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Pruning management of cassava for animal feeding: Parameters of the root

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To evaluate the effects of pruning at different data on the parameters of the root, a randomized complete block experiment involving the IAC-14 cassava variety was conducted between years 2008/2010, at UNESP, Botucatu, Brazil. Plants were pruned monthly from the 7th to the 15th month after planted. The chemical analyses were performed at the time of harvest, that is, 22 months after planting (MAP). Production and yield plus the starch, crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF), total digestible nutrients (TDN), nitrogen-free extract percentage (NFE) and total sugars (TS) contents of the root were analyzed. Pruning shoots of IAC-14 variety before the physiological rest affects positively yield and the percentage of root, and do not affect the root starch content.

Key words: Food science, starch, fiber, ruminant, monogastric.

INTRODUCTION

Brazil is one of the world's major producers of cassava and the most important one in productivity and industrialization of cassava starch (FAO, 2010). While cassava in other producing countries are harvested between 8 and 12 months of cultivation regardless of the final destination of the root, as a rule, Brazilian cassava grown for the processing industry is harvested between 18 and 24 months after planting (MAP) (Lorenzi, 2003),

Another unique aspect is that the Brazilian cultivation of cassava plant is clearly divided into two sectors, table and industry. Such distinction applies from the variety to the farming techniques. The table varieties have by principle low hydrocyanic acid content in fresh pulp roots. Varieties for industries can be divided into two segments: flour production and starch extraction. Besides root yield, bark color is critical in flour production and thus clear barks are preferred in order to avoid tainting the final product with dark pigments which is a consumption

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disqualification factor. For starch extraction or alcohol production, the factor of primary importance is dry matter (DM) content (Lorenzi, 2003), which has a highcorrelation with starch content (Borges et al., 2002), regardless of bark color, pulp or format.

Oliveira, (2010) commented that the pruning of the shoots of cassava can be incorporated as a seemingly efficient and viable strategy, although its recommendation will require deeper study about the interaction between pruning and environmental conditions.

The effects on the yield components and nutritive value of roots are influenced by pruning data, however the results found in the literature are controversial, and it depends on the phonological stage that plant is pruned (Conceição, 1981; Sagrilo et al., 2003; Aguiar, 2011).

According to Aguiar, (2011) and Andrade et al. (2011), pruning managed after the first physiological rest causes reduction of roots in DM content and in their starch content (Borges et al., 2002).

Considering the possibility of using the root of cassava as a food source for animals of economic interest and starting from its productive and nutritive characteristics, this study was designed to evaluate potential changes to these characteristics in plants pruned at ten different data.

MATERIALS AND METHODS

The experiment was conducted at the Lageado Experimental Farm (22°51' S, 48°26' W, altitude 786 m) owned by UNESP, Botucatu, during the years 2008 to 2010. The local climate is humid with some water deficit in April, July and August (Cunha and Martins, 2009).

The soil of the experimental area is classified as clayey structured distroferic red latosol (Carvalho et al., 1983), and with the following chemical characteristics: pH ($CaCl_2$) = 5, organic matter (dm^{-3}) = 21, P resin ($mg{\cdot}dm^{-3}$) = 15, H + Al ($mmolc{\cdot}dm^{-3}$) = 44 , K ($mmolc{\cdot}dm^{-3}$) = 2.9, Ca ($mmolc{\cdot}dm^{-3}$) = 30, Mg ($mmolc{\cdot}dm^{-3}$) = 13, base saturation = 46, cation exchange capacity = 90 and V% = 52. Between 20 to 40 cm deep the soil showed pH ($CaCl_2$) = 5, organic matter (dm^{-3}) = 16, P resin ($mg\ dm^{-3}$) = 8, H + Al ($mmolc{\cdot}dm^{-3}$) = 38, K ($mmolc{\cdot}dm^{-3}$) = 1.5, Ca ($mmolc{\cdot}dm^{-3}$) = 28, Mg ($mmolc{\cdot}dm^{-3}$) = 14, base saturation = 43, cation exchange capacity = 81 and V% = 53.

The experiment was carried out in a complete randomized block design with 10 treatments and 4 replications. The treatments were composed of 9 different pruning times and one control, without pruning. Plants were pruned monthly from April to December, 2009. The crop was harvested 22 months after planting and the chemical analyzes were performed on the root material sampled at harvest.

Planting was manual with a density of 12,500 plants ha^{-1}. Considering the results of soil chemical analysis and the recommendations of Lorenzi et al. (1996), 200 kg ha^{-1} of NPK 08-28-16 + 0.5 Zn fertilizer were applied at planting. Treatments were set up in plots of 48 plants, 4 rows of 12 plants each. The useful plots consisted of the 20 plants in the two central lines of each plot. On 24 September, 2008, 0.20 m long IAC-14 cassavas were planted. Roots were harvested between 21 and 29 July, 2010.

Plants were pruned to 0.10 m at the previously defined times and at harvest. Root fresh weight was determined immediately after the harvest of each plot. Ten roots were randomly picked from each plot and then mechanically chopped to pieces. A sample of approximately 400 g was taken from each treatment and dried in an oven with forced air circulation at 60°C until attaining constant weight. Root DM yield in t ha^{-1} was computed from the root DM and fresh matter yield of each plot.

Computation of the total DM yield in t ha^{-1} was performed from the DM and the total yield of fresh root in each plot.

Root samples underwent chemical parameter analysis. DM, starch (Instituto Adolfo Lutz, 1985), total sugars (TS), ash (AOAC, 1984) and crude protein (CP) (AOAC, 1984) were analyzed at the Chemical Analysis Laboratory of the *Centro de Raízes e Amidos Tropicais* – CERAT, FCA, UNESP, Botucatu. Ether extract (EE) (Van Soest, 1991), crude fiber (CF) (AOAC, 1990), neutral detergent fiber (NDF) and acid detergent fiber (ADF) (Van Soest, 1991) analysis were carried out at the Laboratory Of Food Science of the *Faculdade de Medicina Veterinária e Zootecnia*, UNESP, Botucatu. The percentage of total digestible nutrients (TDN) was calculated using the methodology proposed by Kearl (1982): %TDN = 40.2625 + 0.1969 + 1.1903 × EE-0.1379 × CF.

The nitrogen-free extract percentage (NFE) was calculated according to Winton and Winton (1947): %NFE = 100 − (CP + EE + Ash + CF).

Data were subjected to analysis of variance and means were separated using Tukey's test at the 0.05 probability level.

RESULTS AND DISCUSSION

The DM content (%) of cassava root was affected by pruning time (Table 1). Productivity in tons of fresh matter per hectare was not affected and the experimental mean value was 27.85 t ha^{-1}. Root DM yield had similar results to those of DM content in each treatment.

Andrade et al. (2011) found no difference in DM yield of roots of cassava plants pruned at different dates however, the no pruning treatment showed lower productivity when compared with the pruning ones, in his experiment pruning started at 8 MAP and was repeated every month up to 20 MAP. In a similar study Oliveira, (2010) found differences in root yield between treatments pruned and without pruning, and Sagrilo et al. (2003) found a cubic effect on the DM concentration of IAC-14 cassava roots, pruned monthly from 12 to 21 MAP.

The reduction in root mass is due to the cassava plant consuming the reserves stored in the tuberous roots for overcoming vegetative buds dormancy and for leaf growth, always when the plant has environment conditions to develop (Andrade et al., 2011; Oliveira et al., 2010). This explains the fact that when pruning is done at 7, 8 and 9 MAP a lower percentage of dry roots results as well as pruning done farther from harvest having higher percentages of DM and yield. Pruning at 12, 13 and 15 MAP resulted in lower productivity due to total restructuring of shoots in the second growth stage, associated with the occurrence of rain and temperatures adequate for vegetative growth (Sagrilo et al., 2003; El-Sharkawy, 1990).

Unlike the other pruning times, effects of pruning were detected in the cassava root starch contents (Table 2). The lowest cassava root starch content (71.06%) was recorded when the shoot was pruned in June, that is, 9 MAP.

Table 1. Content (%) and yield on fresh and dry basis (t ha^{-1}) of cassava roots harvested 22 MAP from plants pruned at different dates.

Pruning dates	MAP	Fresh matter	Dry matter	Dry mass
		t ha^{-1}	%	t DM ha^{-1}
Apr/09	7	26.98[a]	39.94[ab]	10.82[ab]
May/09	8	30.43[a]	42.80[a]	13.03[a]
Jun/09	9	30.59[a]	40.93[a]	12.52[ab]
Jul/09	10	31.78[a]	41.42[a]	13.17[a]
Aug/09	11	27.95[a]	40.86[ab]	11.48[ab]
Sep/09	12	24.15[a]	39.50[ab]	9.54[ab]
Oct/09	13	24.71[a]	35.01[b]	8.74[b]
Nov/09	14	27.21[a]	37.11[ab]	10.10[ab]
Dec/09	15	24.61[a]	37.60[ab]	9.28[ab]
No pruning	-	30.12[a]	41.39[a]	12.48[ab]
Average		27.85	39.66	11.12
CV (%)		12.65	6.12	15.42
MSD		8.57	5.91	4.17

Different letters in columns differ by Turkey test (0.05), CV - coefficient of variation, MSD - minimum significant difference.

Table 2. Content (%) and yield in dry matter (t ha^{-1}) of starch from cassava roots harvested 22 MAP from plants pruned at different times of the year.

Treatment	MAP	Starch	Production of starch
		% DM	t ha^{-1}
Apr/09	7	87.53[a]	9.53[a]
May/09	8	82.88[a]	10.77[a]
Jun/09	9	71.06[b]	8.88[a]
Jul/09	10	90.61[a]	11.94[a]
Aug/09	11	88.07[a]	10.21[a]
Sep/09	12	79.54[a]	7.63[a]
Oct/09	13	87.39[a]	7.71[a]
Nov/09	14	90.00[a]	9.09[a]
Dec/09	15	90.45[a]	8.42[a]
No pruning	-	90.88[a]	11.32[a]
Average		85.84	9.55
CV (%)		7.50	18.81
MSD		15.66	4.37

Different letters in the columns differ by Turkey test (0.05), CV - coefficient of variation, MSD - minimum significant difference.

Marques et al. (2000), in a study on the replacement of corn by cassava root and other types of food found 82.5% starch in DM, but just as Michelan et al. (2007), who observed 55.35% starch in DM, those authors did not specify the range studied. The IAC-14 variety was selected because of its greater percentage and yield of starch in roots which makes it more suitable to industrial uses. Sagrilo et al. (2003) found effects of pruning time and root DM starch contents varying from 56 to 75% for the IAC-14 variety. Plants pruned between 14 and 18 MAP had lower means when compared to plants pruned from 21 to 22 MAP which was explained by the fact that the demand for carbohydrates accumulated in the roots is outweighted by its photosynthesis production.

There were no differences in the percentage of ash in root's DM. The coefficient of variation was 15.77% and the least significant difference 2.38. The average root ash content was 6.21%.

The content of EE in the roots was not affected by the pruning times of treatments and showed a mean value of

Table 3. Content (%) of crude fiber (CF), neutral detergent fiber (NDF), acid detergent fiber (ADF) and total digestible nutrients (TDN) of cassava roots harvested 22 MAP from plants pruned at different dates.

Treatment	MAP	CF	NDF	ADF	TDN
		% DM			
Apr/09	7	1.64^{d}	3.18^{c}	2.25^{cde}	79.51^{a}
May/09	8	2.14^{bc}	3.71^{bc}	2.58^{bc}	79.37^{a}
Jun/09	9	1.71^{cd}	3.51^{c}	2.06^{de}	79.22^{a}
Jul/09	10	1.80^{cd}	3.34^{c}	2.17^{cde}	79.19^{a}
Aug/09	11	1.85^{cd}	3.79^{bc}	2.22^{cde}	78.98^{a}
Sep/09	12	2.75^{a}	4.92^{ab}	3.31^{a}	78.97^{a}
Oct/09	13	2.14^{bc}	3.91^{abc}	2.58^{bc}	78.91^{a}
Nov/09	14	1.50^{d}	3.04^{c}	1.81^{e}	78.77^{a}
Dec/09	15	2.50^{ab}	5.13^{a}	2.90^{ab}	78.60^{a}
No pruning	-	2.10^{bc}	3.73^{bc}	2.53^{bcd}	78.57^{a}
Average		2.01	3.83	2.44	79.01
CV (%)		8.73	13.65	8.10	0.75
MSD		0.42	1.27	0.48	1.44

Different letters in the columns differ by Turkey test (0.05), CV - coefficient of variation, MSD - minimum significant difference.

0.80% of EE. Azevedo et al. (2011) in a study of the use of co-products in ruminant feed, found 0.59% EE in cassava bark, above the ones found in a study by Olafadehan (2011) who working with rabbits detected 0.14% EE in unprocessed cassava barks.

The low content of EE may be related to the root's chemical composition and to the extraction method. Besides lipids, other compounds such as waxes, carotenoids, chlorophyll and vitamins A and D are measured when petroleum ether is used. It is well known (Valdivié and Bicudo, 2011) that cassava root is deficient in those components.

Treatments affected the CF content of cassava root (Table 3). The highest value of CF was obtained when the shoot was pruned at 12 and 15 MAP (2.75 and 2.5%), respectively, which corresponded to the months of September and December. Also, the least means were obtained for pruning at 7, 9, 10, 11 and 14 MAP. Intermediate values were observed for the remaining months.

In an experiment carried out in Egypt, Abd El-Baki et al. (1993) found higher values of CF in cassava roots for the feeding of rabbits, averaging 3.97% of DM. Gil and Buitrago (2002), in a chapter on the use of cassava in animal feed, cite that Buitrago (1990) used as recommendation 2.8% of CF in cassava roots DM and that in the Netherlands van Poppel (personal communication) has found higher values, 4.10% CF in DM, and that analyzes made at CIAT revealed 3.08% of CF in cassava root DM. The values obtained by this work are lower than those found in literature; however, none of those studies reported either the variety employed or the harvest period.

The difference with respect to CF may be related to the bark ratio of cassava roots. This element is richer in fibers than the root pulp (Valdivié and Bicudo, 2011) and the treatment applied may have influenced the amount of bark.

The content (%) of NDF was affected by the treatments applied (Table 3), the average value being highest (5.13% NDF in DM) when the aerial part of the cassava plant was pruned 15 MAP, which corresponds to the month of December. Similar figures were found for September and October. Valdivié and Bicudo, (2011) reported that the average value of NDF in cassava roots is 5.1% for the fresh base and 2.1% for the dry one. Zeoula et al. (2003), in an experiment where corn for ruminants was replaced by alternate energy sources including cassava, found an NDF value of 8.12% of DM. Works on the inclusion of cassava root in animal feed use cassava root meal as a replacement for maize; these works found higher NDF values. Zeoula et al. (2003) reported that the value of NDF from cassava root meal for the experiment with sheep was 12.31% in DM; Caldas Neto et al. (2007) found 11.1% NDF when composing diets for growing steers and Abrahão et al. (2005) for cassava residue, which the author believe to be the mass resulting from the industrial starch removal, found 30.50% NDF in DM, a value almost three times greater than the one for cassava root meal and 8 times as high as the one for whole cassava root. Perhaps such difference can be explained by the industrial extraction of starch causing fiber concentration in the resulting slurry.

Pruning time affects the ADF content in DM (Table 3). Plants whose shoots were removed from 12 to 15 MAP yield more detergent acid fibers in roots. Pruning in November, 2 months later, leads to a lower average of 1.82%.

Table 4. Content (%) on dry basis (t ha^{-1}) of nitrogen free extract (NFE) of cassava roots harvested 22 MAP from plants pruned at different dates.

Treatment	MAP	NFE
		% DM
Apr/09	7	90.31^{ab}
May/09	8	89.03^{abc}
Jun/09	9	90.43^{ab}
Jul/09	10	90.06^{ab}
Aug/09	11	90.74^{the}
Sep/09	12	88.11^{bc}
Oct/09	13	88.92^{abc}
Nov/09	14	89.11^{abc}
Dec/09	15	87.35^{c}
No pruning	-	88.41^{abc}
Average		89.25
CV (%)		1.17
MSD		2.54

Different letters in the columns differ by Tukey test (0.05), CV - coefficient of variation, MSD - minimum significant difference.

Michelan et al. (2007) found an average of 8.57% ADF in whole cassava root scraps for feeding rabbits between weaning and slaughter. Abrahão et al. (2005) found 22.66% ADF in DM of cassava residues. In neither article the authors have specified the variety or the harvest time. The difference in ADF can also be explained by the amount of bark since the root pulp is not rich in ADF constituents (cellulose, lignin and silica).

There was no difference in the content (%) of TDN among treatments which showed average of 79.01% with a 0.75% coefficient of variation.

Regarding cassava root meal, Caldas Neto et al. (2007) and Ferreira Filho et al. (2007) reported values of 80 and 90.40% TDN in DM, respectively.

Root CP content (% DM) did not differ among treatments. DM content found in roots of the plants pruned at different times of the year as well as on those left without pruning averaged 1.72% for a 14.24% coefficient of variation.

According to Valdivié and Bicudo, (2011), in general cassava root has 1.1% CP in DM and 2.40 to 3.19% in fresh matter. Several balanced experimental diets from root, CP figures even though the cassava root is poor in that. Evaluating feed for ruminants, Caldas Neto et al. (2007) found 1.9% CP in DM of cassava root meal, while Ferreira Filho et al. (2007) and Jorge et al. (2002) found 1.62 and 1.8%, respectively. Abd El-Baki et al. (1993) found an average of 5.15% of whole cassava root, while for mashed whole cassava root Cruz et al. (2006) found 2.43%. Abrahão et al. (2005) studying cassava for feeding of young bulls obtained 1.92% CP. The bark of the cassava root, according to Faria et al. (2011), contains 3.94 and 4.38% CP, respectively for dry and fresh matter.

Once the roots are processed into pellets or chips, CP value reaches 2.5% on average (Garcia and Dale, 1999). It is observed that CP content is reduced in the grinding of cassava flour (Caldas Neto et al., 2007; Ferreira Filho et al., 2007; Jorge et al., 2002) higher values being found only in the root bark (Faria et al., 2011) and intermediate ones in whole dry root, ground or not.

The treatments caused differences in NFE values (Table 4). The treatment with pruning in August, 11 MAP, obtained the highest value, 90.74%, not much different from values for 7, 8, 9, 10, 13, 14 and 22 MAP. Root NFE (% DM) values were below those for the other treatments when cassava shoots were pruned at 15 MAP, together with treatments May/2009, Sep/2009, Oct/2009, Nov/2009 and with the no pruning group. Intermediate averages were found for the rest of the treatments.

No differences were observed ($p < 0.05$) in the percentages of root TS. On average IAC-14 cassava roots contained 0.43% of TS in whole roots.

The percentage of root production, relative to the total biomass produced by the plant, shoot plus root, was greater in the absence of pruning where about 54.34% of the total root biomass was relative to the root, that is, in non pruned plants accumulates more in the root, with respect to the total biomass produced. Pruning in other months hardly interfered with the percentage of root production. Pruning before the physiological rest negatively affects the concentration of starch in the root. Although no difference was found in starch yield, probably the plant reorganizing its photosynthetic device after pruning and then having it fresh leaves falling in consequence of the physiological rest causes an energy or starch reserve expenditure higher when compared to treatments that just translocated root assimilates to the post pruning shoot development.

Conclusion

Pruning shoots of IAC-14 variety before the physiological rest affects positively yield and the percentage of root, and do not affect the root starch content.

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Conflict of interest

The author(s) have not declared any conflict of interests.

REFERENCES

Abd El-Baki SM, Nowar MS, Bassuny SM, Hassona E, Soliman ES

(1993). Cassava as new animal feed in Egypt. 3. Pelleted complete cassava feed for growing rabbits. World Rabbit Sci. 1:139-145.

Abrahão JJS, Prado IN, Perotto D, Moletta JL (2005). Características de carcaças e da carne de tourinhos submetidos a dietas com diferentes níveis de substituição do milho por resíduo úmido da extração da fécula de mandioca. Rev. Bras. Zootecn 34:1640-1650. http://dx.doi.org/10.1590/S1516-35982005000500026

Aguiar EB (2011). Estudo da poda da mandioca (*Manihot esculenta* Crantz). Thesis (Doutorado em Agronomia/Agricultura) – Faculdade de Ciêcnias Agrnômicas, Universidade Estadual Paulista, Botucatu. P. 144.

Andrade JS, Viana AES, Cardoso AD, Matsumoto SN, Novaes QS (2011). Épocas de poda em mandioca. Rev. Ciênc. Agron. 42:693-701.

A.O. A. C. (Associaton of Official Analytical Chemists) (1984). Official methods of analysis. 14. ed. Arlington: A.O.A.C. P. 1141.

A.O. A.C. (Associaton of Official Analytical Chemists) (1990). Official Methods of Analysis. 15 ed. Washington D.C. P. 1141.

Azevedo JÁ, Valadares Filho SC, Pina DS, Detmann E, Valadares RFD, Pereira LGR, Souza NKP, Silva LFC (2011). Consumo, digestibilidade total, produção de proteína microbiana e balanço de nitrogênio em dietas para ruminantes de subprodutos. Arqui. Bras. Med. Vet. Zootecn. 63:114-123. http://dx.doi.org/10.1590/S0102-09352011000100018

Borges MF, Fukuda WMG, Rosetti AG (2002). Avaliação de variedades de mandioca. Pesqui. Agropecu. Bras. 37:1559-1565. http://dx.doi.org/10.1590/S0100-204X2002001100006

Buitrago JA (1990). La yuca en la alimentación animal. Centro Internacional de Agricultura Tropical (CIAT). Cali. P. 446.

Caldas Neto SF, Zeoula LM, Prado IN, Branco AF, Kazama R, Geron LJV, Maeda EM, Fereli F (2007). Proteína degradável no rúmen associada a fontes de amido de alta ou baixa degradabilidade : digestibilidade in vitro e desempenho de novilhos em crescimento. Rev. Bras. Zootecn. 36:452-460. http://dx.doi.org/10.1590/S1516-35982007000200024

Carvalho WA, Espíndola CR, Paccola AA (1983). Levantamento de solos da Fazenda Lageado - Estação Experimental "Presidente Médici". Botucatu: Faculdade de Ciências Agronômicas, Universidade Estadual Paulista. P. 95.

Conceição AJ (1981). A mandioca. São Paulo: Nobel. P. 382.

Cruz FGG, Pereira Filho M, Chaves FAL (2006). Efeito da substituição do milho pela farinha da apara de mandioca em rações para poedeiras comerciais. Rev. Bras. Zootecn. 35:2303-2308. http://dx.doi.org/10.1590/S1516-35982006000800015

Cunha AR, Martins D (2009). Classificação climática para os municípios de Botucatu e São Manuel, SP. Irriga, 14:1-11.

El-Sharkawy MA (1990). Effect of humidity and wind on leaf conductance of field grown cassava. Rev. Bras. Fisiol. Veg. 2:17-22.

FAO (2010). Statistical databases: Faostat. Available at <http://www.fao.org>. Acess in: Dec./10/2012.

Faria PB, Silva JN, Rodrigues AQ, Teixeira PD, Melo LQ, Costa SF, Rocha MFM, Pereira AA (2011). Processamento da casca de mandioca na alimentação de ovinos: desempenho, características de carcaça, morfologia ruminal e eficiência econômica. Rev. Bras. Zootecn. 40:2929-2937.

Ferreira Filho JR, Mattos PLP, Silva J (2007). Produção de biomassa de mandioca. Rev. Raízes Amidos Tropic. 3: não paginado.

Garcia M, Dale N (1999). Cassava root meal for poultry. J. Appl. Poult. Sci. 8:132-137. – ver se vai apagar do texto.

Gil JLL, Buitrago JAA (2002). La yuca en la alimentación animal. In: OSPINA, I. A. B; CABALLOS, H. La Yuca del tercer milenio, pp. 527-569.

Instituto Adolfo Lutz (1985). Normas analíticas do Instituto Adolfo Lutz. P. 533.

Jorge JRV, Zeoula LM, Prado IN, Geron LJV (2002). Substituição do Milho pela Farinha de Varredura (*Manihot esculenta*, Crantz) na Ração de bezerros holandezes. 2. Digestibilidade e valor energético. Rev. Bras. Zootecn. 31:205-212. http://dx.doi.org/10.1590/S1516-35982002000100023
http://dx.doi.org/10.1590/S1516-35982002000100022

Kearl LC (1982). Nutrient requirement of ruminants in developing countries. International Feedstuffs Institute. P. 381.

Lorenzi JO, Monteiro DA, Pereira AS, Igue T(1996). Avaliação de variedades de mandioca no estado de São Pulo. Bragantia 42:79-89. http://dx.doi.org/10.1590/S0006-87051983000100008

Lorenzi JO (2003). Mandioca. São Paulo, Brazil: Nobel. P. 166.

Marques JA, Prado IN, Zeoula LM, Alcalde CR, Nascimento WG (2000). Avaliação da mandioca e seus resíduos industriais em substituição ao milho. Rev. Bras. Zootecn. 29:1528-1536. http://dx.doi.org/10.1590/S1516-35982000000500035

Michelan AC, Scapinello C, Furlan AC, Martins EN, Faria HG, Andreazzi MA (2007). Utilização da raspa integral de mandioca na alimentação de coelhos. Rev. Bras. Zootecn. 36:1347-1353. http://dx.doi.org/10.1590/S1516-35982007000600017

Olafadehan OA (2011). Haematological parameters, serum constituents and organ development of growing rabbits as affected by feeding of processed cassava peel. Anim. Nutr. Feed Technol. 11:41–51.

Oliveira SP (2010). Efeito da poda e de épocas de colheita sobre características agronômicas da mandioca. Acta Sci. 32:99-108.

Sagrilo E, Vidigal Filho Os, Pequeno MG, Scapim CA, Vidigal MCG, Diniz SPSS, Modesto EC, Kvutschal MV (2003). Effect of Harvest Period on the Quality of storage roots and protein content of the leaves in five cassava cultivars (*Manihot esculenta* Crantz). Braz. Arch. Biol. Technol. 46:295-305. http://dx.doi.org/10.1590/S1516-89132003000200022

Valdivié MIN, Bicudo SJ (2011).Alimentação de animais monogástricos: mandioca e outros alimentos não-convencionais. Botucatu, Brasil. FEPAF, pP.1-18.

Van Soest PJ, Robertson JB, Lewis BA (1991). Methods for extraction fiber, neutral detergent fiber and nonstarch polysaccarides in relation to animal nutrition. J. Dairy Sci. 74:3583-3597. http://dx.doi.org/10.3168/jds.S0022-0302(91)78551-2

Zeoula LM, Caldas Neto SF, Geron LJV, Maeda EM, Prado IN, Dian PHM, Jorge JRV, Marques JA (2003) Substituição do milho pela farinha de varredura de mandioca (*Manihot esculenta* Crantz) em rações de ovinos : consumo, digestibilidade, balanços de nitrogênio e energia e parâmetros ruminais Rev. Bras. Zootecn 32:491-502.