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Physical and Chemical Quality of Sorghum and Indigofera Silage as Cow Feeding in the Sentra Pertanian Terpadu of PT Arutmin Indonesia Tambang Asamasam

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KEYWORDS
physical quality; chemical silage sorghum; indigofera; cow feed

ABSTRACT
To support the management of forage and cattle fattening business at the Sentra Pertanian Terpadu (SPT) of PT Arutmin Indonesia Tambang Asamasam. This research uses the Field Work Practice (PKL) method which is carried out for three months, starting from March 4, 2024 to June 3, 2024. During this period, various activities are carried out according to a predetermined schedule and can be adjusted to other activities of the company. This street vendor was held at PT Arutmin Indonesia Tambang Asamasam, which is located in Simpang Empat Sungai Baru Village, Jorong District, Tanah Laut Regency, South Kalimantan Province. The results of this study show that Silage P3 (sorghum 40% and indigofera 60%) and P4 (sorghum 20% and indigofera 80%) are seen from physical quality (color, texture, aroma, and pH) and chemical quality, especially protein content, are in accordance with cow fattening. The physical qualities of sorghum silage and indigofera (color, texture and aroma) are almost the same very well there are no failures in the fermentation process. The pH value of silage is able to stay below 4 so that the silage is of good quality. The chemical quality of sorghum and indigofera with water content of 67.78 – 70.02%, ash content 4.03 – 6.83%, crude protein 4.69 – 19.41%, crude fat 7.58 – 9.35%, crude fiber 38.21 – 40.29%, carbohydrates 18.60 -23.59%, phosphorus 0.13 – 0.21%, calcium 0.16 – 0.91% and calories 197.27 – 228.54Cal/g can be used for cattle fattening.

Introduction

The Sentra Pertanian Terpadu (SPT) is a business system that combines crops and livestock in a complete unit. An integrated agricultural system is a management system for agriculture, crops, livestock and fisheries to increase efficiency, productivity of

resources (humans, land and other growth factors), economic improvement, resource conservation, independence, and farmer welfare in a natural and sustainable manner. The implementation of an integrated agricultural system is basically a direct link between the biological and abiotic environment in the agricultural land ecosystem from the results of cultivation contributions (Holik et al., 2019).

The Integrated Agriculture Center is implemented at PT Arutmin Indonesia Tambang Asamasam, where the integrated agricultural system is fostered by the ADM & CDEA (*Administration & Community Development External Affairs*) Department. The CDEA Department has a CSR program that is responsible for fostering Community Development and Empowerment (PPM), one of which is by providing resources to the community to manage agriculture and livestock in order to achieve an independent society.

Livestock managed by the community utilizes forage for animal feed in the Integrated Agriculture Center. The ones cultivated at the Integrated Agricultural Center are cattle, indigofera feed crops, sorghum, elephant grass, odot grass, vegetable crops and fruits. Cattle need feed that can meet their daily needs.

Animal feed greatly affects the needs of livestock, feeding continuously without knowing the nutritional content of feed and the needs of livestock, has an impact on the disruption of the immune system, reproduction and decreased livestock productivity. Until now, one of the obstacles in livestock farming is the high cost of feed production as much as 60-70% to achieve production goals (Setiyatwan et al., 2018). Feed affects the living needs of livestock so that the need for feed must be maintained. The common feeds given to cattle are field grass, forage, concentrates, vitamins and additional supplements. Feed problems can reduce livestock productivity so feed must always be available. Some of the feed ingredients used in the integrated agriculture center as cattle feed have good nutritional content for cattle fattening, namely sorghum and indigofera.

Soft dough *sorghum* contains 10.8% moisture content, 6.70% ash, 8.79% crude protein, 1.20% crude fat, 27.88% crude fiber and 49.83% TDN (Sriagtula et al., 2017), while indigofera contains 97.3% dry matter, 87.9% organic matter, 16% crude fiber, 20.2% crude protein and 1.5% crude fat (Lestari et al., 2022). The production of sorghum seeds per ha at the age of 95 days is 2582 kg/ha, (Najam et al., 2021) while the production of indigofera with a planting distance of 1m × 1.5m is 32.61 tons/ha/year (Ering et al., 2019) with good nutritional content and production, making sorghum and indigofera have the potential to be used as animal feed in various processed forms, such as silage.

The processing of forage in the form of silage has the goal that the provision of forage for animal feed will take place evenly, utilizing the production of forage that has been harvested. Processing by preservation in animal feed affects the physical and chemical quality of forage by losing part of the nutrients that can increase nutritional value and digestibility. The nutritional value of silage is influenced by the type of plant species, growth, dry matter content during harvest, microorganisms and the use of additives (Yulianto et al., 2022).

Based on the description above, a case study was carried out on "Physical and Chemical Quality of Sorghum and Indigofera Silage for Cattle at the Integrated Agricultural Center of PT Arutmin Indonesia Tambang Asamasam". Processing in the form of silage can anticipate the occurrence of forage shortages in the dry season and can accommodate excess production of forage for animal feed or utilize forage at the best growth time but not yet used.

Research Methods

The implementation time for this Field Work Practice (PKL) starts from March 4 2024 to June 3 2024 or for 3 months on Monday-Friday working days, 07.00-17.00 WITA. All activities carried out during PKL that fall within this time period will be adjusted to the schedule if there are other activities from the company. The PKL was held at PT Arutmin Indonesia Tambang Asamasam which is located in Simpang Empat Sungai Baru Village, Jorong District, Tanah Laut Regency, South Kalimantan Province.

Field work practice activities carried out at PT Arutmin Indonesia Tambang Asamasam in the initial stage include introductions between students and the company environment, K3LK induction and continued with presentation of work programs during field work practice. In the second stage, data collection was carried out for case studies such as literature studies and observations followed by making silage with an ensiling process period of 21 days. Next, observations and tests are carried out on physical quality (color, texture and aroma) as well as pH and chemical quality (water content, ash content, crude protein, crude fat, crude fiber, carbohydrates, phosphorus, calcium and calories). The next stage is to prepare a PKL report and every few weeks a presentation will be made of the progress of the PKL.

Results and Discussions

The success factors of silage can be seen from physical qualities such as color, texture, aroma and pH. The results of observations from the study on the physical quality of silage are presented in table 1. In addition, nutritional values such as moisture content, ash content, crude preratein, crude fat, crude fiber, carbohydrates, phosphorus, calcium and calories are presented in table 2. Based on the table, it can be seen that the quality of sorghum and indigofera silage with a storage period of 21 days has a good value.

Physical Quality

The physical quality of sorghum and indigofera silage in SPT can be seen in table 1.

Table 1 Physical quality of sorghum and indigofera silage in SPT

Treatment	Color	Texture	Aroma	Ph
P1	Yellowish green	Does not clump	fragrant	3,14
P2	Yellowish green	Does not clump	Very fragrant	2,96
P3	Yellowish green	Does not clump	fragrant	3,16
P4	Dark green	Somewhat mushy	Quite fragrant	3,63

Source : Results of the 2024 Animal Feed Technology Feed Quality Laboratory Analysis

Description: P1: Sorghum 80%, indigofera 20%, P2: Sorghum 60%, indigofera 40%, P3: Sorghum 40%, indigofera 60%, and P4: Sorghum 20%, indigofera 80%.

Table 1 shows the physical quality of silage in each treatment, namely P1 (80% sorghum, 20% indigofera), P2 (60% sorghum, 40% indigofera), P3 (40% sorghum, 60% indigofera) and P4 (20% sorghum, 80% indigofera), resulting in physical quality, namely color from yellowish green to dark green, texture from whole to slightly mushy, aroma from moderately fragrant to very fragrant and pH from 2.96 to 3.63

The color produced from the data of this street vendor case study is from yellowish green to dark green, this result shows that sorghum and Indigofera silage in the tax return made during street vendors was successfully seen from the physical quality, especially the color. This is not much different from the results of the study (Holik et al., 2019),

which are green to yellowish-green in color, almost the same as the plant before the ensilase. Silage colors that resemble the original color are good silage and silage that is different from the original color is low-quality silage (Kurniawan & Fathul, 2015). The green color that changes to brownish-green color is caused by changes in the plant during the fermentation process caused by aerobic respiration as long as the oxygen supply is still there, until the plant sugar runs out, so that the sugar is oxidized into CO2 and water, and there is heat until the temperature rises and causes the silage color to turn brownish-green (Kholis et al., 2018)

The texture produced from the data of this street vendor case study from slightly soft to not clumpy, these results show that silage sorghum and Indigofera in tax returns made during PKl was successfully seen from the physical quality, especially the texture. According to Kojo et al. (2015) good silage does not have a mushy texture, is not watery, does not mold, and does not clump. The texture is a bit soft, which is most likely due to the percentage of the addition of indigofera which is still high in water, where silage is said to be good if it has a dense, soft, non-clumpy and slimy texture. The texture of silage is influenced by the water content >75% will have a slimy texture, mushy and grow mold, while the water content < 25% will have a dry texture and is not susceptible to mold. High water content can cause an increase in oxygen in the silo, while low water content causes a compaction reaction so that a lot of oxygen is trapped in the silo (Silalahi et al., 2023)

The aroma produced from the data of this street vendor case study ranged from quite fragrant to very fragrant, these results showed that sorghum and Indigofera silage in the SPT made during street vendors were successfully seen from the physical quality, especially the aroma. (Herlinae et al., 2015) argued that medium-quality less acidic aromatic silage in fermented feed indicates a decrease in silage pH, where a decrease in pH affects the aroma of acidity after the maturation of the feed shows that the fermentation process is occurring.

pH is one of the criteria to determine the quality of silage. The results of this case study show that the pH of silage ranges from 2.96 to 3.63. The lowest pH at a high percentage of sorghum proves that sorghum plants are able to produce a good silage process (Kurniawan & Fathul, 2015). According to (Sliusarenko et al., 2011) Low pH values will inhibit the growth of harmful bacteria such as *Clostridium* and *Enterobacterium.* Where silage made from sorghum has the advantage of high water *soluble carbohydrate* (WSC) content ranging from 10.92 – 22.91%. This is very possible to use sorghum as a silage material without additional ingredients to grow lactic acid bacteria quickly (Kurniawan & Fathul, 2015), while the high pH at this high percentage of indigofera is suspected to be silage material has a fairly high pk content, so the achievement of a stable pH in the ensilase process will be slower, because of the *buffer* capacitysilage becomes larger, making it difficult for the pH to drop (Despal et al., 2011). The pH value of sorghum silage and indigofera obtained (Kurniawan & Fathul, 2015) was higher than that of this study, which was 3.67 – 4.93. The degree of acidity is one of the indicators to determine the success of silage, because a good pH is between 4.2 – 4.5. A pH value of < 4.1 or >4.8 indicates that the silage produced is not good (Kurniawan & Fathul, 2015).

5.Chemical Quality

The chemical quality of sorghum and Indigofera silage in SPT can be seen in table 2.

Table 2 Chemical quality of sorghum and indigofera silage in SPT

Nutritional Content	Treatment			
	P1	**P2**	**P3**	**P4**
Moisture Content (%)*	70,02	69,18	68,05	67,78
Ash Content (%)	4,03	4,43	5,59	6,86
Crude Protein (%)	4,69	10,60	13,44	19,41
Crude Fat (%)	9,35	8,29	7,58	8,56
Crude Fiber (%)	40,29	39,54	38,21	39,75
Carbohydrates (%)	23,59	23,22	22,06	18,60
Phosphor (%)	0,13	0,15	0,17	0,21
Calcium (%)	0,16	0,37	0,57	0,91
Calories (Cal/100g)	197,27	209,89	210,22	228,54

Source : Results of Analysis of the Laboratory of Various Commodities, Banjarbaru Industrial Service and Standardization Center

*: Results of the 2024 Animal Feed Technology Feed Quality Laboratory Analysis

Description: P1: Sorghum 80%, indigofera 20%, P2: Sorghum 60%, indigofera 40%, P3: Sorghum 40%, indigofera 60%, and P4: Sorghum 20%, indigofera 80%.

The moisture content of sorghum silage and indigofera in SPT (Table 2) ranged from 67.78 (P4) to 70.02 (P1). The results of the data analysis of the case study of street vendors in the tax return show that the increasing use of indigofera in the silage process reduces the moisture content. The decrease in moisture content is due to an increase in dry matter due to microbial activity during silage which remodels the substrate during the silage process so that the nutrient content increases. The moisture content of the ingredients before and after the silage making process is different due to the respiration process that can reduce the moisture content of the material or the formation of metabolic water during the fermentation process which can increase the water content of silage (Syahrir et al., 2014).

The moisture content in fermentation refers to the amount of water present in the fermentation material. The right moisture content is essential in the fermentation process because it can affect the growth of microorganisms responsible for converting ingredients into the desired product. The optimal moisture content varies depending on the type of fermentation performed, but generally ranges from 40% to 80%.

Low moisture content can inhibit the growth of microorganisms, while high moisture content leads to the growth of unwanted microorganisms, such as fungi or harmful bacteria (Prasetyo et al., 2019).

The decrease in silage water content is due to an increase in BK after the fermentation process which is suspected to be due to the length of drying time in the oven.

The ash content of sorghum silage and sndigofera in SPT (Table 2) ranged from 2.98 (P4) to 5.52 (P1). Ash is the residue of combustion in a kiln with a temperature of 400-600 C that contains inorganic substances or minerals (Agustono et al., 2017). The results of the case study of street vendors in the tax return show that the increasing use of indigofera in the silage process reduces ash levels. The results of the case study of street vendors in the tax return show that the increasing use of indigofera in the silage process reduces ash levels.

The ash content in sorghum and indigofera silage with values ranging from 4.03% to 6.86%. The results of this case study are lower than (Arbiansyah et al., 2023) the composition of bagasse with indigofera produces ash kada ranging from 3.39% - 8.87%.

The ash content is related to the decrease in mineral materials, so the content of organic matter containing nutrients will increase. This increase in value is likely due to the presentation of indigofera, the higher the percentage value of indigofera in the material, the higher the ash value. A decrease in ash content in feed ingredients is highly expected, because it is related to minerals, so if the ash content decreases, the content of organic matter will increase, where organic matter contains quite important nutrients, such as protein, fat, carbohydrates and vitamins (Barokah et al., 2017).

Crude protein is one of the most important nutrients needed by livestock at different levels of production at all stages of life. The results of this study show that PK silage is significantly influenced by the presentation of indigofera. The increase is noticeable, where the higher the percentage of indigofera in silage, the higher the PK content will be. This is due to the high content of crude pretein produced by indigofera so that the more indigofera is added, the higher the crude protein content of silage.

The crude protein of sorghum silage and indigofera in SPT ranged from 4.69 (P1) to 19.41 (P4). Crude protein The use of indigofera 60% obtained a PK content of 13.44%. The results of this case study are lower than (Kurniawan & Fathul, 2015) where silage with a mixture of 40% sorghum and 60% indigofera produces 19.42% crude protein. This difference is likely due to the difference in the research location, where the research site has slightly acidic soil, crop life and maintenance management.

Crude fat content is one of the nutrients that utilizes nutrients, usually in the form of fatty acids (Rodiallah et al., 2023). Based on the results of the analysis, it was shown that the crude fat content of sorghum silage and indigofera ranged from 7.58% (P3) to 9.35% (P1). The crude fat value of this case study is not much different from (Beding et al., 2022) where the Silage *of Sorghum Plumosom Monoculture with* a value of 7.043. The low silage content in this percentage is because the plants at the harvest time are quite old at the time of making silage. According to (Nompo, 2013) the younger the plant, the higher the crude fat content and vice versa, as the plant ages, the fat content decreases.

Crude fiber is one of the important factors that determine the quality of silage. Coarse fibers are organic materials that are resistant to acid hydrolysis and weak bases. Table 5.2 shows that the fiber content ranges from 38.21% (P3) to 40.29 (P1). This result is higher than the results from (Untu et al., 2022) which stated that the crude fiber content of sorghum silage of chisel varieties with a storage period of 3 weeks was 22.53. This difference may be due to the different harvest ages of sorghum and indigofera as well as the nutrient composition due to different varieties. According to (Septian, 2023), the longer the harvest life of the plant, the higher the crude fiber content. An increase in the crude fiber content of plants can occur due to the increase in stem and leaf size. The longer the harvest life of the plant, the more opportunities to carry out the process of photosynthesis and store nutrients in the plant. Photosynthesis will produce glucose, then the glucose will be converted into proteins and fats for growth (Wiraatmaja, 2017).

Carbohydrates are the largest feed component for ruminant feed and can be partitioned into fiber carbohydrates (*Fiber carbohydrate*, FC) and non-fiber (*non-fiber carbohydrate*, NFC). The carbohydrates of sorghum silage and indigofera in SPT (Table 5.1) ranged from 18.60% (P4) to 23.59% (P1). The results of the analysis of the data of the case study of street vendors in the tax return show that the more the use of sorghum in the silage process increases the carbohydrate content. According to Kurniawan et al. 2016, sorghum contains *quite high Water Soluble Carbohydrate* (WSC) ranging from 10.92% to 22.91%. This allows sorghum as a silage material without the addition of substrate to grow.

The mineral content that is often mentioned in feed quality is included in the recommendations of the *National Research Council* , namely only calcium (Ca) and phosphorus (P). Ca and P are included in the macro minereal category (Somanjaya & Falahudin, 2021). The mineral content of Phosphorus and calcium in sorghum and indigofera silage is (phosphorus 0.13 % - 0.21%) and (calcium 0.16% - 0.91%). The results of data analysis of case studies of street vendors in SPT show that the more indigofera is used, the more it will increase the mineral content of Ca and P.

The calories of sorghum and indigofera silage in SPT (Table 5.1) ranged from 197.27 (P1) to 228.54 (P4). The results of the analysis of data from the case study of street vendors in the tax return show that the more indigofera is used, the more it will increase the calorie content. All forms of energy are converted into heat which is associated with processes in the body expressed in units of heat (calories). Energy functions to move blood circulation, absorb unnecessary food substances, breathe, regulate body temperature, etc. (Candrawati, 2016).

Conclusion

Based on the results and discussions obtained, several conclusions can be drawn as follows: The silage of P3 (sorghum 40% and indigofera 60%) and P4 (sorghum 20% and indigofera 80%) is seen from the physical quality (color, texture, aroma, and pH) and chemical quality, especially the protein content, which is in accordance with the fattening of cows. The physical qualities of sorghum silage and indigofera (color, texture and aroma) are almost the same very well there are no failures in the fermentation process. The pH value of silage is able to stay below 4 so that the silage is of good quality. The chemical quality of sorghum and indigofera with water content 67.78 – 70.02%, ash content 4.03 – 6.83%, crude protein 4.69 – 19.41%, crude fat 7.58 – 9.35%, crude fiber 38.21 – 40.29%, carbohydrates 18.60 -23.59%, phosphorus 0.13 – 0.21%, calcium 0.16 – 0.91% and calories 197.27 – 228.54Cal/g can be used for cattle fattening.

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