Pasture potentialities in family farming production systems in Los Ríos province, Ecuador, during the Summer

Potencialidades de los pastos en los sistemas de producción de la agricultura familiar en la provincia de Los Ríos, Ecuador, en el verano

Emma D. Torres-Navarrete[1], Adolfo R. Sánchez-Laiño[2], Danis M. Verdecia-Acosta[3*], Jorge L. Ramírez-de la Ribera[4], Luis G. Hernández-Montiel[5], Gustavo Curaqueo-Fuente[6], Samir A. Zambrano-Montes[7]

Abstract — **The aim of this study is to determine the potentialities of the most used grasses in family production systems in Los Ríos province, Ecuador, during the summer. The study was carried out in research areas and in the Ruminology and Nutritional Metabolism Laboratory of the Quevedo State Technical University. The species most used in livestock systems were selected to carry out studies of productive behavior (total biomass, total DMY, leaves and stems) and quality (DM, CP, ashes, OM, P, Ca, NDF, ADF, Lignin, Cel, Hcel, CC, IVDMD, ISDMD, OMD, ME and NLE), which underwent cluster analysis to group species with similarity. For production and chemical composition, three main components were obtained with eigenvalues greater than one and that explain 87.27% of the variability between varieties. In component one, 11 indicators related to protein, energy and the structural components of the cell were shown with values of preponderance greater than 0.75. For the cluster analysis, five groups were formed, with the best results for the third group, made up of *M. maximus* with high values in CP, leaf/stem ratio, ISDMD and ME. All this information would contribute to the design of technological alternatives for sowing, establishment, management, and use of its biomass as a food source where the productivity and sustainability of the ecosystem are minimized.**

Keywords - **chemical composition, conglomerate, pastures, digestibility, energy.**

Resumen — **El objetivo de este estudio es determinar las potencialidades de los pastos más utilizados en los sistemas de producción familiar en la provincia de Los Ríos, Ecuador, durante el verano. El estudio se realizó en áreas de investigación y en el Laboratorio de Ruminología y Metabolismo Nutricional de la Universidad Técnica Estatal de Quevedo. Las especies más utilizadas en los sistemas ganaderos fueron seleccionadas para realizar estudios de comportamiento productivo (biomasa total, RMS total, hojas y tallos) calidad (MS, PB, cenizas, MO, P, Ca, FDN, FDA, LAD, Cel, Hcel, CC, TT, FT, TCT, DIVMS, DISMS, DMO, EM y ENL), a las que se les realizaron análisis de conglomerados para agrupar especies con similitud. Para la producción y composición química se obtuvieron tres componentes principales con valores propios superiores a uno y que explican 87.27 % de la variabilidad entre las variedades. En el componente uno se mostraron 11 indicadores relacionados con proteína, energía y los componentes estructurales de la célula con valores de preponderancia mayor de 0.75. Para el análisis de conglomerados se formaron cinco grupos, con los mejores resultados para el tercer grupo, lo integró el M. maximus con valores altos en la PB, relación hoja/tallo, DISMS y EM. Toda esta información contribuiría al diseño de alternativas tecnológicas para siembra, establecimiento, manejo y uso de su biomasa como fuente de alimento donde se minimiza la productividad y la sostenibilidad del ecosistema.**

Palabras Clave - **composición química, conglomerado, pastos, digestibilidad, energía.**

I. INTRODUCTION

LIVESTOCK is an activity associated with problems of deforestation, erosion, loss of biodiversity, degradation of pastures and pollution with greenhouse gases (GHG), the latter related also to climate change [1], [2]; the foregoing, coupled with a population demanding food, characterized by a social dichotomy, where the majority of the population in the rural sector

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*Corresponding author: dverdeciaacosta@gmail.com

[1]Universidad Técnica Estatal de Quevedo, Ecuador. (etorres@uteq.edu.ec). ORCID number 0000-0002-9212-5593

[2]Universidad Técnica Estatal de Quevedo, Ecuador. (arsanchez@uteq.edu.ec). ORCID number 0000-0001-5428-4473

[3]Universidad de Granma, Cuba [dverdeciaacosta@gmail.com. https://orcid.org/0000-0002-4505-4438

[4]Universidad de Granma, Cuba (jramirezrivera1971@gmail.com). ORCID number 0000-0002-0956-0245

[5]Centro de Investigaciones Biológicas del Noroeste, Baja California Sur, México (lhernandez@cibnor.mx). ORCID number 0000-0002-8236-1074

[6]Universidad Católica de Temuco, Chile, (gcuraqueo@uct.cl) ORCID number 0000-0001-9946-737x

[7]Universidad Técnica Estatal de Quevedo, Ecuador. (szambrano@uteq.edu.ec) ORCID number 0000-0001-9053-4150

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is located in the stratum of extreme poverty in contrast to the concentration of wealth in few [3].

On the other hand, livestock systems for ruminants in the world are totally dependent on the availability of natural resources, affected by climate change [4]. This livestock production process generates variation in the availability of forage and, consequently, a reduction in livestock production [5]. These conditions create the need to adopt alternatives, such as implementing sustainable agricultural production systems with environmental conversion to address these problems [6].

However, compared to many other regions of the world, the Latin American and Caribbean (LAC) region is well poised to increase its scale of trade and agricultural production. The sources that give the region a comparative advantage lie, in part, in the abundance of water and land resources. LAC's participation in world agricultural trade went from eight percent in the mid-1990s to 13% in 2015 [7], [8].

The 90% of livestock in Latin America, specifically in Ecuador, is carried out in a traditional way, there aren't livestock and productive records, which prevents proper management of productive and reproductive parameters, which affects profitability. However, due to the great biological richness of the region, there is a great variety of plant species of the tree component that could be managed and used sustainably in animal production systems. Said tree cover could reduce dependence on external inputs (animal feed supplements, fertilizers, herbicides, fossil fuels, and others), in addition to conferring benefits on both animals and producers, due to their multiple uses as fodder, green manure, shade, fences, windbreaks, food, firewood, wood, among others [9].

This approach constitutes an option for the reconversion of traditional agricultural production systems to alternative systems with greater economic and environmental efficiency; it could even contribute to the resilience of landscapes dominated by livestock in the face of the consequences of climate change and the reduction of greenhouse gas emissions[10]; in addition to constitute a viable option for the increase of production in the agricultural systems of Ecuador.

If we take into account the above, the knowledge of the potential of the grass species that best adapt to family livestock systems in Ecuador will contribute to the design of management strategies for these; as well as the proper use and exploitation of the natural resources [11] and of the agricultural or agro-industrial residuals that constitute pollutants [1], which, integrated into the diet of ruminants, become rational elements of nutritional complementation, especially valuable in drought conditions.

Hence, it would be important to know the potential of grasses used in family production systems in Los Ríos province in Ecuador during the summer.

II. METHODS

A. Experimental ecology

The study was carried out in production areas and the Ruminology and Nutritional Metabolism Laboratory of the Quevedo State Technical University, located in the Experimental Campus "La María", km 7 1/2 of the Quevedo-Mocache road, Los Ríos, Ecuador, whose geographical location is 01° 6' and 79° 29' and at 73 meters above sea level (masl). The study of the potentialities of grasses was carried out during the years 2017 and 2018, in the summer period (July-December) for each year.

The climate it is characteristic to the zone called Tropical Monsoon, whose ecological classification corresponds to Tropical Humid Forest [12]. During the experimental period for the years 2017 and 2018, the climatic variables behaved as follows: rainfall of 2,020.6 mm, average, maximum and minimum temperature (25.87, 33.25 and 23.5 °C, respectively) and relative humidity of 90%. For the summer period of both years of study, an average of 202.06 mm of rainfall occurred, 25.32, 33.48 and 23.04 °C of average, maximum and minimum temperatures and 88% relative humidity. The soil present in the area is Dystrandept according to the United States Department of Agriculture, Natural Resources Conservation Service [13] classification and its chemical composition appears in table 1.

TABLE I
SOIL CHARACTERISTICS

Indicator	Value	SD±
pH	5.36	0.03
N, cmolc kg-1	1.48	0.05
P, cmolc kg-1	5.30	0.20
K, cmolc kg-1	0.52	0.01
Ca, cmolc kg-1	1.59	0.05
Mg, cmolc kg-1	0.82	0.05
Sand,%	24.00	2.65
Silt,%	56.00	2.65
Clay,%	20.00	3.46

B. Treatment and experimental design

For the study, a completely randomized block design was used with four replicates and the treatments were the species and varieties (*M. maximus*, *B. dictyoneura*, *B. brizantha*, *B. hibrido* vc Mulato I, *B. mutica*, *Eriochloa polystachya*, *Echynochloa polystach*ya, *A. scoparius*, *C. nlemfuensis*, *Cenchrus purpureus x Cenchrus typhoides*, *C. purpureu*s vc Elephant and *C. purpureus* vc Maralfalfa), which were identified and assorted according to Kröpf and Villasuso's classification [14].

C. Procedures

The areas of each species (4 plots of 25 m², 100 m² in total) had 96% population and at the beginning of the seasonal period (summer) a homogeneity cut was made for the different species and varieties: At a height of 10 cm from the ground, the equalization cut was made for *M. maximus*, *B. dictyoneura*, *B. brizantha*, *B. hybrid* vc Mulato I, *B. mutica*, *Eriochloa polystachya*, *Echynochloa polystachya*, *A. scoparius* and *C. nlemfuensis*; while for *Cenchrus purpureus x Cenchrus typhoides*, *Cenchrus purpureus* vc Elephant and *Cenchrus purpureus* vc Maralfalfa it was 15 cm due to the characteristics that these plants have of using the accumulation of reserve substances in this basal section of the stem in order to produce vigorous regrowth [15].

For the taking of samples, 25 m² plots were delimited; in this procedure, the recommendations of Herrera, Verdecia, and Ramírez [16] for tropical grasses, for the collection of plant material in each plot, 0.5 m, were not taken for each of the edges and the central part was harvested; then, the entire biomass was weighed to determine the yield of total biomass and dry matter (DMY); subsequently, leaves and stems were separated and weighed again to determine dry matter yield of leaves and stems and the leaf/stem ratio. During the experimental stage, irrigation and fertilization were not applied.

D. Chemical analysis

Each species and variety (plots or repetitions, 4 in total, 2 kg of plant material were taken) were deposited in paper bags in cool and shaded places to avoid photorespiration, then they were transferred to the laboratory where they were dried in a forced air circulation oven at 65 °C; later, they were ground to a particle size of 1mm and stored in amber bottles until their analysis in the laboratory in which they were determined: dry matter (DM), crude protein (CP), ash, organic matter (OM), phosphorus (P), calcium (Ca) according to De Lucena, Azevedo, Avelar, Burlamaqui, Nunes, and De Seixas-Santos [17]; neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin, cellulose (Cel), hemicellulose (Hcel) and cell content (CC) according to Goering and Van Soest [18].

For in vitro digestibility, the protocol recommended by the manufacturer for the DaisyII® incubator (ANKOM Tecnology, Fairport, NY-USA) was followed, using FN° 57 bags with a pore size of 25 µm and dimensions of 5 x 4 cm made of polyester/polyethylene with filaments extruded in a three-dimensional matrix. In each one, 0.25 g of sample was deposited, to obtain an effective area per bag of 36 cm², which corresponds to a ratio of sample size and bag surface area of 14.4 mg.cm², and they were heat sealed (Ankom Tecnology Corporation).

A replica of each of the species and varieties was randomly incubated in each digestion jar; as well as a bag as a target, in order to generate the correction factor for the possible entry of particles or weight loss. The procedure was performed in duplicate. The samples were incubated for 48 h in the DaisyII® at 39.2 ± 0.5 ºC, with constant shaking and circular movement. After incubation, the bags were washed with cold water to stop the fermentation.

For the *in situ* of dry matter degradability (ISDMD), the method was used [19]. Four Brahman bulls weighing 450.3 ± 35.2 kg-1 and 2 years of age were used, provided with a rumen cannula (4-inch internal diameter, Bar Diamond, Parma, Idaho, USA). The animals were housed in individual pens and fed a diet based on Savoy grass (Megathyrsus maximus), King grass (Cenchrus purpureus) and mulberry (Morus alba), with free access to mineral salts and water. Bags (15 cm x 10 cm) were used for the incubations with a pore size of 45 µm.

Samples for each of the species and varieties were incubated in duplicate in each animal. After 72 hours, the bags were removed, washed with cold water, and frozen at -30 ºC. These were thawed in a refrigerator at 4 ºC, washed with cold water to stop fermentation. The digestibility of organic matter was determined according to Aumont, Caudron, Saminadin, and Xandé [20] and metabolizable energy (ME) and net lactation energy (NLE) were determined according to Caceres and Gonzalez [21]. All analyzes were performed in duplicate and by replicate.

E. Statistical analysis and calculations

For the analysis of the results, the main components were performed, for which the rotation method was applied: Varimax normalization with Kaiser and the Bartlett's sphericity test was performed, which was highly significant ($P < 0.01$) and the KMO statistic (Kaiser -Meyer-Olkin) with a value of 0.60. The reliability of the survey was determined by using Cronbach's Alpha Coefficient with a value of 0.82.

The components were chosen with an accumulated explained variability equal to or greater than 77% and within each factor or main component, those indicators with factors of weight or preponderance greater than or equal to 0.75. With the selected variables, they were grouped and a cluster [22]; analysis was carried out to establish the groups with similarity in their productive components and chemical composition.

For the analysis of principal components, the establishment of the indicators and contribution to explain the variability's between the species and varieties of grasses. It was based on the principle that the relationship between the variables evaluated, a necessary condition to carry out the principal component analysis (PCA), presented correlation values greater than 0.50, with both positive and negative relationships, and that their value was not less than 50% of the total number of these, as well as the non-autocorrelation between variables.

III. RESULTS AND DISCUSSION

For the yield and chemical composition in summer, three main components with eigenvalues greater than one were obtained and that explain 87.27% of the variability between varieties. In component one, 11 indicators related to the constituents of the cell content were shown with preponderance values greater than 0.75 related to the constituents of the cell wall. In the second component, only calcium and the leaf/stem ratio were determined, and in the third component, biomass and dry matter yield (table II).

The first component shows that these indicators explain the greatest variability (62.77) and showed NDF, ADF, Cel, Hcel, ratios of neutral detergent fiber/nitrogen (NDF/N) and acid detergent fiber/nitrogen (ADF/N) as those of greater effect on the quality of grasses. This may be due to the type of growth that these species present and to the decrease in the crude protein content and the increase in the cell wall with the maturity of the plant [23]; aspects that were demonstrated in the current investigation, although in the case of grass species the fibrous content is more marked than in other forage species.

TABLE II
MAIN COMPONENTS OF THE PRODUCTION AND COMPOSITION OF GRASSES IN SUMMER

	Components		
	Cell content	**Minerals and leaf/stem ratio**	**Yield**
Total biomass	0.114	0.398	0.769
Total DMY	0.195	0.401	0.782
DM	0.827	-0.402	0.053
CP	-0.926	-0.065	0.179
Ca	0.251	0.850	-0.255
P	0.624	0.058	-0.107
NDF	0.964	0.028	-0.171
ADF	0.984	0.082	0.011
Lignin	0.915	0.233	-0.098
Cel	0.973	0.048	-0.071
Hcel	0.944	0.166	-0.066
Ash	0.391	-0.504	0.325
ISDMD	-0.795	0.542	0.012
leaf/stem	0.188	-0.850	0.195
AFD/N	0.981	0.138	-0.032
NFD/N	0.971	0.099	-0.163
ME	-0.807	0.532	0.188
Eigenvalue (λ)	10.671	2.885	1.281
Variance (%)	62.769	16.972	7.533
Cumulative variance (%)	62.769	79.741	87.273

In component two, calcium was characterized, and the leaf/stem ratio showed influence in this component and in the third component the day matter yield and biomass. In studies by Cedeno-Vilamar, Arturo, Murilo, and Medina-Vergara [24], and Espinales-Suarez, Pincay-Ganchozo, and Luna-Murilo [26], in the morphobotanical characterization of 19 accessions of *Brachiaria brizantha* and 25 of *Cenchrus purpureus* (Schumach.) vc Morrone, obtained variability in the first component of 24.01 and 24.63, the rest of the components were located in descending order.

This behavior was attributed to the fact that these accessions and varieties belong to the same species and, therefore, have interspecific characteristics that can be very similar and not very variable for some of the indicators in particular, which allows these high productions of biomass, proportion of leaves, rusticity and plasticity; therefore, they adapt to a great diversity of soil types (including those of low fertility) and to adverse climatic conditions (high temperatures and low rainfall) [25]. The differences with our study are related to the differences found between species and varieties with different types of growth, development, phenology, rusticity, and yields; hence the variability's found.

In this sense, when evaluating varieties of *Cenchrus ciliaris* [27], morphologically and nutritionally, they obtained five components with 93% of explained variance, but in the first two the indicators with the greatest preponderance were grouped and 70% of the variability was explained. Where the height of the plant, CP, ADF, lignin, yield in total dry matter and stems stood out in (principal components) PC1 in terms of their preponderance; while PC2 the DMY of the leaves, leaf/stem ratio and IVDMD. These results are lower than those achieved in our research by the different types of species and varieties with different morphology and type of growth. Aspects previously described that reaffirm the variability found since the fibrous structural components in the forages explain the variability in their quality. This agrees with what is written in the literature in relation to the fact that crude fiber determines a minimum of digestible fractions, with a wide range of variability; while the determination of the cell wall offers a more accurate criterion regarding the nutritional quality of the forages (hemicellulose, cellulose and lignin) and the ADF corresponds to the presence of cellulose and lignin.

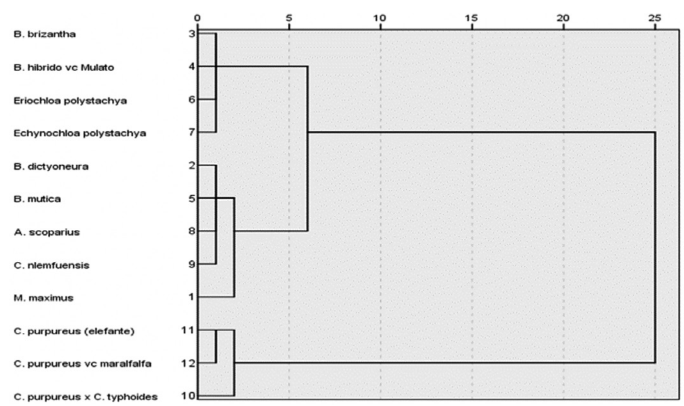

Fig. 1. Dendrogram of the production and chemical composition of the grasses during the summer

The cluster analysis for the main variables allowed grouping according to the similarity in the productivity and chemical composition of the species and varieties during the summer in five groups (fig. 1, table III). The first was characterized by low contents of NDF, ADF, Lignin, Cel, Hcel, NDFN, ADF/N and high CP, ISDMD and ME for the varieties *B. brizantha*, *B. hybrid* vc Mulato I, *Eriochloa polystachya* and *Echynochloa polystachya*, with contributions of nutrients per hectare with 111.51 kg.ha-1 of CP, 710.52 GJ.ha-1 of ME and 397 GJ.ha-1 of NLE.

B. dictyoneura, *C. nlemfuensis*, *A. scoparius* and *B. Mutica* formed the second group with low biomass and dry matter yields. The third group was made up of *M. maximus* with medium to high values in CP, leaf/stem ratio, ISDMD, ME, and variables in the rest of the indicators. The fourth group consisted of *C. purpureus* with the Maralfalfa and Elephant varieties with the highest yields (total biomass and DMY).

C. purpureus x *C. typhoides* integrated the fifth group typified by low levels of CP, ISDMD, leaf/stem ratio, ME, and elevated DM, NDF, ADF, lignin, Cel, Hcel, NDF/N and ADF/N ratios. Where it is the second group showed the lowest contribution of nutrients with 63.2 kg.ha-1 of CP, 490.62 GJ.ha-1 of ME, 256.78 GJ.ha-1; the third, although it presented the best relationship in terms of nutritional contribution (131.58 Kg.ha-1 of CP; 897.28 GJ.ha-1 of ME; 496.64 GJ.ha-1), its contribution was lower than the Cenchrus of groups IV and V with 2242.91 and 1489.15 Kg.ha-1; 18078.12 and 13083.98 GJ.ha-1; 9937.68 and 7045.22 GJ.ha-1 due to differences in productivity.

These results coincide with those reported by De Lucena, Azevedo, Avelar, Burlamaqui, Nunes, and De Seixas-Santos [17], and De Lucena, Azevedo-Rodrigues, Avelar-Magalhães, Burlamaqui-Bendahan, Numes-Rodrigues, and De Seixas-Santos [28], who reported for *B. humidicola* cv. Llanero and *B. brizantha* cv. Piatã protein levels of 10 and 13% and low levels of cell wall, with negative relationships with age. This behavior is attributable to the variety, effect of dilution of nutrients by moisture content, growth and therefore increase of the cell wall and its components; as well as yield, aspects verified in the current investigation due to the variability between varieties due to the type of growth.

In Ecuador, several cultivars of *Brachiaria spp*. have been introduced, which have the potential to increase the productivity of existing grass systems. Among them are Decumbens, Brizantha and Mulato I, of which there are some reports on their acceptance by farmers due to their high nutritional value, adaptation to a wide range of soils and tolerance of pests and diseases [29]. In the current study it was possible to verify that it was present in close to more than 30% of the cattle farms in the study region.

In this sense, Reyes, Mendez, Luna, Verdecia, Macias, and Herrera [30], and Reyes, Mendez, Verdecia, Luna, Rivero, and Herrera [31] found in edaphoclimatic conditions in the regions of El Empalme (Guayas province) (245.6 mm, 25.8 °C, 86% RH) reported for these varieties CP (11.25-12.5%), NDF (37-37.5%), ADF (19.5-21.5%), Lignin (3-3.55%), Cel (17-18%), Hcel (16-16.2%), NDF/N (23-21.37), ADF/N (12.5-12.36), IVDMD (53-53.5%) and ME (7.75-7.94 MJ.kg-1). These results confirm the wide range of adaptation to different climate and soil conditions, which allow the effects of the climatic zone to diminish.

Similar results were reported by Garcia, Pezzani, Lezama, and Paruelo [23], and Bravo, Garcia, Contreras, Pena, Alcala, and de Ortega [32] in *E. polystachy*a and *P. dilatatum*, with values of 12% PB and 38% CP. Meanwhile, Aumont, Caudron, Saminadin, and Xande [20], in *S. splendida* under conditions of the Ecuadorian Amazon, found 11, 77, 35, 39 and 43% of CP, NDF, ADF, Hcel and DMD; respectively. Differences found are due to the type of species and the experimental conditions, since the chemical characteristics are influenced by the degree of maturity of the species, growth and development achieved.

TABLE III
GROUPS OBTAINED IN THE CONGLOMERATE ANALYSIS FOR THE PRODUCTION AND CHEMICAL COMPOSITION OF THE GRASSES DURING THE SUMMER

Indicators	Group				
	B. brizantha* *B. hibrido vc Mulato I* *E. polystachya* *E. polystachya	***B. dictyoneura* *C. nlemfuensis* *A. scoparius* *B. mutica***	***M. maximus***	***C. purpureus vc Elefante* *C. purpureus vc Maralfalfa***	***C. purpureus x C. typhoides***
Biomass $t.ha^{-1}$	2.29±1.52	1.59±0.44	2.48	61.3±3.30	52.72
DMY $t.ha^{-1}$	0.93±0.53	0.74±0.20	1.28	26.43±2.23	20.54
MD.%	28.67±3.89	33.58±1.93	30.27	34.04±0.28	35.59
CP.%	11.19±0.83	8.54±0.77	10.28	8.49±0.44	7.25
Ca.%	0.5±0.15	0.55±0.14	0.52	0.59±0.028	0.64
NDF.%	37.94±4.19	60.21±4.89	52.27	59.9±2.85	68.71
ADF.%	20.85±3.04	36.7±3.74	27.91	41.5±1.07	44.54
Lignin.%	2.79±0.31	4.64±0.76	3.54	4.94±0.16	5.57
Cel.%	16.82±1.41	30.6±1.83	25.84	32.46±1.27	36.24
Hcel.%	16.12±0.57	28.61±2.92	24.4	31.39±1.45	33.35
ISDMD.%	55.33±6.42	47.82±2.41	52.39	48.54±1.26	46.56
leaf/stem	0.79±0.15	0.81±0.092	0.87	0.79±0.013	0.79
ADF/N	11.78±2.41	26.98±2.78	16.97	30.63±2.36	38.41
FND/N	21.4±3.65	44.24±3.63	31.79	44.25±4.37	59.26
EM. $MJ.Kg^{-1}$	7.64±0.70	6.43±0.24	7.01	6.84±0.22	6.37

When evaluating quality indicators, Reyes, Mendez, Luna, Verdecia, Macias, and Herrera [30], and Reyes, Mendez, Verdecia, Luna, Rivero, and Herrera [31] reported interactions between variety-regrowth age (maturity), they concluded that this effect is an indication that these factors should be evaluated as a system and not in isolation, mainly because the climate, soil, its fertility and management; among other aspects, they influence their behavior. These introduced grass species have, as main characteristics, the improvement of the productivity and nutritional value of the pasture with a view to achieving better productive performance (meat and milk) in cattle.

It is interesting that, during the study, higher amounts of leaves were obtained with respect to the stems (leaf/stem ratio) with productivity greater than 50% for this first fraction. However, it maintains the same response reported in the literature for tropical grasses with an increase in NDF/N and ADF/N ratios, as well as a decrease in energy intake (ME; NLE) and digestibility (DMD; OMD) [33].

The decrease in the digestibility of the dry matter is affected by the growth of the plant (maturity). This brings with it a thickening of the cell wall, which reduces the intercellular space where the nutrients (protein) are found and is a function of the relative proportion of each chemical component and its individual digestibility. In addition, it is influenced by the increase in structural components, as well as silica and the monomeric components of lignin. Results higher than 50% digestibility for these species were obtained by [34], [35]. While [33] in *Brachiaria humidicola* cv. Chetumal with cutting frequencies every 21 and 28 days found results of 54-60%; these values are below those reached in the present study, differences attributable to the intrinsic characteristics of each individual, forage age and management conditions.

B. dictyoneura, *C. nlemfuensis*, *A. scoparius* and *B. mutica* formed the second group with low biomass and dry matter yields. Similar results were obtained by Elizondo-Salazar and Espinoza-Fonseca[36], and Reyes, Mendez, Luna, Herrera, Guaman, and Espinosa-Coronel [37] when evaluating *C. nlemfuensis* in conditions of 1466-2229 mm, 17.9-25 °C and 86.88% relative humidity. These reported 1.77 and 0.75 $t.ha^{-1}$ of fresh biomass and dry matter. Hence, Roca, Zamora, Zamora, and Felix [38], and Mendez, Reyes, Luna, Verdecia, Espinoza,. Pincay, Espinosa, Macias, and Herrera [39] state that the structure of the species and the prevailing climatic conditions, mainly humidity, light and temperatures, directly influence the productivity of the species and varieties of pastures in the different periods of the year. In this way we can define that the biomass production capacity of pastures is related to the quality of the pasture, the animal consumption of the grass in grazing, and with the productive capacity of the pastoral systems.

Under conditions of the Pasco region, Peru (1500 mm, 15.5 °C, 92% RH), Lopez, Nunez, Aguirre, and Flores [40] reported superior results in DM production in *B. mutica*, *M. minutiflora* and *S. sphacelata* of 2, 1.5 and 0.88 $t.ha^{-1}$; those who attributed the variability of the results to the fluctuation of temperature (19; 19.78 and 22 °C) and the demands of evaporation and availability of water in the soil (26.8; 25.5 and 25.8%). These aspects are essential for the proper functioning of the photosynthetic activity of plant species that directly influence their growth and productivity.

In this sense, it is stated in the international literature that temperature and humidity show an inversely proportional relationship, because the higher the average temperature, the lower the soil humidity; product a: a greater loss of water by evaporation, hence the need for research on the effects of extreme phenomena in different phenological phases of crops to maintain the sustainability of agroecosystems. This statement agrees with the reports of Confalone, Vilatte, Aguas, Barufaldi, Eseiza, and Ponce [41], and Apraez, Galvez, and Apraez [42].

The third group was made up of *M. maximus* with medium to high values in CP, leaf/stem ratio, ISDMD, ME and medium values in the rest of the indicators. Similar results were reported by [39], in the regions of Empalme (225.6 mm; 25.8 °C; 86% RH) and Guayas (117.2 mm; 23.77 °C; 79% HR) with CP levels (11-12.39%); leaf/stem ratio (2.15-2.88); DMD (52-53%) and ME (6.12-7 MJ.Kg-1) and production of leaves higher than the stems in both conditions.

While Mendez, Reyes, Luna, Verdecia, Espinoza, Pincay, Espinosa, Macias, and Herrera [39] when evaluating the effect of the variety and the climatic zone in Megathyrsus (cultivars: Común. Tanzania and Tobiatá), only found interaction for the yield indicators and the leaf/stem ratio for the region with the highest rainfall in the Tanzania cultivar. For quality CP, DMD, ME, NLE; there were no differences between the varieties, but the effect of climate was found with the best values for the region with the least rainfall.

In this Hence, Roca, Zamora, Zamora, and Félix [38], Herrera [43], Herrera, Garcia, and Cruz [44], and Cuervo-Vivas, Santacoloma, and Barreto [45] pointed out that the elements of the climate interact and have a marked effect on the growth and development of the species and varieties of grasses in the different months of the year; we can explain that this behavior is due to the fact that plant species exist, reproduce and endure in certain edaphoclimatic contexts; what can be considered as tolerance to those conditions. These aspects are revealed in the present study due to the differences and similarities found in terms of quality indicators, in relation to their differences in growth habit, structure and phenology of the species under study.

The values of CP, digestibility and energy intake are in the range of what is reported in the literature [39], [46], [47]; when studying five varieties of *Megathyrsus maximus* (Common, Tanzania, Dwarf, Likoni, Mombaza and Tobiatá), they did not find significant differences when evaluating the effect of the variety on digestibility; in the cases reporting DMD higher than 47%, that behavior is attributable to the Constitutive similarities of the different cellular components of the plant depending on the variety.

The fourth group was formed by C. purpureus with the Maralfalfa and Elephant varieties with the highest yields (total biomass and DMY). Under conditions of the Ecuadorian Amazon [45] (1426 mm, 23.7 °C and 83.8%, rainfall, average temperature and relative humidity) reported values higher than 90 $t.ha^{-1}$ and 20 $t.ha^{-1}$ of biomass and dry material; respectively. These variations are given by natural causes or by human action such as: the availability of water, development of the root system of the plant and time of year; these produce morphological changes such as the decrease in leaf blades and the increase in vascular bundles, results that differ from those obtained in the current study: 81.3 and 26.46 $t.ha^{-1}$.

While under conditions of Valle of Cauto, eastern Cuba in salinity-tolerant varieties, Herrera [15] reported inferior results. Discrepancies with this study that are attributed to the fact that, there are specific conditions that are very different from the rest of Cuba and the tropics in Valle of Cauto, especially the climatic characteristics, such as higher temperatures, with more than 34 °C and less rainfall (790 mm), where the topography and types of soils are abundantly plastic, which makes their management difficult and makes them prone to salinization processes. On the other hand, Herrera [15] and Martínez and González [48] reported for the varieties CT-115, CT-169, Morado, King grass and the hybrids OM-22, H-1 and H-2; productions per cut during the period of low rainfall of 8-12 $t.ha^{-1}$. Those who report that DM production was higher in the dry season (November-May) when compared to the rainy season where rainfall reached 653 mm, which is below the historical average for the region and could affect the expected yield.

This corroborates that the behavior of rainfall, soil, planting time and other climatic factors can affect the behavior of one or another variety and change the order of merit between them. To make decisions about the variety to plant, other factors are important, such as the leaf-stem relationship, establishment, persistence and distribution of annual production [15]. On the other hand, Ray, Almaguer, Ledea, Benitez, Arias, and Roselle [49], when evaluating varieties of Cenchrus tolerant to drought, found a higher percentage of leaves and leaf area with respect to the parent and control (Cenchrus Cuba CT-115), which allows generating a greater amount of biomass, providing the animals with elements with higher nutritional quality. This research shows the adaptability of these varieties to the conditions of fragile ecosystems and in the process of degradation, very frequent in the current conditions of exploitation of livestock ecosystems in tropical regions such as the region under study.

C. purpureus x *C. typhoides* integrated the fifth group typified by low levels of CP, ISDMD, leaf/stem ratio, ME and elevated DM, NDF, ADF, lignin, Cel, Hcel, NDF/N and ADF/N ratios. . Results that coincide with those reported in varieties tolerant to drought in the Valle of Cauto region, Cuba by Ledea, Ray, La-O-Leon, and Reyes [50], Ledea, Verdecia, La-O-Leon, Ray, Reyes, and Murilo [51], and Ledea, La-O-Leon, Ray, and Vazquez [52] where they obtained increases in DM, NDF and decrease in CP with values of 7.6% CP, 77% NDF, 33% ADF, 37% Cel, 35.3% Hcel, OMD 44%, ISDMD 45%; without presenting differences between the varieties.

The increase in fibrous content is given by a greater number of stems than leaves, which brings with it an increase in structural carbohydrates. Thus, the decrease with the maturity of CP and digestibility could be due to the senescent process and the increase of the cell wall. This morphological behavior is characteristic of tropical grasses in response to climatic conditions and the effect of their rapid growth. This is one of the issues for which perhaps differences between the varieties of this genus were manifested; in addition to coming from the same parent and having similarities that impose a uniform response from the chemical point of view for the rumen degradability parameters of organic matter, the values were low. This is associated, according to Ledea, La-O-Leon, Ray, and Vazquez [52], due to the increase in the passage rate and the decrease in the digestion rate; which causes faster output of undigested organic matter from the rumen, and causes a tendency to decrease the total microbial yield, since this would generally increase if the amount of fermented organic matter is greater.

For their part, Valenciaga, Lopez, Delgado, Galindo, Herrera, and Montenegro [53], when evaluating the effect of Saccharomyces cerevisiae hydrolyze on the *in situ* degradability of DM, OM, NDF and ADF of *Cenchrus purpureus* cv. OM-22, reported increases as concentrations of this additive in the diet rose. The increase in the rumen degradability of the nutrients of the evaluated forage, with the increase in the amount of yeast enzymatic hydrolyze added to the diet, can be related to what has been written in the literature about the activating effect of yeast strains in populations of total viable bacteria and cellulolytic bacteria, when these strains are used as additives in ruminant diets.

IV. CONCLUSIONS AND RECOMMENDATIONS

The indicators with the greatest determination on the characterization of the grasses in the edaphoclimatic conditions of Los Ríos province, Ecuador, were the protein content, energy contribution, constituents of the cell wall, leaf-stem and nitrogen-cell wall relationships, which favor a decrease in quality as productivity increases.

The species with the greatest adaptability and behavior for the region were *Cenchrus purpureus* vc Maralfalfa and Elephant; *Brachiaria brizantha*, *Brachiaria hybrid* vc Mulatto I, *Megathyrsus maximus*, *Eriochloa polystachy*a and *Echynochloa polystachya*. Although the best behavior was presented for the group formed by Megathyrsus maximus with an adequate relation between production, chemical composition, and energy contribution.

It is recommended to consider all this information which would contribute to the design of technological alternatives for sowing, establishment, management and use of its biomass as a food source where productivity and sustainability of the ecosystem are minimized, in addition to conducting new research to assess the impacts of the proposed technological alternatives on livestock and the ecosystem.

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