Agrisost | Vol. 25, No. 3, September-December 2019: 1-6

ISSN-e: 1025-0247

Phenological Characterization and Production of Biomass from 12 Varieties of Sugar to Feed Cattle

Yoslen Fernández Gálvez[1], Isabel C. Torres Varela[2], Joaquín Montalván Delgado[2], Yusvel Hermida Baños[2], Douglas Montes Alvarez[2], Alfredo L. Rivera Laffertte[2] & Yoslen Fernández Caraballo[2].

[1]ORCID https://orcid.org/0000-0002-7824-9215, Deputy Director of Research and Technological Innovation, Territorial Station of Sugar Cane Research, Mid-east, Florida, Camagüey, Cuba, [2] Deputy Director of Research and Technological Innovation, Territorial Station of Sugar Cane Research, Mid-east, Florida, Camagüey, Cuba.

Citation: Fernández Gálvez, Y., Torres Varela, I., Montalván Delgado, J., Hermida Baños, Y., Montes Alvarez, D., Rivera Laffertte, A., & Fernández Caraballo, Y. (2019). Phenological Characterization and Production of Biomass from 12 Varieties of Sugar to Feed Cattle. *Agrisost*, *25*(3), 1-6. Retrieved from https://revistas.reduc.edu.cu/index.php/agrisost/article/view/e3337

Received: April 7, 2019 Accepted: July 7, 2019 Published: September 10, 2019

Funding source: Undeclared.

Conflicts of interest: No conflict of interest has been declared.

Email: yoslen@eticacm.azcuba.cu

Abstract

Context: One of the main limiting factors of cattle production in Cuba is linked to low availability of quality pasture in sufficient amounts, during the dry season. Sugar cane has anatomical and physiological features that offer advantages as food and energetic supplement to ruminants.
Objective: To characterize 12 varieties of sugar cane for cattle nutrition.
Methods: Phenological evaluations were made and biomass production was determined in a study conducted at the Territorial Station of Sugar Cane Research (ETICA), mid-east Camagüey, in dry lands. A randomized block experimental design was made, consisting of 12 treatments (varieties) and three replications. The phenological composition of the stump (stem, top, and whole) was determined at 14 months in all the varieties. Agronomic variables plant height, stem diameter, number of stems m^{-2}, active leaves, and production of green biomass by fractions and as a whole, were determined as well.
Results: The study demonstrated the existence of no significant differences in the phenological composition among the varieties. Concerning variables crop yield and green biomass production, varieties C92-325, C86-12, C99-374, C90-530, and C97-366 showed the greatest potential.
Conclusions: Its use is recommended in the major cattle raising areas in the province and the country with similar edaphoclimatic conditions to the experimental area.

Key words: forage, stem, cane top, whole fraction, crop yields.

Introduction

In Cuba, productive diversification in agriculture may contribute significantly to partial or total substitution of imports of raw materials, thus it is a pressing need and a goal to meet (Fernández et al., 2014). In that context, conception and diversification as a development strategy in livestock production, especially cattle, calls for the utilization of sugar cane as food and energy supplement during the dry season mainly. In this period, quality pasture availability in sufficient quantities is low in the major cattle raising areas in Cuba.

Sugar cane is the highest producer of useful biomass for cattle nutrition. Some dry land varieties chosen only demand irrigation during the early stage. Using little fertilization in the humid and sub humid tropics, the crop can produce high yields. It is the only poaceae that increases nutrient contents with age. There is no need to preserve excess from the rainy season, so forage cuts in the rainy season can be avoided. This crop has a high genetic variability, with many varieties that can be planted in most tropical and sub-tropical environments. Variety adaptation to all edaphoclimatic conditions is broad. Plantations may remain productive for many years when they are properly handled. Harvest can be mechanized or manual (both highly productive) (Bastidas, Rea, De Sousa, Hernández & Briceño, 2012; Siqueira, Roth, Moretti, Benatti & Resende, 2012; Voltolini et al., 2012; Ramírez-Cathí et al., 2014; Bezerra et al., 2017; Salazar et al., 2017).

All the above confirm that sugar cane is one viable and sustainable choice for cattle nutrition today. Therefore, knowing the varieties with the greatest forage producing potential in certain edaphoclimatic areas is highly practical. This will allow for a more efficient use of the crop, and contribute to more stable and sustainable productions of milk and beef, especially during the dry season in Cuba. Hence, the aim of this paper is to characterize 12 varieties of sugar for cattle nutrition.

Materials and Methods

This study was done at the Territorial Station for Sugar Cane Research (ETICA), mid-east Camagüey, in the municipality of Florida, located on 21º 30' north latitude and 78º 15' west longitude, 57.47 meters above sea level. The field experiment was conducted on brown soil with carbonates, according to Hernández, Pérez, Bosch, Rivero & Camacho (1999).

Planting was made on November 2016, using a randomized block experimental design, consisting of 12 treatments (varieties) and three replications. The plantation (48 m^2) consisted in four 7.5 m long rows, with 1.60 m separation between them, and 0.60 m separation between plants. Tilling was performed according to INICA (2014).

At 14 months, the phenological composition of the stump (stem, top, and whole) was evaluated in all the varieties, according to Molina & Tuero (1995). Agronomic variables plant height, stem diameter, number of stems m^{-2}, active leaves, and production of green biomass by fractions and as a whole, were determined as well.

To achieve normal distribution of the percentage values of stem, nodes, and stalks, they were arcsine square root transformed (1-(x/100). The number of stems m^{-2} and active leaves were calculated by the square root (x). The means and standard errors were estimated in each case. Analyses of variance were performed and the Tukey ($p<0.5$) test for multiple mean comparisons was applied. All statistics were analyzed with Statgraphics Centurion XV. I.

Results and discussion

Evaluation of the phenological composition showed no statistically significant differences among the varieties in the three stalk fractions (stem, top, and whole) that make the plant (Table 1).

Table 1. Phenological composition of the varieties studied

Variety	Stem %	Top %	% Straws
C92-325	77.25	14.83	7.92
SP70-1284	75.67	18.44	5.89
C97-366	71.33	21.39	7.28
My5514	75.83	15.51	8.66
C90-469	74.01	21.58	4.41
B80250	80.58	15.23	4.19
C99-374	77.81	17.67	4.52
C86-12	80.17	12.72	7.11
C1051-73	73.35	21.51	5.14
C86-156	77.48	17.12	5.40
C90-530	80.76	15.55	3.69
C323-68	75.86	15.86	8.28
Sig.	NS	NS	NS
$\bar{X}$	76.67	17.28	6.04
SE	0.88	0.76	0.43

The weight percentage of stem fraction was better in varieties C90-530, B80250, and C86-12. Meanwhile, C97-366 and C1051-73 showed the best weight percentages of this fraction. The stem is considered important for both industrial and livestock production, it is the organ that contains sucrose, an easily fermented carbohydrate when present in the rumen. Besides, this fraction also contains structural carbohydrates that supply energy needed by ruminants (Suárez et al., 2018). Moreover, the composition of this fraction depends on the variety, age, plant cycle, location, technological handling, and others (Chaves, 2008).

Concerning the weight percentage of tops in plant biomass, the highest values were reached by C90-469, C1051-73, and C97-366. This fraction is an important source of forage, considering the studies conducted in Cuba by Stuart (2002), who evaluated *in situ* the influence of top and stem proportion on the composition and digestibility of commercial varieties at 48 h. Interestingly, the varieties with bigger tops were not necessarily the least digestible, even with smaller stems (or sugar). Since the top of sugar cane is a desirable element in the diet of animals due to the contributions in nitrogen, vitamin, and long fiber, these varieties are more recommended for cattle nutrition.

Furthermore, the weight percentage represented by the straw may be assumed to largely depend on the self-strawing capacity of the plant. In other words, the senescent leaves easily detach from the stem naturally. Varieties C90-530, C99-374, C90-469, and B80250 share the self-strawing capacity; as can be seen in Table 1, they showed the lowest values of weight percentage of that fraction, during the study.

Casanova (1982) cited by Lecca (2017), determined that the phenological composition of sugar cane depends on the variety, agrotechnical management, and age, and there is a direct relation between that proportion and crop yields.

Generally, the results observed in the phenological composition of the sugar cane varieties evaluated are similar to the reports of Franco (1981), Chaves (2008), Leyva (2012), and Suárez et al. (2018), where the weight percentage of the stem fraction varies between 70 and 80%, the top, between 10 and 20%, and average weight values of straw fraction, below 10%, in relation to the total biomass from the plant tops in sugar cane varieties aged 12-14 months.

In turn, López, Ramos & Mendoza (2003), in a study done in Mexico, published values of phenological composition of eight sugar cane varieties, which differ from the values achieved in this study. Those authors found a mean value of weight percentage of stem of 76.67%. The mean value for straw of total biomass weight from the top was significant, reaching 16.87%. These results confirm the capacity of sugar cane varieties present in Cuba to undergo self-strawing (Suárez et al., 2018).

Regarding the agronomic variables evaluated in terms of number, diameter, and length of stems, and for the number of active leaves, statistically significant differences were observed (Table 2).

The indicator number of stems was stronger in C97-366 and C323-68. The former is a low-sugar content genotype, which was chosen merely due to forage-producing criteria, for its high genetic potential to achieve that goal. Presently, there is a national project through which the main cattle raising areas in the province of Camagüey are being gradually planted with this variety. Its genetic potential is high in terms of number of stems, which favors the production of increased volumes of green and dry biomass per surface unit (Llanes et al., 2015). In turn, C323-68, is a highly productive crop, which depends a great deal on its high genetic potential. These results corroborate the positive correlation between the number of stems and sugar cane yields (Leyva, 2012).

Table 2. Behavior of agronomic variables

Variety	NT (m^{-2})	DT (cm)	LT (cm)	NHA
C92-325	11.33$^{(a)}$	3.03^{a}	308.00^{a}	5.67$^{(ab)}$
SP70-1284	8.00$^{(bc)}$	2.85^{bc}	279.33^{abc}	4.67$^{(b)}$
C97-366	12.67$^{(a)}$	2.66^{d}	280.67^{abc}	5.33$^{(ab)}$
My5514	7.33$^{(c)}$	2.68^{d}	247.00^{d}	5.33$^{(ab)}$
C90-469	7.67$^{(bc)}$	2.65^{d}	298.33^{ab}	5.00$^{(b)}$
B80250	9.33$^{(abc)}$	2.79^{cd}	264.00^{cd}	5.00$^{(b)}$
C99-374	11.33$^{(a)}$	2.94^{ab}	261.67^{cd}	6.67$^{(a)}$
C86-12	10.33$^{(abc)}$	3.08^{a}	267.33^{bcd}	5.00$^{(b)}$
C1051-73	8.00$^{(bc)}$	2.69^{d}	245.00^{d}	5.00$^{(b)}$
C86-156	10.00$^{(abc)}$	2.79^{cd}	273.00^{bcd}	5.33$^{(ab)}$
C90-530	10.67$^{(ab)}$	2.86^{bc}	279.33^{abc}	5.00$^{(b)}$
C323-68	12.33$^{(a)}$	2.42^{e}	268.33^{bcd}	5.00$^{(b)}$
Sig.	*	*	*	*
$\bar{X}$	9.92$^{(3,13)}$	2.79	272.67	5.25$^{(2.29)}$
SE	0,42$^{(0.06)}$	0.03	3.98	0,13$^{(0.02)}$

NS: Number of stems **SD:** Stem diameter
SL: Stem length **NAL**: number of active leaves
( ) Significance of transformed means (Tukey $p<0.05$)

Varieties C86-12 and C92-325 showed the highest average values of stem diameter with over 3 cm. Overall, the other genotypes evaluated showed very similar values to Morales, Gálvez & Jorge (1997), and Jorge, H., Jorge, I. & Bernal, (2004 and 2010).

Stem length in sugar cane is influenced by biotic, abiotic, and agronomic management factors. Stem length, number of stems, and stem diameter are the three main yield components in sugar cane (Manimaran, Kalyanasundaram, Ramesh & Sivakumar, 2009; Ehsanullah, Khawar, Jamil & Ghafar, 2011; Leyva, 2012; Munsif et al., 2015). Throughout the evaluations, C92-325 and C90-469 stood out, with maximum values of 295 cm long, which can be considered positive at 14 months in dryland conditions.

The number of active leaves is highly important, due to the responsibility of this organ in photosynthesis and biomass production. The most outstanding variety, though, was C99-374, which, along with C97-366, was chosen following merely forage criteria, and the two are part of the same national project.

In terms of biomass production per plant fraction and as a whole, there were statistically significant differences among the varieties in all the variants evaluated (Table 3). Overall, the most outstanding genotypes in this forage indicator were C92-325, C86-12, C99-374, C90-530, and C97-366, with more than 130 t ha^{-1}. Which, according to Ruíz (2012), makes this a highly productive variety, by surpassing 110 t ha^{-1} in dryland conditions.

The results of this study are higher than Leyva (2012), who evaluated four varieties of sugar cane on two locations of Las Tunas province (C137-81, C86-503, C90-530, and B63118) for animal nutrition in dryland conditions. The mean biomass values achieved on the two locations, ranged between 59 and 65 t ha^{-1} at 12 months. The higher yields found in the 12 varieties studied, compared to the values published by that author, confirms their good forage potential for ruminant nutrition, particularly during the dry season in Cuba.

Table 3. Production of biomass by plant fraction, and as a whole

Variety	PBV (t ha^{-1})			
	Stem	**Top**	**Straw**	**Whole**
C92-325	130.87^{a}	24.78^{a}	11.89^{a}	167.54^{a}
SP70-1284	73.67^{bc}	13.95^{bc}	6.69^{bc}	94.31^{bc}
C97-366	103.37^{ab}	19.57^{ab}	9.40^{ab}	132.34^{ab}
My5514	54.18^{c}	10.26^{c}	4.93^{c}	69.37^{c}
C90-469	65,53^{c}	12.41^{c}	5.95^{c}	83.89^{c}
B80250	77.82^{bc}	14.73^{bc}	7.07^{bc}	99.62^{bc}
C99-374	103.93^{ab}	19.68^{ab}	9.44^{ab}	133.05^{ab}
C86-12	106.83^{ab}	20.23^{ab}	9.71^{ab}	136.77^{ab}
C1051-73	57.99^{c}	10.98^{c}	5.27^{c}	74.24^{c}
C86-156	86.53^{bc}	16.38^{bc}	7.87^{bc}	110.78^{bc}
C90-530	103.66^{ab}	19.63^{ab}	9.42^{ab}	132.71^{ab}
C323-68	78.48^{bc}	14.86^{bc}	7.14^{bc}	100.48^{bc}
Sig.	*	*	*	*
$\bar{X}$	86.91	16.46	7.89	111.26
SE	4.61	0.88	0.42	6.01

Furthermore, Rincón & Rodríguez (1971), in Colombia, reported that the highest biomass production was achieved with CC8475 (81.7 t ha^{-1}). These results were also below the ones found in this study. Castro, Andrade, Botrel & Evangelista (2009), published higher values to this study, on evaluation of biomass production in three sugar cane varieties, in three different periods. The mean production of green biomass was 144.98 t ha^{-1} (124.03 t from stems and 20.95 t from leaves), under irrigation and balanced fertilization.

Accordingly, the varieties evaluated showed a satisfactory agronomic behavior with high biomass productions during the study, which gives sugar cane an advantage in comparison to other forage crops. Planting the most forage productive varieties in this study on cattle locations will help mitigate pasture deficit, especially in the dry season, and therefore, contribute to better productive cattle indicators if this source of forage is properly administered.

Conclusions

The study demonstrated the existence of no significant differences in the phenological composition among sugar cane varieties. Concerning variables crop yield and green biomass production, varieties C92-325, C86-12, C99-374, C90-530, and C97-366 showed the highest potential. Therefore, its use is recommended in the major cattle raising areas in the province and the country with similar edaphoclimatic conditions to the experimental area.

Author contribution

Yoslen Fernández Gálvez: research planning, experimental design, analysis of results, manuscript assembly, redaction of the manuscript, final review.

Isabel C. Torres Varela: experimental design, analysis of results, manuscript redaction, final review.

Joaquín Montalván Delgado: experimental design, analysis of results, manuscript redaction, final review.

Yusvel Hermida Baños: experimental design, analysis of results, manuscript redaction, final review.

Douglas Montes Alvarez: experimental design, data collection, interpretation of results.

Alfredo L. Rivera Laffertte: experimental design, data collection, interpretation of results.

Yoslen Fernández Gálvez: experimental design, data collection, interpretation of results.

Conflicts of interest

The authors declare no conflicts of interest.

References

Bastidas, L., Rea, R., De Sousa Vieira, O., Hernández, E., & Briceño, R. (2012). Análisis de variables agronómicas en cultivares de caña de azúcar con fines azucareros, paneleros y forrajeros. *Bioagro, 24*(2), 135-142. Retrieved on March 10, 2019, from: http://bioagrojournal.com/index.php/path/article/view/142/143

Bernal, N., Morales, F., Gálvez, G., & Jorge, I. (1997). *Variedades de caña de azúcar. Uso y manejo*. Ciudad de La Habana, Cuba: Instituto Nacional de Investigaciones de la Caña de Azúcar (INICA).

Bezerra, J. D. C., Ferreira, G. D. G., Campos, J. M. de S., Oliveira, M. W. de, Andrade, A. P. de, & Nascimento Júnior, J. R. S. do (2017). Biometric and chemical characteristics of sugarcane varieties for use as forage in limiting soil water conditions. *Revista Brasileira de Zootecnia*, *46* (5), 384-392, doi: http://dx.doi.org/10.1590/S1806-92902017000500003

Castro, H. S. de, Andrade, L. A. de B., Botrel, E. P., & Evangelista, A. R. (2009). Rendimentos agrícola e forrageiro de três cultivares de cana-de-açúcar (Saccharum spp.) em diferentes épocas de corte. *Ciência e Agrotecnologia*, *33*(5), 1336-1341, doi: http://dx.doi.org/10.1590/S1413-70542009000500020

Chaves Solera, M. (2008). Uso de la caña de azúcar como forraje. *Ventana Lechera. Revista Especializada. San José, Costa Rica, Dos Pinos*, *10* (3), 45-51. [Sitio Argentino de Producción Animal] Retrieved on March 10, 2018, from: http://www.produccion-animal.com.ar/produccion_y_manejo_pasturas/Cania_azucar/07-uso_cana_azucar_como_forraje.pdf

Ehsanullah, Khawar, J., Jamil, M., & Ghafar, A. (2011). Optimizing the row spacing and seeding density to improve yield and quality of sugarcane. *Crop Environ*. *2*, 1-5. Retrieved on March 10, 2019, from: https://www.researchgate.net/publication/266741691

Fernández Gálvez, Y., Ramírez Peláez, H., Pedraza Olivera, R., Guevara Leyva, R., Llanes Díaz, A., Montalván Delgado, J.,…Noy Perera, A. (2014). Uso de la caña de azúcar como alimento animal en el municipio Carlos Manuel de Céspedes. Centro Azúcar, *41*(2), 12-25. Retrieved on March 10, 2019, from: http://centroazucar.uclv.edu.cu/media/articulos/PDF/2014/2/2.pdf

Franco, R. (1981). Estudio comparativo de variedades de caña para forraje en condiciones de secano. *Pastos y Forrajes*, *4* (2), 157-164. https://payfo.ihatuey.cu/index.php?journal=pasto&page=article&op=view&path%5B%5D=1658

Hernández, A., Pérez, J. M., Bosch, D., Rivero, L., & Camacho, E. (1999). *Nueva versión de clasificación genética de los suelos de Cuba*. La Habana: Instituto de Suelos. Minagri-Agrinfor.

INICA (2014). *Instructivo Técnico para el manejo de la Caña de Azúcar*. (2da ed.). La Habana: Editorial Imp. Iré Producción.

Jorge, H., Jorge, I., & Bernal, N. (2004). *Catálogo nuevas variedades de caña de azúcar*. Ciudad de La Habana, Cuba: Instituto Nacional de Investigaciones de la Caña de Azúcar (INICA).

Jorge, H., Jorge, I., & Bernal, N. (2010). *Catálogo nuevas variedades de caña de azúcar*. Ciudad de La Habana, Cuba: Instituto Nacional de Investigaciones de la Caña de Azúcar (INICA).

Lecca Vázquez, S. I. (2017). *Evaluación de los factores de producción y comercialización del cultivo de caña de azúcar (Saccharum officinarum), en zonas de la carretera Iquitos-nauta*. (Tesis publicada para optar por el Título profesional de Ingeniero Agrónomo). Universidad Nacional de la Amazonia Peruana, Iquitos, Perú. Retrieved on March 10, 2019, from: http://repositorio.unapiquitos.edu.pe/bitstream/handle/UNAP/4869/Samuel_Tesis_Titulo_2017.pdf?sequence=1&isAllowed=y

Leyva Quevedo, J. G. (2012). *Evaluación de variedades de caña forrajera en las condiciones edafoclimáticas del norte de Las Tunas*. (Tesis de Maestría en Pastos y Forrajes, publicada). Universidad de Matanzas “Camilo Cienfuegos”, Matanzas, Cuba. Retrieved on March 10, 2019, from: https://biblioteca.ihatuey.cu/link/tesis/tesism/joseleyva.pdf

Llanes, A., Fernández, Y., Pedraza, R. M., Sánchez, J. A., Álvarez, M. L., Torres, I., et al. (noviembre, 2015). *Comportamiento fenológico de dos nuevos cultivares de caña de azúcar (Saccharum spp.) para forraje*. Ponencia presentada en Memorias del V Congreso Internacional de Producción Animal Tropical. La Habana, Cuba.

López, I., Aranda, E.M., Ramos, J.A., & Mendoza, G.D. (2003). Evaluación nutricional de ocho variedades de caña de azúcar con potencial forrajero. *Revista Cubana de Ciencia Agrícola*, *37* (4), 381-386. Retrieved on March 10, 2019, from: https://www.redalyc.org/pdf/1930/193018056006.pdf

Manimaran, S., Kalyanasundaram, D., Ramesh, S., & Sivakumar, K. (2009). Maximizing sugarcane yield through efficient planting methods and nutrient management practices. *Sugar Technol*., *11*(4), 395-397, doi: https://doi.org/10.1007/s12355-009-0068-7

Molina, A., & Tuero, O. (1995). Selección de variedades de caña de azúcar para el ganado vacuno. *ACPA*, *15*(1-2), 21-23.

Munsif, F., Ali, K., Khalid, S., Ali, A., Ali, M., Ahmad, M.,… Basir, A. (2015). Influence of row spacing on weed management, biomass and yield of chip bud settlings of sugarcane. Pak. *J. Weed Science*, *21*(1), 137-144. Retrieved on January 6, 2019, from: https://www.researchgate.net/publication/307175483

Ramírez-Cathí, H., Salcedo Martínez, A. C. C., Briones Encina, F., Lucero Magaña, F.A., Cárdenas Lara, A., Marcof Álvarez, C., & Martínez González, J.C. (2014). Rendimiento, caracterización morfológica y bromatológica de la punta de caña de azúcar en la Huasteca Potosina, México. *Revista Cubana de Ciencia Agrícola*, *48* (4), 411-415. Retrieved on January 6, 2019, from: https://www.redalyc.org/html/1930/193033033017/

Rincón, E. J., & Rodríguez, C. J. (1971). Producción de leche de vacas mestizas de Criollo por Pardo Suizo y Holstein, mantenidas a potrero en el Estado Zulia. *Revista Agronomía Tropical*, *21* (3), 205-213. Retrieved on January 6, 2019, from: http://www.sian.inia.gob.ve/revistas_ci/Agronomia%20Tropical/at2103/arti/rodriguez_c.htm

Ruíz, L. (2012). Realidades y perspectivas del forraje de caña de azúcar (Saccharum Officinarum) en la alimentación del ganado vacuno. *Ciencia y Tecnología Ganadera*, 6 (3), 123-146.

Salazar Ortiz, J., Trejo Téllez, L. I., Valdez Balero, A., Sentíes Herrera, H.E., Rosas Rodríguez, M., Gallegos Sánchez, J.,… Gómez Merino, F. C. (2017). Caña de azúcar (Saccharum spp.) en la alimentación de rumiantes: experiencias generadas con cañas forrajeras. *Agroproductividad*, *10* (11), 70-75. Retrieved on January 6, 2019, from: http://revista-agroproductividad.org/index.php/agroproductividad/article/view/62/57

Siqueira, G. R., Roth, M. de T. P., Moretti, M. H., Benatti, J. M. B., & Resende, F. D. de. (2012). Uso da cana-de-açúcar na alimentação de ruminantes. *Revista Brasileira de Saúde e Produção Animal*, *13*(4), 991-1008, doi: https://dx.doi.org/10.1590/S1519-99402012000400011

Stuart, R. (24-25 julio, 2002). *Selección de variedades de caña de azúcar forrajeras.* Ponencia presentada en el IV Foro Internacional «La caña de azúcar y sus derivados en la producción de leche y carne». La Habana, Cuba.

Voltolini, T. V., Silva, J. G. da, Silva, W. E. de L., Nascimento, J. M. L. do, Queiroz, M A. Á., & Oliveira, A. R. de. (2012). Valor nutritivo de cultivares de cana-de-açúcar sob irrigação. *Revista Brasileira de Saúde e Produção Animal*, *13*(4), 894-901, doi: https://dx.doi.org/10.1590/S1519-99402012000400001