(DOI): 10.5935/PAeT.V8.N1.06

Brazilian Journal of Applied Technology for Agricultural Science, Guarapuava-PR, v.8, n.1, p.55-62, 2015

Cientific Paper

Biomass production and bromatologic of silage to aerial parts of twenty accesses of sweet potato

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Abstract

The objective of this study was to evaluate the adaptability of 20 accesses of sweet potato as the characteristics of biomass production and physical composition of the plant, as well as the qualitative characteristics of the resulting silage: UGA001; UGA006; UGA019; UGA023; UGA030; UGA043; UGA045; UGA049; UGA056; UGA064; UGA066; UGA073; UGA077; UGA079; UGA082; UGA084; UGA087; UGA090; UGA095; UGA100 aiming for feeding ruminants. The experimental design was a randomized complete for 20 hits and four replicates, each replicate was represented by a plot with an area of 2 m². The UGA006 access excelled in the production of green and dry biomass with values of 127,267 kg ha^{-1} and 15,345 kg ha^{-1}, respectively. The qualitative characteristics of different accessions of sweet potato relating to crude protein, neutral detergent fiber and acid detergent fiber were presented, in general, suitable for silage, but the dry matter proved inadequate the conservation process in this way, the high potential of wastewater generation.

Key word: acid detergent fiber, crude protein, neutral detergent fiber, production of biomass.

Producción de biomasa y bromatológica del ensilaje de la porción aérea de veinte accesos de Camote

Resumen

El objetivo de este estudio fue evaluar la capacidad de adaptación de veinte accesos de camote cuanto a las características de producción de biomasa y de la composición física de la planta, así como las características bromatológicas del ensilaje resultante: UGA001; UGA006; UGA019; UGA023; UGA030; UGA043; UGA045; UGA049; UGA056; UGA064; UGA066; UGA073; UGA077; UGA079; UGA082; UGA084; UGA087; UGA090; UGA095; UGA100, con el objetivo de alimentar a los rumiantes. El diseño experimental fue completamente al azar compuesto por veinte accesos y cuatro repeticiones. Cada repetición fue representada por una parcela con área útil de 2 metros cuadrados. El acceso UGA006 se destacó en la producción de biomasa verde y seca con valores de 127,267 kg ha^{-1} y 15.345 kg ha^{-1}, respectivamente. Las características bromatológica de los diferentes accesos de batata dulce relativa a los diferentes contenidos de proteína cruda, fibra en detergente neutro y fibra en detergente ácido se presentaron, en general, adecuado para ensilaje, pero las cantidades de materia seca resultaron insuficientes al proceso de conservación en esta manera, por lo alto potencial para la generación de efluentes.

Palabras clave: fibra en detergente neutro, fibra en detergente ácido, producción de biomasa, proteína bruta

Received at: 06/09/14 Accepted for publication at: 10/03/15

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Produção de biomassa e bromatológica da silagem da porção aérea de vinte acessos de batata-doce

Resumo

O objetivo deste trabalho foi avaliar a adaptabilidade de 20 acessos de batata-doce quanto às características de produção de biomassa e de composição física da planta, assim como as características bromatológicas da silagem resultante: UGA001; UGA006; UGA019; UGA023; UGA030; UGA043; UGA045; UGA049; UGA056; UGA064; UGA066; UGA073; UGA077; UGA079; UGA082; UGA084; UGA087; UGA090; UGA095; UGA100, visando à alimentação de ruminantes. O delineamento experimental foi inteiramente casualizado composto por 20 acessos e quatro repetições, cada repetição foi representada por uma parcela com área útil de 2 m². O acesso UGA006 destacou-se na produção de biomassa verde e seca com valores de 127.267 kg ha^{-1} e de 15.345 kg ha^{1}, respectivamente. As características bromatológicas dos diferentes acessos de batata-doce relativas aos teores de proteína bruta, fibra em detergente neutro e fibra em detergente ácido apresentaram-se, de maneira geral, aptas para produção de silagem, mas os teores de matéria seca mostraram-se inadequados ao processo de conservação nesta forma, pelo alto potencial de geração de efluentes.

Palavras chave: fibra em detergente ácido, fibra em detergente neutro, produção de biomassa, proteína bruta.

Introduction

The sweet potato (Ipomoea (L.) Lam.) Is a dicotyledonous family of Convolvulaceae, has vegetative cycle 5-6 months, the best crop development occurs in locations or times when the average temperature is above 24ºC, and the annual rainfall is around 1,000 mm. Can be grown in temperate regions only during periods of spring and summer, it cannot stand frost (SILVA et al., 2004). Fits well in many soil types, but with greater preference to drained, with sandy-loamy texture and rich in organic matter (WOOLFE, 1992).

It is the fourth most consumed vegetable through their roots, and widespread in most regions of Brazil gaining some economic importance. Produced mostly by small farmers, due to their hardiness, ease of adaptation and multiplication, taking advantage of reduced use of inputs, and good resistance against drought. Constitutes a food with good nutritional value for human consumption, mainly as a source of energy and protein, but also with emphasis in animal feed and industrial production of flour, starch and alcohol (MOREIRA et al., 2011; SOUZA, 2000). It is also known that the branches of sweet potatoes are rich in starch, sugars, vitamins and possess high percentage of crude protein and digestibility (MONTEIRO et al., 2007).

The culture of sweet potato is considered rustic, it shows little response to fertilizer application, growing in poor and degraded soils plus high resistance to pests, which makes it a marginal culture, and classifies it according to producers as a source of extra income on the farm (SILVA et al., 2004). According to the same author, among the major cultural practices are ridging and weeding, which is usually performed manually, since there are no herbicides registered for culture.

Due to the increased importance of roots in food and industry, the aerial part of the plant, in other words, the branches are mostly discarded without any use. In China and Vietnam unlike what occurs in Brazil, the branches are widely used in animal feed in fresh or as silage (MONTEIRO et al., 2007). The net income of farmers can be increased with the use of these branches in animal feed since it is a valuable resource that is usually discarded.

In this sense, the use of the technique of the sweet potato silage for animal feed, especially for ruminants may become a viable option. Studies evaluating the potential viability of clones sweet potato order to feed culture showed potential for this purpose, both in the ready supply of branches, as well as silage (MASSAROTO, 2008).

The production of silage in addition to making a more balanced diet, can, in many situations, decrease the nutritional deficit on forage availability due to seasonality of forage production in their growth cycle.

Therefore, the aim of the study was to evaluate the adaptability of 20 accesses of sweet potato as the characteristics of biomass production and physical composition of the plant, as well as the qualitative characteristics of the resulting silage.

Material and Methods

The experiment was conducted at the Department of Animal Production (NUPRAN), Division of Agricultural and Environmental Sciences, Universidade Estadual do Centro Oeste - UNICENTRO, located in Guarapuava / PR under the geographical coordinates 25° 23° 36° S, 51° 27° 19° and 1.120 m of altitude, on soil classified as Latossolo Bruno Distroférrico (EMBRAPA, 2006), CFB climate (subtropical humid mesothermal), no dry season, with cool summers and mild winter as classification Koppen, average annual minimum temperature of 12,7ºC, annual mean maximum temperature and relative humidity 23,5ºC the average annual air of 77.9% and average annual rainfall of 1.944 mm. Prior to planting soil analysis, which showed the following chemical characteristics was performed (profile 0-20 cm): pH $CaCl_2$ 0,01M: 4,7; P: 1,1 mg dm^{3-}; K^+: 0,2 cmolc $dm^{-3;}$ MO: 2,62%; Al^{3+}: 0,0 $cmol_c$ dm^{3-}; H^++; Al^{3+}: 5,2 cmolc dm^{-3}; Ca_2^+: 5,0 $cmol_c$ dm^{-3}; Mg^{2+}: 5,0 $cmol_c$ dm^{-3} and base saturation: 67.3%.

Adaptability of 20 accesses of sweet potato was evaluated in the region of Guarapuava - PR, for the production characteristics of green and dry biomass, physical composition of the plant, as well as the qualitative characteristics of the resulting silage, for this the following accessions were chosen: UGA001; UGA006; UGA019; UGA023; UGA030; UGA043; UGA045; UGA049; UGA056; UGA064; UGA066; UGA073; UGA077; UGA079; UGA082; UGA084; UGA087; UGA090; UGA095; UGA100 as experimental material.

Accesses were collected in the genebank Universidade Estadual do Centro Oeste, UNICENTRO, which were obtained from collecting expeditions in producing fields, settlements, Indian reservations and duplicates of commercial cultivars of the Universidade Federal de Lavras, EMBRAPA and Universidade Federal do Tocantins.

Seedling planting occurred on October 10, 2010 in plots with a total area of 6 m^2 (2m x 3m) with floor area of evaluation of 2 m^2 (1m x 2m). After 30 days of planting the seedlings, there was the basic fertilization with 300 kg ha^{-1} fertilizer formulated 08-30-20 (N-P_2O_5-K_2O). Already nitrogen topdressing occurred 45 days after planting at a ratio of 69 kg ha^{-1} of N as urea (46-00-00) as fertilizer recommendations for the crop sweet potato Manual of Fertilization and liming for the states of Rio Grande do Sul and Santa Catarina (CQFS - RS / SC, 2004).

Early planting, the area was desiccated with glyphosate-based herbicide (commercial product Roundup Original®: 3.0 L ha^{-1}) and crop management up to 40 days after onset of sprouting of branches was practiced hand weeding in controlling undesirable plants.

At the end of the culture cycle (09/04/2011), yields of green and dry biomass (kg ha^{-1}) were determined by weighing the contents contained in the floor area of each plot harvested manually. This practice has allowed obtaining samples of plants composed of homogeneous and representative manner, used for determining the proportion of anatomical structures by targeting components stems of plants, leaves and petioles.

Samples of whole plant and structural components were weighed and pre-dried in an oven at 55ºC forced air until constant weight to determine DM content.

At the time of harvest, also a second sample of shoots of different accessions were chopped and ensiled in PVC silos under the dimensions of 0.1m by 0.5m. After 48 days of ensilamento the PVC silos were opened and silage samples were weighed and dried in an oven pre-forced air at 55ºC until constant weight to determine the DM content, and following ground in a Willey mill , with the sieve of 1 mm mesh. In pre-dried samples of silage were determined the concentrations of ash and crude protein (CP) as AOAC (1995) and neutral detergent fiber (NDF) according to VAN SOEST et al. (1991), and acid detergent fiber (ADF) according to GOERING VAN SOEST (1970).

The experimental design was completely randomized, with 20 treatments and four replications. Data were subjected to analysis of variance comparison of means by Duncan's test at 5% significance level, using the SAS (1993) statistical program.

Results and Discussion

The Table 1 presents data on production of green biomass and dry biomass of different accessions of sweet potato

To produce green biomass was obtained averaging 62,939 kg ha^{-1}, and the access UGA006 showed higher average with 127,267 kg ha^{-1} and the access UGA030 showed lower average production of green biomass 26,600 kg ha^{-1}. The same behavior was observed for biomass dry weight, averaging 7456 kg

Table 1. Production of green biomass and dry biomass of different accesses of sweet potato.

Access Sweet Potato	Biomass, kg ha^{-1}	
	Green	Dry
UGA001	66.713bc	8.564bcde
UGA006	127.267a	15.345a
UGA019	48.558bcd	5.289ef
UGA023	55.167bcd	7.082bcdef
UGA030	29.600d	3.188f
UGA043	83.108b	10.168b
UGA045	56.667bcd	8.047bcde
UGA049	46.975bcd	5.447def
UGA056	73.950bc	9.732bcd
UGA064	81.575bc	9.813bc
UGA066	54.713bcd	7.202bcdef
UGA073	52.813bcd	5.458def
UGA077	58.508bcd	5.738cdef
UGA079	72.450bc	8.430bcde
UGA082	76.700bc	7.848bcde
UGA084	68.375bc	7.255bcdef
UGA087	60.913bcd	7.666bcde
UGA090	46.733bcd	5.617cdef
UGA095	53.617bcd	6.046bcdef
UGA100	44.375cd	5.191ef
Averages	62.939	7.456
CV %	42.08	41.37
P > F	0.0448	0.0242

Averages in the column followed by different lowercase letters differ by Duncan test at 5%.

ha^{-1}, with access UGA006 who presented with higher mean value of 15,345 kg ha^{-1}, and the access UGA030 showed lower average 3188 kg ha^{-1} one fact that can be attributed to poor adaptability of access to soil and climate.

The average production of green biomass was higher than that reported by CARDOSO et al. (2005) obtained in their experiment 60,687 kg ha^{-1}, but according to the author of the clone increased production in their experiment was the first clone (Frangipani - MG) with 141,000 kg ha^{-1}, which is higher than the UGA006 access. Work Done by AZEVEDO et al. (2000), the Universidade Federal de Lavras for characterization of resistant clones of sweet potato as productivity obtained an average of 18.46 t ha^{-1}, and the clone was 92,762 access that had the highest average among the clones with 33.51 t ha^{-1}.

Table 2 shows the dry matter of the structural components of sweet potato (stems, petioles and leaves) and dry matter of the whole plant.

The averages of dry matter found in the branches, petioles, leaves and whole plant were 13.59%; 7.23%; 16.93%; 11.79%, respectively.

The highest levels of dry matter of stems were obtained by UGA045, UGA066, UGA077 access, averaging 16.05%; 15.97% and 16.48%, respectively, did not differ statistically (P>0.05) of UGA001, UGA006, UGA023, UGA 043 UGA056, UGA087 access.

For the dry matter of the petiole hits that showed higher levels were UGA066, UGA001, UGA056 and UGA082, with averages of 9.05%; 8.25%; 8.47%; 8.76%, respectively.

The dry matter of the leaves had means of 22.11%; 18.28%; 20.00%; 15.64% and 18.92%, for UGA090, UGA043, UGA045, UGA064 and UGA077 respectively accesses.

For the dry matter content of the whole plant, the access UGA045 showed higher average with 14.22% and did not differ statistically from UGA023, UGA056 and UGA066 hits with averages of 13.24%; 13.48% and 13.20% respectively, below the values

Table 2. Levels of dry matter of the structural components (stems, petioles and leaves) and dry matter content of the whole plant of different accesses of sweet potato.

Access Sweet Potato	Levels of dry matter, %			
	Branches	Petioles	Leaves	Whole Plant
UGA001	14.64ab	8.25abcd	17.23bcd	12.75bcd
UGA006	14.41abc	7.53cdef	22.08bcd	12.16bcde
UGA019	11.92cde	7.61cdef	15.61cd	10.67fghi
UGA023	14.23abcd	6.61fgh	18.20abcd	13.24abc
UGA030	11.76de	4.55i	15.79bcd	10.77efghi
UGA043	14.37abc	6.20gh	18.28abc	12.17bcde
UGA045	16.05a	7.44cdef	20.00ab	14.22a
UGA049	11.23e	6.29gh	17.69bcd	11.59defg
UGA056	14.20abcd	8.47abc	16.02bcd	13.48ab
UGA064	12.82bcde	7.50cdef	15.64abcd	11.94cdef
UGA066	15.97a	9.05a	14.69dc	13.20abc
UGA073	12.50bcde	6.01h	15.93bcd	10.32ghi
UGA077	16.48a	8.11abcde	18.92abc	11.25i
UGA079	12.88bcde	7.90bcde	14.72dc	11.81cdef
UGA082	12.50bcde	8.76ab	14.42d	10.05hi
UGA084	13.21bcde	7.04efgh	14.21d	10.49fghi
UGA087	15.05ab	7.28defg	14.21d	12.29bcd
UGA090	11.97cde	7.27defg	22.11a	11.37defgh
UGA095	13.21bcde	6.02h	17.22bcd	11.54defg
UGA100	12.55bcde	6.61fgh	15.63cd	11.80cdef
Averages	13.59	7.23	16.93	11.79
CV %	13.57	11.83	24.35	9.17
P > F	0.0281	<0.0001	0.4590	0.0003

Averages in the column followed by different lowercase letters differ by Duncan test at 5%.

considered optimal for silage production, with the ideal levels are around 30 and 35% dry matter (VIANA, 2009), below these values, as found in the experiment in question, means that the plant contains much water in its composition, making these plants when subjected to the storage process in the form of silage effluent produce, reducing the quality of the silage and compromising the entire process of storage in this way.

Table 3 presents data on the physical composition of the plant divided on stems, petioles and leaves in different accessions of sweet potato.

The UGA077 access the greatest participation of branches in the physical structure of the plant compared to the other accessions, with an average of 60.00%, the crude component part of the whole plant in greater proportion compared to petioles and leaf c0differ statistically (P>0.05) of UGA006, UGA019, UGA064, UGA079, UGA084 and UGA090 hits, averaging 27.63 %; 30.83%; 28.40%; 27.16%; 28.60% and 27.40%, respectively. Participation of leaves in the physical structure of the whole plant sweet potatoes showed an average of 50.00% and 48.05% for UGA030 and UGA049 accesses, respectively.

Table 4 presents the data of average pH, dry matter, ash, neutral detergent fiber, acid detergent fiber and crude protein of the silage the aerial portion of 20 accessions of sweet potato.

All Access sweet potato had mean pH values between 4.13 (UGA030) and 3.86 (UGA079), within the range considered acceptable for silage. A similar result was found by MONTEIRO et al. (2007), where the pH ranged 3.8 to 4.5 in silage sweet potato vines.

The dry matter content of silage averaged 13.26% to 11.78% range this being the lowest level and the highest 15.56% dry matter content of silage from different accessions of sweet potato.

For contents ash of the silage and the UGA082 UGA095 accessions had higher averages with values of 9.65% and 9.03% with no statistical differences between them. Already UGA006, UGA056, UGA064 UGA079 hits and not statistically different, with lower average ash content of the silage (6.76%, 6.68%, 6.95% and 6.40%, respectively). It is believed that the

Table 3. Physical composition of the structural components (stems, petioles and leaves) on a dry basis, of different accesses of sweet potato.

Access Sweet Potato	Physical Plant Structural composition (dry basis)%		
	Branches	Petioles	Leaves
UGA001	39.59cdef	26.43bcde	34.00bc
UGA006	40.20bcdef	27.63abcd	32.20bc
UGA019	33.61ef	30.83ab	35.56bc
UGA023	47.81bcd	24.17cdef	28.00bcd
UGA030	33.33f	16.70ghi	50.00a
UGA043	43.36bcdef	19.96fgh	36.66bc
UGA045	39.09cdef	23.33cdef	37.60b
UGA049	35.93ef	16.03hi	48.05a
UGA056	39.73bcdef	22.16defg	38.13b
UGA064	39.04cdef	28.40abc	32.56bc
UGA066	41.69bcedf	26.20bcde	32.13bc
UGA073	40.30bcdef	21.39efgh	38.30b
UGA077	60.00a	12.00i	28.00bcd
UGA079	44.06bcde	27.16abcde	28.76bcd
UGA082	42.19bcdef	26.17bcde	31.63bc
UGA084	50.00b	28.60abc	21.40d
UGA087	47.04bcd	26.48bcde	26.50cd
UGA090	39.13cdef	27.40abcd	33.46bc
UGA095	49.07bc	23.13cdef	27.76bcd
UGA100	37.87def	32.63a	29.50bc
Averages	42.15	24.34	33.51
CV %	17.89	17.95	22.68
P > F	0.0279	<0.0001	0.0093

Averages in the column followed by different lowercase letters differ by Duncan test at 5%.

high levels of ash contamination with soil of branches at the ensilage are allocated.

The rating of the fiber forage has great importance for the formulation of diets for ruminants, for parameters such as intake and digestibility, the measurement are made necessary by having correlation with dry matter intake and absorption efficiency. The fibrous portion of the plant is a source of carbohydrates used as energy by the ruminal microorganisms, with minimum required 55-60% of neutral detergent fiber in the dry matter diet elephant grass base (VAN SOEST, 1994).

The contents of neutral detergent fiber silage ranged from 46.50% to UGA001 access, this being the highest level and 39.80% for UGA087 access this being the lower content of neutral detergent fiber.

To the levels of acid detergent fiber access the UGA001 averaged 40.93% and the access UGA045 averaged 28.12% which is the lowest level of acid detergent fiber, not statistically differ (P>0.05) of UGA019, UGA056, UGA066 and UGA087 access.

Crude protein showed range of 17.67% to 10.82% and the UGA030 UGA064 access and the highest and lowest crude, protein respectively. The values obtained are within acceptable for feeding ruminants parameters, since these animals require on average 7% (MINSON, 1984) of crude protein in the normal way to meet the needs of the rumen. VIANA et al. (2011), working with different accessions of sweet potato silage found an average of 10.93% crude protein in silage analysis, this result agrees with the minimum value found in this work.

Table 4. Mean values of pH, dry matter, ash, neutral detergent fiber, acid detergent fiber and crude protein of the silage the aerial portion of 20 accessions of sweet potato.

Access Sweet Potato	Chemical composition of silage (dry basis)%					
	pH	DM	ASH	NDF	ADF	CP
UGA001	4.12a	13.83bc	8.41cde	46.50a	40.93a	14.03bc
UGA006	3.86h	13.00cde	6.76jk	44.86abcd	35.65abcd	11.58efg
UGA019	3.95defg	13.22cd	8.38cde	42.18abcde	32.70cde	14.46b
UGA023	4.00cde	12.78de	8.88bc	41.77bcde	36.92abc	14.48b
UGA030	4.13a	12.22def	8.54cde	42.62bcde	35.66abcd	17.67a
UGA043	4.02abc	13.11cd	7.22hij	42.42abcde	35.84abcd	13.08bcdef
UGA045	3.93fg	15.56a	7.56fghi	41.71bcde	28.12e	13.29bcde
UGA049	3.9gh	14.78ab	7.84efgh	43.72abcde	35.70abcd	11.42efg
UGA056	3.94efg	14.44b	6.68jk	40.55de	33.67bcde	13.18bcdef
UGA064	3.96defg	13.22cd	6.95jik	45.73ab	40.49a	10.82g
UGA066	4.08ab	13.17cd	7.28ghij	44.33abcde	31.87cde	12.26cdefg
UGA073	3.95defg	13.17cd	9.28ab	43.44abcde	35.22abcd	12.15cdefg
UGA077	4.00cdef	12.00ef	7.96efg	42.93abcde	37.20abc	12.59bcdefg
UGA079	3.86h	14.22b	6.40k	45.30abc	34.95abcd	11.18b
UGA082	3.99cdef	12.22def	9.65a	43.72abcde	39.79ab	14.63b
UGA084	4.04bc	13.00cde	8.33cde	45.60abc	41.55a	13.92bcd
UGA087	3.99cdef	11.67f	8.71bcd	39.80e	29.57de	13.80bcd
UGA090	3.97cdef	14.78ab	7.8efgh	44.17abcde	38.43abc	14.24bc
UGA095	3.94efg	13.00cde	9.03abc	41.06cde	35.05abcd	11.93defg
UGA100	3.98cdef	11.78f	8.07def	39.74e	36.88abc	12.19cdefg
Averages	3.98	13.26	7.99	43.06	35.81	13.15
CV %	1.32	5.76	6.94	7.62	13.59	11.6
P>F	0.0001	0.0001	0.0001	0.3747	0.1123	0.0009

Averages in the column followed by different lowercase letters differ by Duncan test at 5%.

Conclusion

Accesses of sweet potato production had satisfactorily dry biomass with qualitative characteristics within expected standards, but with high moisture content, thus showing that other techniques such as wilting is required for storage in the form of silage.

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