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Evaluation of forage potential and nutritional composition of Brachiaria Hybrid Sabia AIG-330 J at three mowing ages

Evaluación del potencial forrajero y composición nutricional del pasto Brachiaria Híbrido Sabia AIG-330 J, a tres edades de corte

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Abstract: At the Faculty of Agricultural Sciences, Mutiles campus, in San Mateo, Esmeraldas, Brachiaria Hybrid Sabia AIG-330 J was evaluated at three cutting ages (30, 60 and 90 days), using a completely randomized experimental design and statistical analysis with Fisher's test at 5%. Variables of forage potential were studied, such as cutting height, cover, green forage production and dry matter, as well as nutritional composition (dry matter, ash, protein, fiber, nitrogen free extract and ethereal extract). The results showed significant differences, highlighting greater height at 90 days (1.32 m) and greater production of green forage (77.13 ton/ha/year) and dry matter (13.13 ton/ha/year). Nutritional analysis revealed a decrease in protein content with increasing cutting age, being higher at 30 and 60 days (14.16%) and lower at 90 days (10.86%). Fiber reached its maximum at 90 days (31.50%). These findings suggest that cutting at 60 days offers an optimal balance between biomass production and nutritional value, recommending the Brachiaria Sabia AIG-330 J hybrid as an efficient forage source for this age.

Key words: Bromatological, Sage, Coverage, Cayana, Protein, Fiber.

Resumen: En la Facultad de Ciencias Agropecuarias campus Mutiles, en San Mateo, Esmeraldas, se evaluó el pasto Brachiaria Híbrido Sabia AIG-330 J a tres edades de corte (30, 60 y 90 días), mediante un diseño experimental completamente aleatorizado y análisis estadístico con la prueba de Fisher al 5%. Se estudiaron variables de potencial forrajero, como altura de corte, cobertura, producción de forraje verde y materia seca, así como composición nutricional (materia seca, cenizas, proteína, fibra, extracto libre de nitrógeno y extracto etéreo). Los resultados mostraron diferencias significativas, destacando mayor altura a los 90 días (1,32 m) y mayor producción de forraje verde (77,13 ton/ha/año) y materia seca (13,13 ton/ha/año).

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El análisis nutricional reveló una disminución en el contenido de proteína con el aumento de la edad de corte, siendo más alto a los 30 y 60 días (14,16%) y menor a los 90 días (10,86%). La fibra alcanzó su máximo a los 90 días (31,50%). Estos hallazgos sugieren que el corte a 60 días ofrece un balance óptimo entre producción de biomasa y valor nutricional, recomendando al híbrido Brachiaria Sabia AIG-330 J como una eficiente fuente forrajera para esta edad.

Palabras clave: Bromatológico, Sabia, Cobertura, Cayana, Proteína, Fibra.

INTRODUCTION

Livestock farming in our country is developed mainly based on natural and/or cultivated pastures, considering pastures as the basic and most economical feed in animal feeding, where forage production fluctuates due to the fact that adequate management techniques are not practiced and also due to the effect of annual climatic conditions and zonal environmental variations, affecting the availability and quality of forage (Guaicha, 2015).

Importantly, research by Assis et al. (2023) on the accumulation and distribution of dry matter and nutrients in Brachiaria decumbens and ruziziensis in an intensive forage production system provides valuable data that can complement the current study on Brachiaria hybrid Sabia AIG-330 J. In particular, Assis' findings on nutrient dynamics and their effective management in intensive systems highlight the importance of proper soil and fertilization management to maximize both yield and nutritional quality of forage. This reinforces our focus on evaluating how variations in cutting age influence nutritional composition and forage potential, adapting and optimizing management practices for specific growing conditions in Esmeraldas.

In the province of Esmeraldas, one of the main factors limiting the scope of sustainable livestock production is the scarce availability and low nutritional quality of pastures during long periods of drought (Ramírez et al., 2008, p. 2).

During the last few years, scientific progress in genetics has generated forage varieties that adapt to diverse environmental conditions, however, due to ignorance of the productive and nutritional value they are not cultivated (Barén and Centeno 2017).

Among the improved species is Brachiaria Hybrid Sabia Aig-330 J, developed by Barenbrug, a global leader in the market of forage crops

that have adapted to the environmental conditions of different regions. It is currently marketed in Ecuador and in the province of Esmeraldas. But there is no information about the productive behavior and nutritional value in the area of Esmeraldas, for this reason and considering the need for research on new varieties of grasses, it was decided to carry out this work, where the following objectives were proposed: To evaluate the forage behavior of Brachiaria Hybrid Sabia AIG-330 J, at three cutting ages (30, 60 and 90 days) in the Faculty of Agricultural Sciences Mutiles campus and determine the nutritional value at 30, 60 and 90 days of cutting through a proximal analysis.

MATERIALS AND METHODS

This research was carried out on the premises of the Faculty of Agricultural Sciences, Mutiles campus, located in the San Mateo parish of Esmeraldas canton, Esmeraldas Province, with a duration of 120 days.

Experimental Units

The size of the experimental unit was 30 m2 (5x6m), each with a total of 48 experimental plots with a total net trial area of 1440 m^2.

Materials, Equipment and Facilities

Materials

To carry out the experiments with the Brachiaria hybrid Sabia AIG-330 J, several important materials were used to conduct and document the study. Among the basic materials used were hand tools such as sickles and hammers, necessary to process and cut the grass, and ropes and stakes were used to define the study areas in the experimental site. In addition, identification labels were used to delimit the study areas within the experimental field, in order to ensure a correct characterization and monitoring of the plots. Measurements of plot dimensions and grass growth were carried out with the help of a flexometer. During the study, detailed data were collected in notebooks, and paper covers were used for the collection and temporary storage of samples. In addition, a camera was used for visual documentation of the experiment and site conditions.

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Equipment

The analysis and processing of the samples collected in the experiment was supported by specialized laboratory equipment. An analytical balance was also used to accurately determine the weight of the dry and fresh samples, which is crucial for the analysis of the nutritional composition and biomass of the grass. In addition, advanced computer equipment was available for the management and analysis of the data collected in the field. This equipment allowed processing the statistical results and performing the necessary calculations to evaluate the study variables, such as the nutritional composition of the grass and its forage potential at different cutting ages. The use of this equipment was essential to ensure the accuracy and reproducibility of the results of the experiment.

Treatment and Experimental Design

For this research, plots of Brachiaria Hybrid Sabia AIG-330 J were used, which were cut three times, 30, 60 and 90 days after sowing, with 16 replicates per treatment (days of cutting), which were evaluated under a Completely Randomized Design (CRD), which is adjusted to the following additive linear model:

$$Yij = \mu + Ti + €ij$$

Where: Yij = Value of the parameter in determination.
μ = Mean.
Ti = Effect of treatments (days of cutting after planting).
€ij = Error effect.

Experiment outline

Table 1. *Design of experiment scheme*

Treatment	code	repetitions	T.U.E m2	Total m /treatment^2
30 days	T1	16	30	480
60 days	T2	16	30	480
90 days	T3	16	30	480
Total				1440

*T.U.E= Size of the Experimental Unit, 30 m2 plots

Experimental Measurements

The measurements that will be taken into account in the research are:

- Plant height (cm)
- Basal coverage (%)
- Aerial coverage (%)
- Green biomass production (t/ha/year)
- Dry matter production (t/ha/year)
- Proximal analysis.

Statistical Analysis and Significance Tests

The experimental results were subjected to the following statistical techniques:

- Analysis of variance (ADEVA).
- Separation of means by Fisher's method ($P \leq 0.05$) and ($P \leq 0.01$).

Experimental Procedure

The proposed research was developed with the planting of Brachiaria Hybrid Sabia AIG-330 J, through the application of the following activities:

1. Identification of research area: Land with accessible roads close to programs that allow permanent surveillance.

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2. Land Preparation: Primary and secondary tillage activities were carried out to prepare the bed for grass planting.
3. Delimitation of the research area: With the use of barbed wire, to prevent the entry of animals that interfere with the research.
4. Division of plots: for the development of this activity, a tape measure, pegs and stakes were used to delimit small research plots of 30m2 (5m x 6m).
5. Plot labeling: The plots were labeled randomly, and once the order was determined, labels were placed on each 30 m2 plot.
6. Sowing: The Sabia seeds were placed at a distance of 30 x 30 cm between plants and between rows with the help of stakes that allowed them to go straight and orderly.
7. Weed control: 20 days after germination of the grasses, manual weeding was carried out, removing weeds that could compete with the established grass in each plot.
8. Irrigation: irrigation was carried out as a mimic twice a week until the soil was completely humid, ensuring water absorption by the plant.

Samples were collected manually using the quadrat method at 30, 60 and 90 days after grass establishment. During collection, agro-botanical data were meticulously recorded. Subsequently, these samples were subjected to laboratory analysis using proximate analysis techniques. At the conclusion of the experimental phase, the data were tabulated and organized for statistical analysis.

Evaluation Methodology

Basal coverage (%)

To determine the basal cover, the Canfield line method was used, under the following procedure; the area occupied by the plant on the ground was measured, the total of these was added in centimeters and by simple rule of three, the percentage of basal cover was obtained.

Aerial coverage (%)

In relation to basal cover, the Canfield line method was used, where the area occupied by the plant in the middle part of the foliage was measured, the total of these was added in centimeters and by simple rule of three, the percentage of basal cover was obtained.

Plant height (cm)

Plant height was determined with a flexometer from the soil surface to the terminal half of the highest leaf, considering random samples of 12 plants in the middle zone of the plot, to obtain an overall average and eliminate the edge effect.

Green biomass production (t/ha/year)

The work was based on weight, for which a representative sample was cut from each plot, using a quadrant of 1 m^2, the weight obtained was related to 100% of the plot, and subsequently the production was estimated in Tn/ha.

Dry matter production (t/ha/year)

The calculation of forage production in dry matter Tn/MS/ha was based on the production of green forage, a sample of forage was taken to the laboratory to evaluate the dry matter content.

Proximal analysis

The moisture, ash and crude protein percentages were determined at 30, 60 and 90 days of age using the following methodology:

Moisture percentage determination (%)

Also known as moisture as offered (TCO), and consisted of drying the forage in the oven at a temperature of 60 to 65°C until constant weight, drying lasts 24 hours.

Determination of protein percentage (%)

For the determination of the protein, three processes were used: digestion, distillation and titration. In the digestion, the sample is subjected to heating with concentrated sulfuric acid, selenium oxide and

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sodium sulfate, in this process the sample carbohydrates and fats of the sample are destroyed to form CO2 and H2O, the protein decomposes with the formation of ammonia, which intervenes in the reaction with sulfuric acid and forms ammonium sulfate.
This sulfate is resistant in acid medium and its destruction with ammonia release occurs only in basic medium; after the formation of the ammonium salt, a 50% strong base will act and the nitrogen is released in the form of ammonia, this ammonia is retained in a 2.5% boric acid solution and will be titrated with 0.1N HCL.

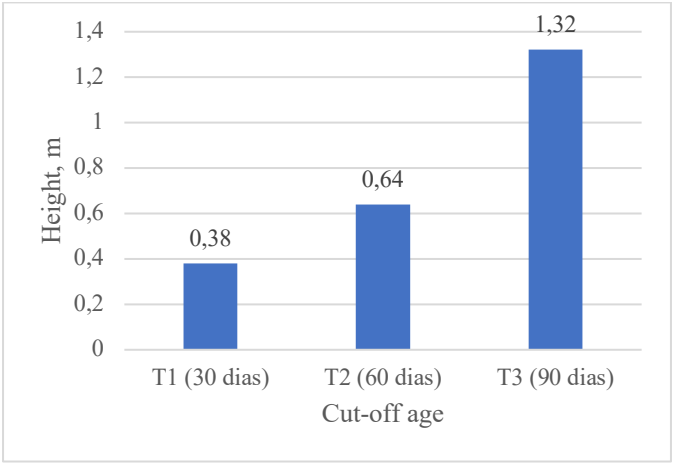
Ash determination (%)
The ash determination was carried out by dry incineration, which consists of burning the organic substance of the sample in the muffle at a temperature of 600° C., with this the organic substance is combusted and CO2, water, ammonia is formed and the inorganic substance (mineral salts) remains in the form of residues, the incineration is carried out until a gray or light gray ash is obtained.

RESULTS

Agro botanical behavior of Brachiaria Hybrid Sabia AIG-330 J, different cutting ages after sowing.

Height, m
In plant height, highly significant statistical differences ($P< 0.0001$) were recorded between cutting intervals, reaching the greatest height in plots cut at 90 days with an average of 1.32 m, followed by 0.64 m at 60 and 0.38 m at 30 days of cutting (Figure 1). Given these results López et al. (2017), states that the grasses of the genus Brachiaria as new expectations for producers since their species have been disseminated due to their enormous level of adaptation, yield and high nutritional value for animal feed.

Figure 1. Height of Brachiaria Hybrid Sabia AIG-330 J at different mowing intervals.



In his study Avellaneda J, et al. (2018), reports a height of 27.50 cm at 28 days. Herrera L., (2017) when evaluating "agronomic behavior and chemical composition of Brachiarias decumbens, determined a height of 121.63 cm at 50 days. For their part (García & Díaz, 2015) in which they reached plant heights of Brachiaria genus of 144.82 cm at 90 days of cutting, being superior to the results of the present research.

The differences found may be influenced by grass variety, environmental conditions, soil and plant factors, including temperature, rainfall, soil fertility and crop age.

Baseline Coverage, %.

For the basal coverage variable, highly significant statistical differences were found ($P<0.0001$) between cutting days, with the highest basal coverage in treatment T3 (90 days of cutting) with an average of 49.31%, followed by treatment T2 (60 days of cutting) with 21.71% and the lowest response in treatment T1 (30 days of cutting) with 12.65% (Figure 2).

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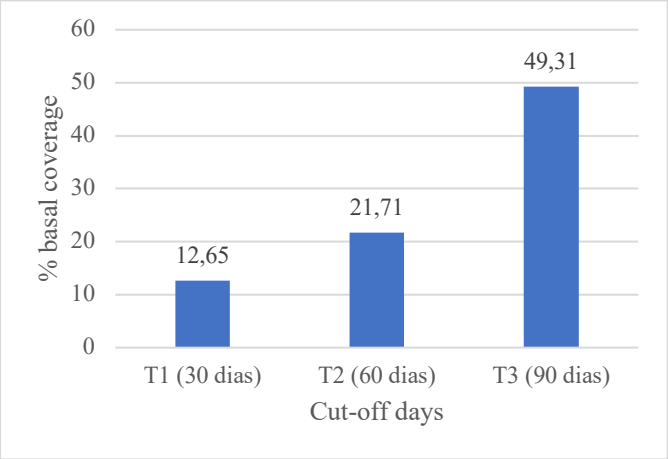
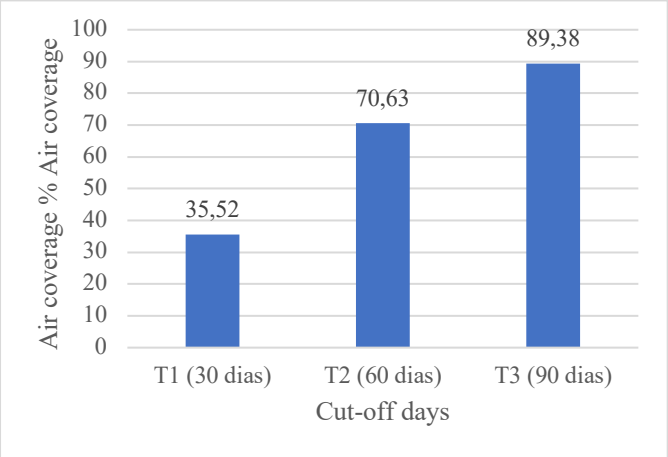
Figure 2. Basal cover of Brachiaria Hybrid Sabia AIG-330 J at different mowing intervals.



Air Coverage, %.

The aerial coverage by effect of the different cutting periods, showed highly significant differences (P< 0.0001), the highest response was shown when cutting the hybrid sabia at 90 days with 89.38%, decreasing at 60 days with an average of 70.63% and being 30 days of cutting who obtained the lowest percentage with 35.52%, which shows that the age of cutting influences the aerial coverage of this hybrid as shown in Figure 3.

Figure 3. Aerial cover of Brachiaria Hybrid Sabia AIG-330 J at different mowing intervals.



The answers obtained are related to the study of Peralta, A. et al. (2017), who with the purpose of characterizing the productive development of tropical forage grasses, determined that Brachiarias in its different varieties present aerial coverages between 84.06 and 92.06 %.

PV production/Ton/ha/year.

The Fv/ton/ha/year production registered highly significant differences (P< 0.0001) among the days of cutting, with the highest at 90 days with 77.13 ton/ha/year and the lowest result of 5.22 ton/ha/year at 30 days (Figure 4). These results allow inferring that forage production increases as the plant develops.

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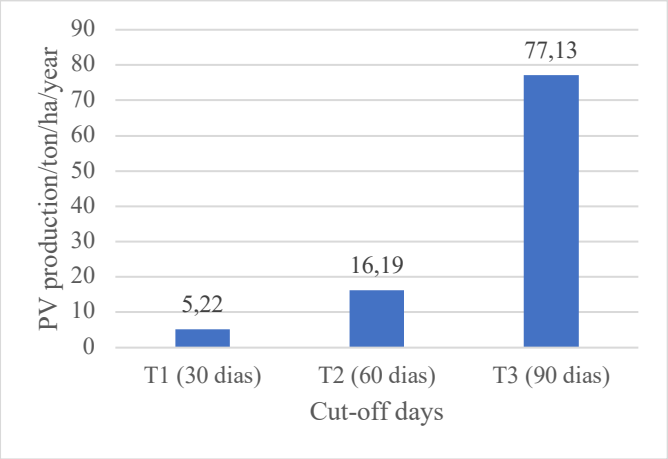
Figure 4. FV/ton/ha/year of Brachiaria Hybrid Sabia AIG-330 J, at different cutting intervals.



Biomass obtained at 90 days are higher than those recorded by Suárez and Neira (2014) and Proaño (2017), with 71.79 and 54.02 t M.V/ha/year in Brachiaria brizantha grass. This superiority is due to the innate botanical characteristics of the sage hybrid, i.e. the density and weight of the stems and the foliar part, in itself the development of these and senescence of the tissues; in addition to the environmental factor such as the type of soil and management of the cultivar.

In relation to the data obtained http://www.huallamayo.com.pe. (2010), mentions that the production of green matter of Brachiaria brizantha is up to 180 tons/hectare/year; depending exclusively on environmental and management conditions; in addition, it is not possible to compare with research because the hybrid sabia is being introduced for the first time in Ecuador, so it is compared with reference values of other varieties studied in Ecuador.

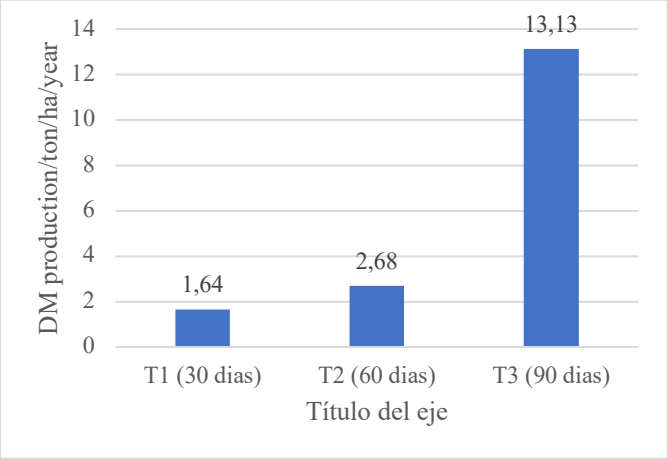
DM production/Ton/ha/year.

The dry matter production of the sabia hybrid as a function of cutting age showed highly significant differences among treatments ($P< 0.0001$), obtaining the highest dry matter production at 90 days of cutting with 13.13 t/ha/year, followed by the plots cut at 60 days with 2.68 t/ha/year, the lowest production was recorded at 30 days of cutting

with 1.64 t/ha/year (Figure 5). This shows that cutting age influences dry forage production.

Biomass is a very important aspect when assessing the pastoral interest of different plant communities and the potential for their utilization by different herbivores (Gómez. 2018).

Figure 5. DM production/ton/ha/year of Brachiaria Hybrid Sabia AIG-330 J, at different mowing intervals.



The above data are within the average established by Barenbrug, (2020), a world leader in the forage segment, who reports a production of 12 to 16 ton/ha/year, so it can be said that the frequency and intensity of cutting are two components of forage management strategies that determine yield and quality.

Nutritional performance of Brachiaria Hybrid Sabia AIG-330 J, different cutting ages.

Dry Matter Percentage %.

Dry matter content registered highly significant differences (P< 0.0001), among days of cutting, with the highest result at 30 days with

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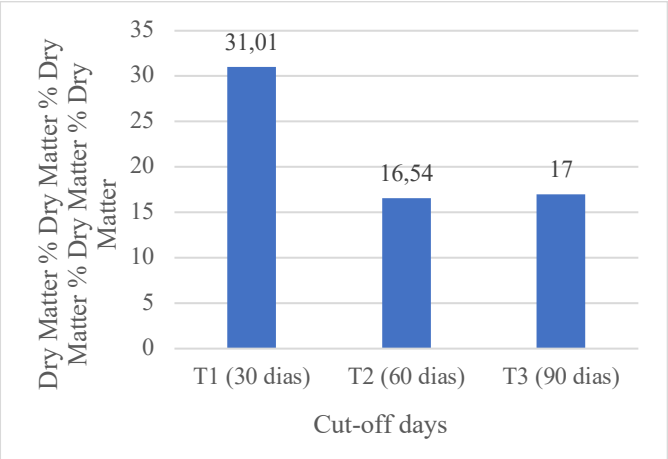
31.01%, and the lowest result of 16.54% at 60 days (Figure 6). This shows that cutting age influences dry matter content.

Figure 6. Dry matter content of Brachiaria Hybrid Sabia AIG-330 J at different cutting intervals.



In their research Reyes et al., (2019) demonstrate the following DM percentages in three varieties of Brachiarias: Brachiaria decumbens at 21 days found 22.44% and 28.58%, at 42 days of regrowth, Brachiaria brizantha at 21 days found 20.84% and 26.30% at 42 days, on the other hand, Mulatto I at 21 days found 19.30% and 25.35% at 42 days respectively values that differ from the present research due to the varieties studied.

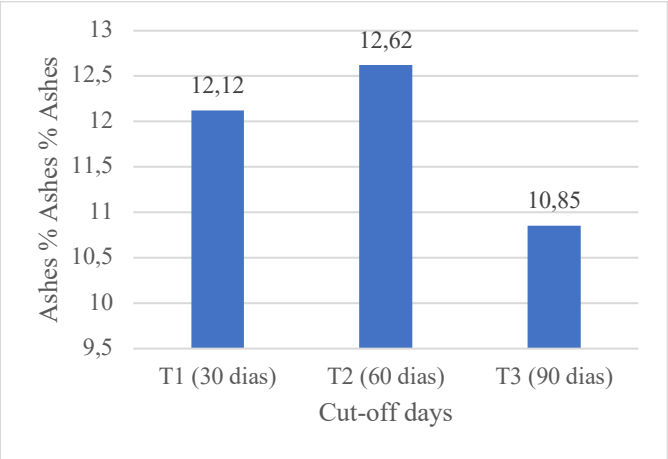
Ramirez et al. (20 15), consider that the age of regrowth is one of the most influential factors in the growth and quality of pastures, since the longer the age of regrowth, the higher the yield, the worse the quality; this indicates that frequent defoliation is often more desirable to use grass of higher nutritional value.

Percentage of ash (%).

With respect to the variable ash content or mineral fraction of the plant, significant differences (P< 0.0001) were found between treatments, with the best contents at 30 and 60 days of cutting with 12.12% and 12.62%, respectively, and the lowest ash content at 90 days with

10.85%, i.e., as the plant matures, the inorganic part of the plant shows a decrease (Figure 7).

Figure 7. Ash content of Brachiaria Hybrid Sabia AIG-330 J at different cutting intervals.



Pinargote (2018) , obtained in his research 10.50 %, data lower than the results of this research, this was due to the variety studied, management conditions and climate that affect the mineral content of the grass.

In this regard, Ramírez et al. 2015, indicate that the mineral content decreases with the age of the grass because this fraction is present in greater quantity in young cultivars and in the growth stage, especially in leaves, young shoots and radical ends; the mineral decrease as the grass ages is related to its vegetative development, that is, due to the lower presence of leaves in the stems. The aforementioned is corroborated by Loor et al. (2019), add that the age of cutting, as well as the species, are factors that exert significant differences on the rate of ash concentration in pastures.

Percentage of Protein %.

Through the analysis of the protein content of sagebrush grass presented highly significant differences (P< 0.0001), where the lowest protein

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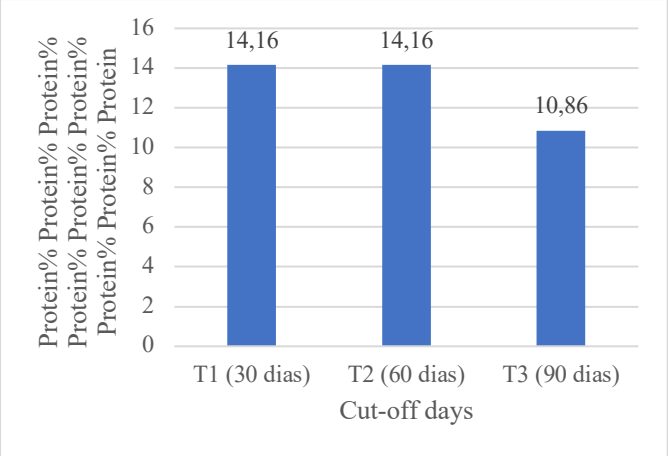
content was evidenced at 90 days with 10.86% and the highest content was recorded at 30 and 60 days of cutting with 14.16% after sowing (Figure 8). The superiority found during the 30 and 60 days of cutting is due to the indications of Miranda (2019), grasses show higher protein contents in the initial stages of development, which decreases as they approach their maturity stage (flowering), which is explained by the fact that nitrogen is translocated from the leaves to the base of the stems and roots (reserve tissues).

Figure 8. *Protein content of Brachiaria Hybrid Sabia AIG-330 J at different cutting intervals.*



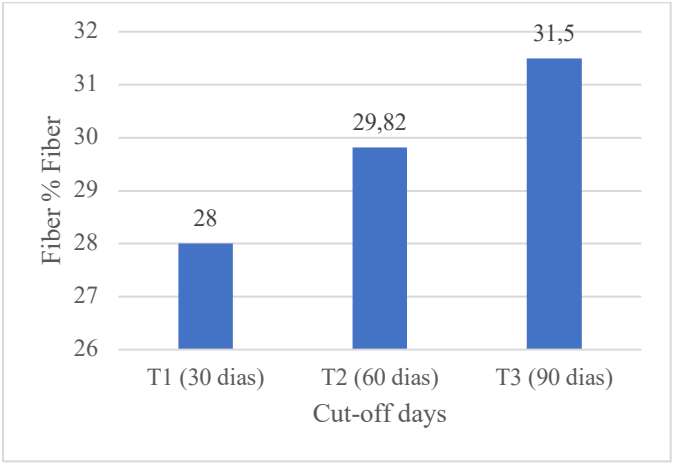
In this regard, Vendramini et al. (2014), in their research on Brachiaria brizantha grass, obtained values similar to the present research at 30 and 60 days of cutting. Rojas (2020), indicates that Brachiaria hybrid sabia grass has a protein range that varies from 9.2 to 13.4%. The variability in the results may be due to what is indicated in http://www.infocarne.com. (2014), who indicates that the nutritive value of a forage is higher during vegetative growth and lower in the seed formation stage, since when the plant advances to maturity, the concentration of protein, energy, calcium, phosphorus and digestible dry matter are reduced, so forages that are produced for the purpose of feeding livestock should be harvested or grazed in the pre-flowering stage.

In the same sense, Castillo (2015), defines that pastures harvested at an early age have a higher crude protein content, but the availability of biomass is low, while very mature harvested pastures produce a large amount of forage, with a low quality, therefore, it is important to seek an adequate balance between forage production and nutritional quality, which allow the ideal nutrition of ruminants.

Percentage of Fiber %.

The fiber content in sage grass recorded highly significant differences (P< 0.0001), between the days of cuts reporting the highest at 90 days with 31.50%, followed by the plots cut at 60 days with 29.82% and the lowest result was observed at 30 days of cutting with 28% (Figure 9). This may be due to what Beltran, 2016, indicates that an increase in fiber during the cutting periods is related to the rise of the stems portion, since these are more lignified, which is why pastures with lower content of this fraction are more digestible and consumed than pastures with higher fiber content.

Figure 9. Fiber content of Brachiaria Hybrid Sabia AIG-330 J at different cutting intervals.



The values found in the present research are related to León et al. (2018), who recorded a fiber content in Brachiarias spp of 28.17 and

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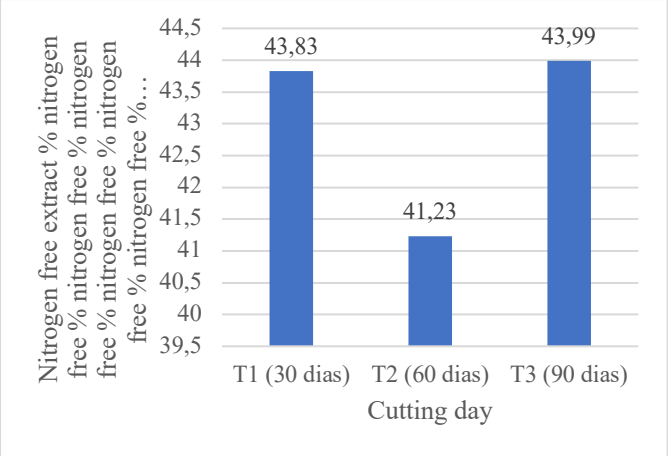
30.17% at 28 days, results that allowed them to indicate that, a feed to be digestible needs to have a fiber content of less than 50%, and for a grass to be mostly digestible by cattle, it should have from 28 to 36% fiber depending on the day of harvesting or grazing. Therefore, Brachiaria sabia grass is within the allowable range during the 30 and 60 days of cutting.

In this regard Bonifaz et al. (2018), indicate that fiber is a generally non-digestible material, but represents a vital role in the metabolism of ruminants, fiber is very important in the process of metabolism of these animals improving digestibility and absorption of nutrients. Bernabé (2015), points out that the fiber content of forages is a good indicator of their quality, since forages with lower amounts are generally more digestible and are consumed in greater quantities than forages with higher amounts of this nutritional fraction.

Percentage of Nitrogen Free Extract %.

For the nitrogen free extract variable, highly significant differences were observed ($P \leq 0.01$), between the days of cutting, reporting the highest values during 30 and 90 days of cutting with 43.83% and 43.99% respectively, the lowest response was at 60 days with 41.23% (Figure 10). Contreras (2006) affirms that the higher the age and especially in summer, the lower the nitrogenous elements, increasing the non-nitrogenous extract, which corroborates the data obtained in this research.

Figure 10. Free Nitrogen Extract Content of Brachiaria Hybrid Sabia AIG-330 J at different cutting intervals.



The results obtained in the present research are lower than Zambrano (2016), who when evaluating the forage and nutritional potential of Brachiaria decumbens and tanzania grasses obtained a value of 46.72%. The differences found are due to the variety evaluated, day of cutting and climatic conditions where the experiment was developed.

Combellas et al. (2016), indicates that the nitrogen free extract theoretically represents available and non-fibrous carbohydrates, which is due in part, to the fact that hemicellulose is included in this fraction, it also mentions that the E.L.N. content, of Brachiarias, is between a range of 49.7%.

Percentage of Ethereal Extract %.

The percentages of fat reached by the age of cutting of sagebrush grass reported significant differences between treatments (P< 0.0001), determining that at 90 days of cutting there is higher fat content with an

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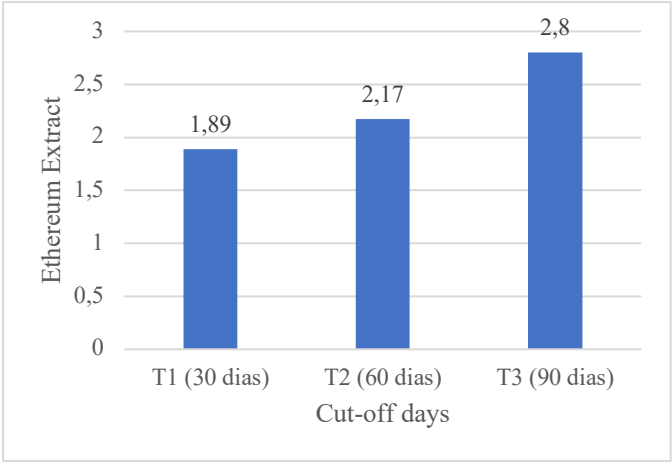
average of 2.80%, differing and surpassing the grass cut at 30 and 60 days of with 1.89% and 2.17% of ethereal extract respectively (Figure 11). The fact that the ethereal extract or fat presents low levels in the first cuts is due to what was indicated by Jácome and Suquilanda (2017), which affirms that pastures cut at an early age do not completely accentuate the lignification of the stem, therefore the fat content will be lower.

Figure 11. Ether extract content of Brachiaria Hybrid Sabia grass AIG-330 J, at different cutting intervals.



Solís et al. (2022), when evaluating the yield and nutritive value of Brachiaria brizantha cv. "Marandú" in semi-arid zones of the Ecuadorian coast, obtained 3.96% lipid content, while Guzmán (2015) recorded an average of 4.30%, higher values than the present research, perhaps due to the different climatic and management conditions of the species.

Authors such as Montalván (2018) and Witting & Azania (2017), indicate that fat components are the product of the decomposition that occurs from the carbohydrates that make up the parenchyma of pasture stems. They provide 2.5 times more energy for each unit of weight that each carbohydrate provides. Generally, the percentage of ethereal extract in a pasture varies between 3% and 10%, this percentage can be reduced as the days go by.

CONCLUSIONS

The best agro-botanical responses in Brachiaria Hybrid Sabia AIG-330 J, were presented at 90 days after cutting with a height of 1.32 meters, basal cover 49.31%, aerial cover 89.38%, green forage production of 77.13 ton/ha/year and dry matter production of 13.13 ton/ha/year.

In the proximal analysis, the 30-day and 60-day cuts showed the highest protein content, good mineral fraction and optimum percentage of ethereal extract. Regarding fiber, the 30-day cut showed the lowest percentage with values not far from 60 days. Dry matter content was affected by grass maturity, therefore the highest dry matter content was reported at early cutting ages.

Based on the nutritional value and the agro botanical behavior, it was determined that the optimal harvest period is 60 days, since there was a balance between the productive and nutritional part, although only 6 annual cuts are obtained, but at this age the crop production is guaranteed 16.19 ton/ha/year (green matter) that will become 2.68 ton/ha/year (dry matter); plant height 64.57 cm; protein content of 14.16%; 12.62% ash and 29.82% fiber.

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