2020) reported that adding molasses and cellulose additives reduced the ADF content from 689.6 g/kg DM to 641.77 g/kg DM.

Table 1. Results of the nutritional analysis of various carbohydrate source materials

Feedstuff	Nutrient Composition (%)					
	DM	CP	CFat	CF	Ash	NDF
Rice Bran	91.47	6.11	2.21	21.48	9.85	35.60
Cassava Waste	88.67	1.41	0.43	18.76	2.82	28.17
Corn Flour	88.75	9.54	8.85	4.08	3.79	18.61

Notes: DM = Dry Matter, CP = Crude Protein, Cfat = Crude Fat, CF = Crude Fiber, NDF = Neutral Detergent Fiber. Results of Analysis of Animal Logistics Indonesia Netherlands (ALIN) IPB Bogor, 2022.

Table 2. Dry matter content of pineapple peel silage (%)

Treatment	Mean ± SD
P0 (100% KN)	89.82 ± 0.78 ^{c}
P1 (70 % KN + 30 % TJ)	90.17 ± 0.19 ^{bc}
P2 (70% KN + 30 % O)	91.28 ± 0.42 ^{ab}
P3 (70% KN + 30% DP)	91.53 ± 0.40 ^{a}
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	91.49 ± 0.63 ^{a}

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Table 3. Pineapple Peel Silage Crude Protein Content (%)

Treatment	Mean ± S.D
P0 (100% KN)	7.81 ± 0.45 ^{b}
P1 (70 % KN + 30 % TJ)	9.16 ± 0.29 ^{a}
P2 (70% KN + 30 % O)	7.09 ± 0.15 ^{cd}
P3 (70% KN + 30% DP)	7.43 ± 0.41 ^{bc}
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	6.62 ± 0.20 ^{d}

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Table 4. Crude Fat Content of Pineapple Peel Silage (%)

Treatment	Mean ± S.D
P0 (100% KN)	1.54 ± 0.14 ^{c}
P1 (70 % KN + 30 % TJ)	3.21 ± 0.12 ^{a}
P2 (70% KN + 30 % O)	0.83 ± 0.17 ^{d}
P3 (70% KN + 30% DP)	2.40 ± 0.12 ^{b}
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	2.25 ± 0.09 ^{b}

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Table 5. Pineapple Peel Silage Ash Content (%)

Treatment	Mean ± S.D
P0 (100% KN)	3.01 ± 0.38 [c]
P1 (70 % KN + 30 % TJ)	3.57 ± 0.38 [bc]
P2 (70% KN + 30 % O)	3.81 ± 0.17 [bc]
P3 (70% KN + 30% DP)	5.30 ± 0.56 [a]
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	3.95 ± 0.32 [b]

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Table 6. Fiber Content of Pineapple Peel Silage (%)

Treatment	Mean ± S.D
P0 (100% KN)	18.06 ± 0.54 [c]
P1 (70 % KN + 30 % TJ)	14.70 ± 0.43 [d]
P2 (70% KN + 30 % O)	20.27 ± 0.41 [ab]
P3 (70% KN + 30% DP)	21.20 ± 0.58 [a]
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	19.88 ± 0.50 [b]

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Table 7. NDF content of pineapple peel silage (%)

Treatment	Mean ± S.D
P0 (100% KN)	45.77 ± 0.82 [b]
P1 (70 % KN + 30 % TJ)	36.25 ± 0.70 [d]
P2 (70% KN + 30 % O)	48.35 ± 0.65 [a]
P3 (70% KN + 30% DP)	43.12 ± 0.65 [c]
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	43.18 ± 0.60 [c]

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Table 8. ADF content of pineapple peel silage (%)

Treatment	Mean ± S.D
P0 (100% KN)	17.70 ± 0.63 [c]
P1 (70 % KN + 30 % TJ)	14.98 ± 0.66 [d]
P2 (70% KN + 30 % O)	19.55 ± 0.62 [b]
P3 (70% KN + 30% DP)	20.83 ± 0.41 [a]
P4 (70 % KN+ 10 % TJ + 10 % O + 10 % DP)	20.80 ± 0.40 [a]

Notes: SD = Standard Deviation, KN = pineapple peel, TJ = corn flour, O = cassava waste, DP = rice bran; each treatment was added with 5% molasses; Different superscripts in the same column show significant differences (P<0.05)

Conclusion

The addition of corn flour as a source of carbohydrates at the level of 30% in pineapple peel silage can improve overall nutritional quality as seen from an increase in crude protein and crude fat and a decrease in crude fiber, NDF, and ADF content compared to other treatments.

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