

Nutritive Value of Cultivated Alfalfa in the Ecuadorian Interandin Region for Ruminant Feeding

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ABSTRACT--- *In the Animal Nutrition and Bromatology laboratory of the Faculty of Animal Sciences-ESPOCH, the nutritional value 50 alfalfa samples cultivated in different cantons of the province of Chimborazo at different heights (2600, 2700, 2800, and 2900) was carried out. msnm); in different phenological stages (30, 35, 40, 42, 49, 50, 56, 59, 63 and 70 days), in order to determine their nutritional value. The proximal analysis of cell walls, digestibility and energy value was carried out, the data were processed descriptive statistics determining that the alfalfa cut at 40 days registered initial humidity (HI) 92.25%, ashes (C) 12.27%, organic matter (MO) 87.73%, crude protein (PC) 22.94%, crude fiber (FC) 29.68%, ether extract (EE) 1.92%, nitrogen-free extract 33.19% (ELN)), neutral detergent fiber (NDF) 37.36%, acid detergent lignin (LDA) 6.91%. Concluding that depending on the content of protein and dry matter, alfalfa grown in the inter-Andean region has a high nutritional value.*

1. INTRODUCTION

Ecuador is a privileged country where almost all agricultural crops of economic importance in the world can be produced, being this the main source of food for different animal species. (Monteros, G, et al., 2014). According to the distribution of soil altitudes nationwide, approximately 4.5 million hectares equivalent to 12.5% are suitable for cultivation. Most of this area corresponds to cultivated pastures and the rest to natural pastures (Bonilla, 2011)

In the inter-Andean region at altitudes of 2000 and 3000 masl, with average temperatures of 12-18 ° C and rainfall ranging from 500 to 1 000 mm, the main forage resource is alfalfa. The potential of this pasture in the Ecuadorian Andes is extremely high; Experimental yields of 20-30 tons DM / ha have been obtained. (Loving it, R. et al., 2005). Alfalfa can maintain animal feed, maintain livestock, improve weight gain or performance in the individual production of milk and meat, it stands out for its high productive capacity and high nutritional value, as it can exceed yields of up to 450 Kg., Of crude protein / ha / year. Its importance lies in the amount of forage obtained per unit of cultivated area, nutritional value, acceptability and animal consumption, whether fresh, hay or silage (Melorose, J. et al., 2011).

The structural components and energy reserves, the species has structural carbohydrates, starch, organic acids, proteins and pectin, all with a very high digestibility (90% or more) (Peter & Soest', 2000). As the forage progresses with its state of maturation, several factors interact physiologically, decrease in the cytoplasm, increasing the structural carbohydrates and the lignification thereof, affecting primarily the nutritional quality by reducing the digestibility and the rate of digestion, reflected in lower voluntary consumption.

The percentage of crude protein is affected by different factors, among them the species, the phenological stage, the part of the plant, the level of soil fertility; obtaining values of decreasing tendency toward maturity, these values oscillate between 10 and 30%. (Parsi, 2001).

Therefore, the nutritional value of a forage can be expressed in terms of its digestibility, its consumption and the efficiency with which its nutrients are used by the animal species. (Carulla, et al., 2003). The quantification of the contents in digestible energy (ED) and in metabolizable energy (ME) constitute the universally accepted criterion of expression of the energy value of a food.

The legumes such as alfalfa, are particularly notable for their protein intake, you can then estimate the content of metabolizable energy from the digestible fraction of the dry matter or organic matter in the diet (René A, 2014).

The net energy corresponds to the portion of the energy of the food that is retained in the body of the animal or forms part of one of its useful products as a source of meat or milk. Activity such as grazing in ruminants includes an energy expenditure that represents an increase in net maintenance energy (ENm) and therefore, the largest amount of each food source is allocated to this type of energy using a lower proportion of the gain of weight (ENg) or milk production (ENL) (Martinez, 2008).

2. MATERIALS AND METHODS

Location of the experiment. The experiment was carried out in the animal nutrition and bromatology laboratory of the Faculty of Animal Sciences (FCP) of the Polytechnic School of Chimborazo, Ecuador (ESPOCH), with a duration of one year and with a number of 50 samples analyzed. In vivo digestibility tests and determination of energy value were also carried out. Thus, the investigation was divided into three stages.

First stage.

Sampling.- For this stage, an approximate weight of one kilogram of fresh material was taken and kept frozen for further laboratory analysis. While to carry out in vivo digestibility tests a biomass of 200 kilograms was available, subjected to a haymaking process for the supply of food to the animals.

Second stage

Prosecution. The samples for the chemical analysis were thawed to room temperature, then three replicas were made using 200g of fresh material subjected to 60 ° C for 48 hours until constant weight to determine the initial moisture content and initial dry matter, then grinding was carried out and the proximal analysis of the products. The bromatological determinations of dry matter (DM), ash (C), ether extract (EE), crude protein (PC) and crude fiber (FC) were carried out according to the official methods of analysis (AOAC, 2005). While neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (LDA) were determined as described by Van Soest (1994).

Third stage

For the determination of the digestibility coefficients and the value of the available energy for the animal (EM., ENL., ENg), 6 male sheep were used, which were placed in metabolic cages under a maintenance system at the maintenance level. of 26 grams of digestible organic matter per kilogram of metabolic weight as cited by Osbourn, (1970). Stool feeding and collection was performed daily for a period of ten days in which both the feces and the remainder of the food were collected for further chemical analysis.

3. RESULTS AND DISCUSSION

Tabla N° 1. BROMATOLOGICAL ANALYSIS OF ALFALFA

Variable %	overaje	TYPICAL ERROR	STANDARD DEVIATION	RANK	MINIMUM	MAXIMUM
Ashes	10,84	0,16	1,15	5,70	8,15	13,85
Organic material	85,14	0,75	5,30	17,91	73,94	91,85
Crude protein	21,26	0,21	1,51	5,88	18,26	24,14
Raw Fiber	29,23	0,44	3,16	17,60	20,58	38,18
Ethereal Extract	2,46	0,07	0,51	2,26	1,37	3,63
Nitrogen Free Extract	36,16	0,44	3,14	16,64	26,14	42,78
Neutral Detergent Fiber	50,65	0,84	5,74	22,26	35,08	57,34
Acid Detergent Fiber	37,41	0,29	1,74	6,64	34,12	40,77
Acid Detergent Lignin	11,05	0,29	1,80	8,35	5,58	13,93
Calculated Gross Energy	4372,02	9,96	71,81	347,23	4205,02	4552,25

Ashes

The result for the ash content reported a general average of $10.84 \pm 1.15\%$. The highest value being 13.85% and the lowest being 8.14%. The values reported by (HARRIS, 1970) in the evaluation of samples of alfalfa, ground and dehydrated, for forages and dry ruder foods, in ash mentioned 11.1%, which does not go very far with the table presented

by Fundación Española for the development of Animal Nutrition, (C. de Blas, 2010) an ash content of 10.20%. While the values presented by (Amella, 2011), in its study Effects of the pre-wilting of the alfalfa in the field on its nutritional value, the alfalfa complete on the sixth day of wilting presented 7.57% of ash. The values presented by Harris and FEDNA: 11.1%; 10.20%, respectively, are related to the results of the present investigation, not to the results of Amella (7.57%), which is lower than those presented in the investigation; which is affected by age cut and phenological status, since the sample was taken at the fourth cut and at 10% flowering.

Organic material

The table gives a general average of 85.14 ± 5.3 ; as the most representative value of MO for alfalfa 91.85% and lowest value in the study is 73.94%.

According to the consumption and digestibility of perennial rhizome peanut hay and commercial alfalfa on dry basis nutrients (Rodríguez, et al., 2006), reports 91.60% of OM. In the In Vitro Phenological Assessment and Digestibility of Alfalfa at Different ages (Nelson, 2000) reports an average of 89.5%.

In the analysis of the Effect of Exogenous Fibrolytic Enzymes in the In Vitro Digestibility of the Cell Wall of Alfalfa Hay (*Medicago Sativa*) presented by (Pino Rodríguez, 2002) we find an average MO content of 85.99%.

The results presented by Rodríguez, Nelson and Pino report: 91.60; 89.5 and 85.99% respectively, do not present statistical differences.

Crude protein

The average value is 21.26 ± 1.5 , with the most representative result being 24.14% and the lowest content being 18.26%.

According to (HARRIS, 1970) in the samples of ground and dehydrated alfalfa, for forages and dry coarse foods, 22.1% of crude protein is reported. (Urbano, 2003) In the yield and chemical composition of eleven varieties of alfalfa (*Medicago sativa*) under cutting in the upper area of the state of Merida, Venezuela, reports 22.67% said element in the study consumption and nutrient digestibility of peanut hay perennial rhizome and commercial alfalfa (Rodríguez et al., 2006) reports a content of 16.61%.

The values presented by (HARRIS, 1970) and (Urban, 2003): 22.1 and 22.67% respectively, are related to those recorded in the present study. Not being so, the results marked by (Rodríguez et al., 2006) with a lower content of 16.61% for this element, is affected by its tropical environment where the plant has a low yield and is susceptible to diseases and insects which It affects the development and nutritional value of the plant.

Raw fiber

In the analysis of alfalfa fiber, a general average of 29.23 ± 3.1 was reported; the highest value of fiber content is 38.18%, while the lowest response was 20.58%. The fiber values reported by (HARRIS, 1970), in the evaluation of alfalfa, milled and dehydrated samples, the fiber content for forages and dry rude foods is 26.1%. In the evaluation of fodder and quality of food for ruminants (Peter & Soest ', 2000), reports 30% for that element. (Nelson, 2000) In phenological evaluation and in vitro digestibility of alfalfa at different ages is 25, 72% between 46 - 52 days of age. The results of (HARRIS, 1970), (Peter & Soest ', 2000), (Nelson, 2000) 26.1; 30 and 25.72% are related to the results obtained in the present investigation, this may be due to the maturity and age of cut that were made.

Ethereal extract

In the evaluation of the ethereal extract the general average is 2.26 ± 0.51 . The lowest response of the content, 1.37% while the highest of the variable in question determined 3.63%. (HARRIS, 1970) Registers 3.20% EE for alfalfa, aerial part, dehydrated and milled, for forages and dry rude foods. On the other hand (Ramón Gorosito, 2014), in the table chemical composition and digestibility of dehydrated alfalfa for foreign trade determine 3.9% on dry substance. We also see in the Spanish foundation table for the development of animal nutrition (C. de Blas, 2010) presents 2.34% as a percentage of that element. (HARRIS, 1970), (Gorosito, 2014), (C. de Blas, 2010) determine 3.20; 3.9; and 2.34%, respectively, are values that are related to the result of this study. Being that it has no major importance in the nutrition of ruminants and its percentage in the proximal analysis is very low and often imperceptible as a nutrient.

Nitrogen Free Element

This component reports an average content of 36.16 ± 3.1 . Being the lowest value 26.14%, and the most outstanding 42.78%. In the data presented by (HARRIS, 1970) a value of 41.8% ELN is registered for alfalfa, milled and dehydrated in forages and dry coarse foods. In the Evaluation of Forages and Food Quality for Ruminants (Peter & Soest ', 2000) reports 43% of said component. The results obtained by (HARRIS, 1970) and (Peter & Soest ', 2000): 41.8%; 43% are related to the results of the present study.

Neutral detergent fiber

The registered values of the percentage of neutral detergent fiber are: a general average of 50.65 ± 5.7 ; where the maximum value 57.34% and the lowest is 35.08% (Peter & Soest', 2000) In the Evaluation of Forages and Food Quality for Ruminants reports a NDF content of 40%, according to (Álvarez Fuentes et al., 2004) in its study Quality of food and profitability of farms Dairy farmers familiar from the valley of Mexico with alfalfa grass who used the population of the aforementioned sector reported 47% of the NDF. In another study of forage digestibility in guinea pigs using the in situ technique performed by (Elizabeth, et al., 2006) using the Osbourn methodology (1982). Cannulas were incubated through the cannula (one per animal) of each of the forages and at an incubation time of 48 hours, with alfalfa being the basic food. Report FDN data 38.08%. (Peter & Soest', 2000), (Álvarez Fuentes et al., 2004) and (Elizabeth et al., 2006) 40; 47 and 38.08% are values that are related to the results obtained in this study.

Acid detergent fiber

In acid detergent fiber we have a general average of 37.41 ± 1.7 , while 57.34% is the highest value, and on the other hand, 34.12% is the lowest value. In the results presented (José Luis & Muñiz, 2003) in their study on the production and quality of the forage of four varieties of alfalfa associated with white clover, perennial ryegrass, tall fescue and ball grass, the leaf had the lowest content of FDA (30.9%), followed by the entire plant (32.2%). On the other hand in the study Consumption and Digestibility of Peanut Hay Nutrients Perennial Rizoma and Commercial Alfalfa (Rodriguez et al., 2006) presents 35.49% for FDA. The values recorded by (Carulla et al., 2003) in their study Nutritional value of the forages most used in the specialized milk production systems of the Colombian Andean zone that reports an average content of 35.1% of NDF. Rodríguez and Carulla report 35.49 and 35.1% respectively for FDN, data that are related to the results of the present investigation. While the results presented by José Luis de FDN, for leaves and complete plant 30.9 and 32.2% respectively are lower than those presented in the study due to their age of cut that was made at the beginning of flowering, as that the plant reaches its maturity it tends to rise.

Acid detergent lignin

The values reported in the present investigation correspond to a general average of 11.05 ± 1.8 ; being 13.93% the highest value and 5.58% the lowest value. In the Comparative study of the chemical-bromatological composition and digestibility of different cultivars of alfalfa presented by (TRIVIÑO & CABALLERO, 1972) It reports a value of lignin 5 of 10.2% as a general average of 6 varieties of alfalfa al (10% flowering)). Similarly (Peter & Soest', 2000) in the Evaluation of Forages and Food Quality for Ruminants presents 7.5% for lignin. These values presented by Triviño and Peter of 10.2 and 7.5% respectively are data that are related to those presented in this study.

Tabla 2. DIGESTIBILITY OF THE NUTRIENTS OF THE ALFALFA

Variables %	overaje	Typical error	Standard deviation	Rank	Minimum	Maximum
Dry matter	63,35	1,05	4,05	15,89	56,97	72,86
Organic Matter	65,85	1,01	3,90	14,86	59,79	74,65
Gross Protein	80,01	0,78	3,04	10,33	75,20	85,53
Raw Fiber	40,07	2,94	11,38	39,57	25,09	64,66
Ethereal Extract	43,57	4,66	16,80	57,81	20,20	78,01
Nitrogen Free Element	79,88	0,96	3,71	14,28	70,78	85,06

Digestibility of Dry matter

In the table you can see the digestibility of all the nutrients resulting in a general average of 63.35 ± 4 of digestibility, the highest value 72.86% while the lowest value is 56.97% for MS.

We also take as a reference the data reported by (Balcarce & Rafaela, 2010) in the food composition table for ruminants corresponding to whole alfalfa bales, cut at the beginning of flowering, with 59.6%, the value of dry matter which resembles the data presented in the present investigation.

Digestibility Organic matter

Regarding the digestibility of organic matter in our results we have a general average of 65.85 ± 3.9 ; the maximum value is 74.65%; being lower 59.79%. In table 14 presented by (Guevara, 2011), we can see that the highest value of digestibility in terms of organic matter is at day 35 with a value of 68.47; As the age of the plant advances, the behavior follows a decreasing order, determining that the lowest value is on day 56 with 63.39%. That is, it is related to the results obtained in the present study.

Digestibility of crude protein

If we refer to crude protein digestibility the best response was 85.53%, on the contrary the lowest result was 75.20%, the table shows a general average of 80.01 ± 3 being quite high. In the study Effects of the Pre-wilting of Alfalfa in the Field on its Nutritive Value (Amella, 2011), reports the 82.82% of digestibility for this element. Also the Table of food composition and nutritional requirements of fattening bulls presented by (Ramón Gorosito, 2014), determines the protein digestibility of 85% and 87% for hay and alfalfa silo respectively. The report presented by Amella is related to our study, while the contribution presented by Gorosito is higher due to the phenological conditions of the younger plant and the stem / leaf ratio.

Fiber Digestibility

We also do a digestibility analysis of the fiber, obtaining the highest value 64.66% and the lowest value 25.09%, the table reports a general average of 40.07 ± 11.3 . In the study of the nutritional value of alfalfa with different phenological stages in sheep, presented by (Guevara, 2011) reports a value of 65.66% and 63.42% for alfalfa cut at 35 and 42 days respectively, these values being related to those reported in the present investigation.

Digestibility of Ethereal Extract

As for the ethereal extract data, the values reported in the table are 78.01% the most representative, while the lowest value is 20.20%; giving a general average of 43.57 ± 16.8 . In the study Nutritive Value of Alfalfa (Medicago Sativa) with Different Phenological States in Ovines (Guevara, 2011) reports a digestibility percentage of Ethereal Extract of 51.23% on average, this being a value that is related to the result of the present investigation.

Digestibility of the nitrogen-free element

The grass that showed the highest digestibility in terms of ELN 85.06%, while the lowest value has a digestibility of 70.78%, giving as a fairly high average of 79.88 ± 3.7 . According to (Guevara, 2011) in its study of the nutritive value of alfalfa with different phenological stages in sheep, the percentage of nitrogen-free extract between days 35 to 70 of 81.15% is reported as the average value, which is related to the results of this research and mentions that despite the high digestibilities this nutrient is very little used as an energy source in ruminants, so it is not considered an important nutrient when it comes from forages.

Table 3. Partial digestible nutrients of alfalfa and usable useful energy values

Cut days	PCD	FCD	EED	ELND	E.M	q	E.NI	E.Ng	NDT
35	17,69	10,10	1,58	30,206	2267	0,52	1274	927	63
42	15,54	9,73	0,53	30,838	2121	0,49	1212	816	61
49	14,42	11,09	0,46	29,690	2059	0,47	1863	783	58
56	15,64	11,45	1,66	28,312	2042	0,46	1124	745	57
63	15,45	13,09	0,00	30,438	2097	0,47	1129	749	57
70	15,34	14,47	0,99	28,608	2142	0,49	1152	781	59
30	18,06	6,60	1,50	31,976	2350	0,54	1217	867	61
60	17,24	20,15	0,00	21,852	2090	0,48	1158	797	59
50	18,56	24,69	0,31	19,759	2239	0,51	1257	909	64
40	19,62	17,75	0,70	27,418	2354	0,54	1338	1014	66
Para consumo	15,09	7,90	1,04	34,017	2123	0,49	1180	821	60
Dieta base	14,03	9,63	1,20	28,907	2016	0,47	1111	750	56
Para consumo	16,52	10,03	0,60	28,631	1996	0,47	1099	740	56
Alfarina	16,15	13,69	0,78	22,940	1937	0,46	1063	705	55
Heno	16,75	11,09	0,74	28,540	2125	0,49	1181	825	60

Metabolizable energy

The metabolizable energy reported by the table, with respect to alfalfa, is 2354.24 kcal / kg, on the other hand the one that contributes least to the metabolism reports a value of 1937 kcal / kg, (HARRIS, 1970), in the evaluation of samples of alfalfa, aerial, ground and dehydrated, details a value of 2242 kcal / kg. In the table of food composition for ruminants

(Balcarce & Rafaela, 2010) of alfalfa in natural pasture, bale of whole alfalfa in pre-flowering and whole alfalfa roll with 20% flowering, express a value of 2.40, 2.15 and 1.85 Mcal / kgMS, which gives us to understand that the pasture in its natural state has greater metabolizable energy, whereas if it is submitted to a type of treatment, its MS decreases, so the other results presented by Balcarce, including the Harris one, are related to the values of the present investigation in which alfalfa was also subjected to a previous process of withering.

Net lactation energy

For lactation energy, 1863 Kcal / kg is reported, the lowest energy contribution for lactation reported is 1063 Kcal / kg. According to the table of nutritional value and food composition presented by FEDNA (C. de Blas, 2010) for net lactation energy, it reports values of 1125 Kcal / kg of alfalfa and high quality lucerne hay of 1470 Kcal / kg. In the study of the nutritional requirements of dairy cow of 600 kg of live weight and 30 kg of milk / day and contribution of alfalfa presented by (Jahn & Cofré, nd) We see that the net energy for lactation provided by alfalfa is 1400 Kcal / kg MS equivalent to 1400kcal / kg. The data reported by both FEDNA; 1125 and 1470 Kcal / kg of live weight for alfalfa in branch and hay respectively and Jahn Cofre 1400 Kcal / kg of live weight are related to the results of the present study.

NDT

If we analyze the total digestible nutrients of the present study, we say that it has a decreasing value, as the grass ages, the NDT decreases, thus the most representative value is 66% that drops to 55%, this being the lowest value of the study. If we observe in the Table of food composition and nutritional requirements of fattening bulls presented by (Ramón Gorosito, 2014) Their report is for alfalfa silos, pre-button alfalfa, and alfalfa hay: 62, 69 and 65% respectively, for ruminants. In applied animal nutrition (HARRIS, 1970) also reports a similar data, showing that in the evaluation of samples of alfalfa, aerial, ground and dehydrated for forages and dry ruminant foods, details a value of 62% of NDT For bovines. The values presented by Gorosito for alfalfa and hay silos; 62 and 65% to 62% are related to the results of this research while the 69% result of total digestible nutrients presented by the same Gorosito in pre-button alfalfa takes advantage over the others by the same fact of being from a plant of an early phenological stage.

4. CONCLUSIONS

With the study we can say that alfalfa grown in the inter-Andean region has a high nutritional value, its protein and dry matter value have high digestibility that exceed 75% and 50% respectively, which favors the diet of ruminants.

According to the values presented in the tables in terms of nutritional value, it can be concluded that the best results were found in cut grasses at 30, 40 to 50 days of age, and because of the fiber content it can be said that the Court should not exceed 70 days of age.

For the present study, samples from different heights (2600 - 2900 msnm) were evaluated, so that a better quality grass is achieved at a height between 2600 and 2800 meters above sea level, at this height we achieve better results in organic matter and protein.

If we consider the energy of alfalfa in what has to do with NDT or E Digestible, the best cut-off time is between day 40 and 50 days where the highest values are.

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