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Physical and Chemical Treatment of Sugarcane Waste for Use in Animal Diet

Ana Carolina de Souza[1], Olivio Fernandes Galão[2], Daniele Cristina dos Santos Bofo[3]
[1,2]*Department of Chemistry, University Center Votuporanga, Votuporanga 15500-006 - SP, Brazil*
[3]*Department of Chemistry, Londrina Estate University.*

Abstract:- It is known that the waste sugarcane is one of most significant solid waste generated by sugarcane agribusiness, due to the quantity generated. In order to identify which treatments of waste, for use in animal diets, existing was performed a bibliographic review of scientific papers. Relevant information has been brought into the possibility of reducing costs for sugarcane mills and consequently reducing the environmental impact with the processing of waste in a byproduct. It can be noticed there is great potential of works and research focused on the sugarcane waste.

Keywords:- Waste. Sugarcane. Lignin. Cellulose.

I. INTRODUCTION

Brazil has excellent conditions for the exploitation of cattle, goats and sheep grazing, however, in certain regions, the difficulty of producing forage in the dry season, has been the main limitation to many producers (SARMENTO et al., 1999). In the tropical regions of Brazil, the seasonal forage production is a concrete fact which has caused huge losses to the national livestock because most producers are not prepared to supplement herd in the period of scarcity of good quality forage. Among the options available at the time, the use of crop residues and agro-industrial by-products have been shown to be interesting and feasible (CANDIDO et al., 1999).

The waste sugarcane has been used as an alternative source to supplement animal for lack of fodder. However, since, like other fibrous foods is composed of cellulose, hemicellulose and lignin, its use has been minimized, because it is considered bulky low-grade (PIRES et al., 2006a). In Brazil, traditionally feedlot diets are balanced with high proportions of bulky due to the high costs of grain and protein concentrates (BULLE et al., 1999). The nutritional value of this lignocellulosic waste is low because the connections which occur between the cell wall cellulose, hemicellulose and lignin. However, there are some practical ways to improve the utilization of waste for animal feed. For this, they use chemical and physical treatments (TEIXEIRA et al., 2007).

The chemical compound must possess certain characteristics that their use can be recommended on a large scale: should promote effective increase in digestibility and / or material consumption, the cost of treatment should be feasible, the chemical must be highly available in the market, the chemical residue in the treated material may not be toxic to the animal, the chemical compound should be required nutrient by the animal or have fertilizer value, the chemical agent must have preservative action in case of preservation of the treated material; should not be toxic nor corrosive to man, and it is desirable that the chemical reaction is fast (SARMENTO et al., 1999).

The physical and chemical treatments used to improve the quality of waste cane sugar, are designed to eliminate or reduce the damaging effects of lignin on degradation of cellulosic compounds by microorganisms in the rumen, promoting the breakdown of complex chemical bonds that component with cellulose and hemicellulose, providing the material theoretically for membership of the microbial population and enzymatic attack fibrolytic (VAN SOEST, 1994).

Among the physical treatments, stand out grinding and heat treatment, and among the chemicals, urea, anhydrous ammonia and sodium hydroxide, alkaline products that normally promote reduction of neutral detergent fiber (NDF), which may positively influence the consumption of dry matter (DM) of food (PIRES et al, 2006a).

However, the use of sodium hydroxide is decreasing by negatively influence mineral balance, increase the passing rate of the cell wall in the rumen and decrease the activity of cellulolytic bacteria, providing decrease in potentially digestible fiber digestion in the rumen (SARMENTO, 1999). According to Teixeira (1990) cited by Sarmento (1999), the use of sodium hydroxide also causes an increase in water intake and, consequently, increased urinary excretion, thus eliminating the excess of sodium ingested, which can result in the accumulation of sodium in the soil.

Anhydrous ammonia has a high nitrogen content (82%) and is typically obtained in the liquid state at high temperatures and pressures. The urea (NH_2CONH_2), which in turn has, on average, 44% nitrogen, is found in solid form and requires the presence of moisture and the enzyme urease in order to produce CO_2 and two NH_3, for each molecule of urea (PIRES et al., 2004).

One effect of the action of ammonia on the unstructured material is the complex formed by fiber components (cellulose, hemicellulose and lignin) providing microorganisms largest area of exposure and thereby increasing the degree of utilization of the different fractions of the fiber (GARCIA & NEIVA, 1994). Another effect is to increase the nitrogen content and thus increases availability for rumen microorganisms (Souza et al. 2001). Rosa (2000) reported that, as the material to be ammoniated usually has a low nitrogen content, which limits the development of microorganisms, the increase in the content of this element after ammoniation, allows more efficient action of the ruminal bacteria on substrate, due to the increase in crude protein synthesized from the addition of non-protein N. The use of urea as a source of ammonia has been studied because of its low cost and easy handling (CANDIDO et al, 1999).

It is proposed by this review, a survey of various forms of treatment of the crushed cane sugar, among other biomass for use in animal diets that have been reported in the literature.

II. BIOMASS TREATED WITH UREA

Carvalho (2006) used four doses of urea, 0, 2.5, 5.0 and 7.5%, for the treatment of waste sugarcane. There was a linear increase in crude protein (CP), with the inclusion of urea doses to waste. The minimum level of PB to promote the proper functioning of the rumen (7.0% CP) was obtained with the addition of 2.62% urea to the value calculated from the linear regression equation. For the levels of neutral detergent fiber (NDF) of waste, there was a linear decrease with increasing doses of urea. NDF found in MS waste were 78.1, 71.3, 64.4 and 57.6%, for the respective doses of 0, 2.5, 5.0 and 7.5% of the additive.

Also according to the Carvalho work (2006), ammoniation decreased waste hemicellulose, at increasing doses of urea. The amounts of acid detergent fiber (ADF) were checked 49.0, 44.4, 39.6 and 34.9%, respectively, for the urea doses 0, 2.5, 5.0 and 7.5%. With the increase of urea, the content of cellulose and lignin decreased. This was possibly by dissolving part of lignin and the disruption of the intermolecular ester bonds between uronic acid hemicellulose and cellulose, during ammoniation (VAN SOEST, 1994). Significant mean increases were observed in vitro digestibility (IVDMD) of treated waste 13.78, 24.20 and 32.42%, respectively, with the application of 2.5, 5.0 and 7.5% urea in compared to untreated waste. According to the authors the increase in IVDMD of forage treated with alkali, usually increase the intake and performance, and can sometimes provide similar results in terms of performance when compared to diets of higher quality. Sarmento (1999) also used to treat urea waste from cane sugar. The results of CP, NDF, hemicellulose and IVDMD were consistent with the results obtained by Carvalho (2006). The treatments FDA, no significant effect was observed for the levels of urea applied. No change of cell wall components such as cellulose and lignin.

Carvalho (2007) added three doses of urea (2.5%, 5.0% and 7.5% based on the dry matter - DM) to waste cane sugar, which promoted increased IVDMD , PB and also the degradation of cell wall constituents. Candido (1999) studied doses of 2, 4, 6 and 8% urea on a dry matter basis. The parameters analyzed were CP, NDF and IVDMD, and the results obtained are in agreement with Carvalho (2006) and Sarmento (1999).

Pires (2006), subjected *Brachiaria brizantha* to different doses (under dry hay) urea at different levels of humidity. Urea was used in the ratios of 3:05 p.100 dry weight of cells bales. Were verified increase in crude protein content of the hay. For variables NDF, ADF, lignin and cellulose found to decrease between the treated and untreated hay. For hemicellulose significant difference was not detected. Values of 34.3 and 43.5 for IVDMD were found in the treatment and control 5 p.100 urea with 30 p. 100 moisture concluding improving the nutritional value of *Brachiaria brizantha* after treatment with urea.

III. BIOMASS TREATED WITH AMMONIA

Pires (2004) treated waste from sugarcane with 4% anhydrous ammonia based on dry matter. For the bin received no treatment, the material appeared almost entirely lost, making it necessary, after 10 months, which is the beginning of the experiment, sugarcane waste acquire again to correspond to the control treatment. The waste silos that received treatment with anhydrous ammonia showed no visible signs of fungus. For silos that received treatment with NH3, observed increased CP and IVDMD, reducing NDF and hemicellulose and minor variations in the values of ADF and cellulose. Based on these results, we can verify the efficiency of NH_3 (dose of 4% DM basis) in the treatment of waste cane sugar.

Gesualdi, (2001) used anhydrous ammonia (1, 2 and 4%) to treat waste from sugarcane. A decrease in NDF, cellulose and hemicellulose both, depending on the treatment with ammonia. The ADF content increased with the treatment of pulp and remained virtually unchanged for the treatment of the tip of cane sugar. Pires (2006b), treated *Brachiaria brizantha* with anhydrous ammonia that was injected into the bales contained in each cell, the amount of 3 dry weight. There was considerable increase in crude protein content and IVDMD of hay. For variables NDF, ADF, hemicellulose, lignin and cellulose was found less variation between the treated and untreated hay.

Rose (1998) evaluated the effects of ammoniated hay *Brachiaria decumbens* adding 2 and 3% anhydrous ammonia based on dry matter. Reduction was observed in the contents of NDF and hemicellulose, due to ammoniation. The treatment did not cause significant changes in the contents of ADF, lignin and cellulose. Ammoniation increased the in vitro digestibility of dry matter.

Treated biomass with calcium oxide

Geron (2010), used the quicklime calcium oxide at a dosage of 0.5% for each 100 kg of waste from sugarcane in *natura* (BIN) diluted in four liters of water to provide the formation of calcium hydroxide.

The dry matter (DM), organic matter (OM), NDF, ADF and mineral matter (MM) showed no changes between the BIN and waste-sugar hydrolyzate (BHI) kept for 28 days. The authors concluded, then, that the processing of sugarcane waste-sugar fresh with lime (CaO) for making pulp from sugarcane hydrolyzate does not change the contents of dry matter, organic matter, neutral detergent fiber and acid detergent fiber and mineral matter in relation to the original raw material (waste sugarcane in *natura*) during the retention period of 28 days. So the crushed sugarcane can be kept fresh for 28 days without the use of lime. Carvalho (2009), also tested calcium oxide to treat waste from sugarcane. The experiment was conducted with four doses of calcium oxide, 0, 1.25, 2.5 or 3.75%, based on dry matter. The crude protein and lignin from sugarcane waste were not affected by the addition of calcium oxide. As for NDF, ADF and cellulose contents decreased linearly as increased doses of calcium oxide in waste cane sugar. Murta (2009) hydrolyzed waste from sugarcane with doses of 0.75, 1.5 and 2.25% CaO. The percentage of dry matter and crude protein remained virtually unchanged and the NDF, ADF, lignin and cellulose decreased with the addition of sodium oxide, the latter two being less significant.

According Balieiro Neto (2007) the use of CaO as an additive promoted reduction in fiber content and increased digestibility. According to the authors the additive level of 1% was able to increase digestibility, reduce cell wall constituents, maintaining NDF and hemicellulose after opening the silo and promote greater stability of the chemical composition and better silage quality.

Ribeiro (2009), studied three doses of CaO (0.75, 1.5 and 2.25%) based on natural raw cane sugar. The doses of calcium oxide caused a linear increase in dry matter digestibility of cane sugar and decrease of NDF, ADF, hemicellulose, cellulose and lignin.

Treated biomass with sodium hydroxide

Sarmento (1999) cited by Pires (2006a) have reported that increasing IVDMD material is treated with alkaline result of the partial solubilization of hemicellulose and cellulose of the expansion, which facilitates the attack the cell wall of microorganisms such material. Hydrolytic alkaline reagents such as sodium hydroxide cause partial solubilization of hemicellulose and lignin, by acting on the links that connect them, and covalent ester type, which are found in grasses (VAN SOEST, 1994).

Pires (2006a) used three doses (2.5, 5 and 7.5% DM basis) of a solution 2:1 (w:w) water: sodium hydroxide for treatment periods of 1, 3, 5 and 7 days. At work there was no effect of the interaction doses of NaOH × days of treatment for any of the variables studied. No effect was observed for MS according doses of NaOH. No effect of NaOH and doses of treatment days on the CP content, calculated by total nitrogen (TN). However, there was a significant effect of doses of NaOH, while a reduction in NDF, ADF, cellulose, lignin and hemicellulose. Also was no effect of increasing doses of NaOH on IVDMD. Manzano (2000) treated waste from sugarcane with 9% H_2O_2 and 7% NaOH based on dry matter. The treatment of sugarcane waste increased the in vitro digestibility of DM and OM. The NDF content decreased with treatment. This observed variation in the fraction of NDF was due to variation detected for the concentration of hemicellulose, which was significantly lower for the waste. The ADF fraction showed no significant differences between the treated and waste in natura. The waste showed lower values of lignin relative to that shown by BIN.

Ribeiro (2009) dealt with the cane sugar with three doses of NaOH (0.75, 1.5 and 2.25%) based on natural matter. The additive influenced the lignin, which quadractricaly, with a minimum of 0.13% at 1.63% NaOH, while in cane sugar without additive, remained constant (7.1%). Doses of sodium hydroxide caused a linear increase in dry matter digestibility of cane sugar and decrease of NDF, ADF, hemicellulose and cellulose.

IV. BIOMASS STEAM PRESSURE TREATED

In the physical process when submitting the crushed sugarcane vapor pressure occur by the action of water, the swelling of the cell wall matrix. After sudden decompression of the mass of the steam condensate evaporate within the fiber, which cause expansion thereof. The fibers treated in this way are much more porous and susceptible to degradation in the rumen (GUTMANIS, 1987).

Mello Junior (1989) treated waste from sugarcane at a pressure of 17 kg / cm² for 5 minutes at temperature ranging between 200 and 220°C. The protein remained virtually unchanged and no differences were observed between the cellulose sugarcane waste (BIN) and waste (BT). There was a more marked effect of treatment on the content of hemicellulose with a fall of 31.43% to 06.27% of the BIN BT. According to the authors this fact is probably due to the separation of hemicellulose from the lignin chains causing that structural carbohydrate hydrolysis and subsequent increase in soluble carbohydrates. With the reduction in the content of hemicellulose is a proportional reduction in NDF content of 94.82% to 64.92%.

Manzano (2000) conducted treatment with steam under pressure (17 kg/cm2 for 5 min) for waste from cane sugar. There was a small increase in the values of in vitro dry matter digestibility (IVDMD) and in vitro digestibility of organic matter (IVOMD) of BT in relation to the BIN. The CP and cellulose remained unchanged. Observed lower values for the ADF and lignin displayed by BIN. The largest variations were observed for hemicellulose and NDF.

V. BIOMASS TREATED WITH SULPHUR COMPOUNDS

Manzano (2000) treated waste with sulfur compounds, which are (in parentheses concentrations of chemical reagents DM basis sugarcane waste):

1 - Waste *in natura* - BIN
2 - 0,66% Na_2SO_3 (5% Na_2SO_3) solution
3 - 0,53% Na_2S + 0,8% NaOH (4% Na_2S + 6% NaOH) solution
4 - 0,4% Na_2S + 0,6% NaOH (3% Na_2S + 4,5% NaOH) solution
5 - 0,27% Na_2S + 0,4% NaOH (2% Na_2S + 3% NaOH) solution
6 - 0,4% Na_2S + 0,6% NH_4OH (3% Na_2S + 4,5% NH_4OH) solution
7 - 0,66% Na_2SO_3 + 0,33% NH_4OH (5% Na_2SO_3 + 2,5% NH_4OH) solution
8 - 0,66% $NaHSO_3$ + 0,33% NH_4OH (5% $NaHSO_3$ + 2,5% NH_4OH) solution

The values of IVDMD and IVOMD pomace treated were higher than the average of BIN. It is a highlight for the treatment of waste 3 (4.0% + 6.0% NaOH Na_2S) that the OMIVD increased by 129% compared with the BIN. The crude protein, cellulose and FDA showed no statistical differences. The largest variation observed NDF, hemicellulose and lignin were on treatment with 4% 6% NaOH + Na_2S.

Pires (2004) used 2.5% Na_2S and 2.5% Na_2S + 4% NH_3 to treat waste. There was a large loss of material treated only with sulfide. However, the mold material had been removed, providing only that they are no signs of visible fungi. For the silo that received no treatment, the material appeared almost entirely lost. The waste silos that received treatment with anhydrous ammonia showed no visible signs of fungus. It is found that the addition of Na_2S did not change the composition or IVDMD. However, for the treatments in which we used NH_3, reveals increased CP and IVDMD, reducing NDF and hemicellulose and minor variations in the values of ADF and cellulose. Gesualdi (2001) used ammonium sulfate (1, 2 and 4%) to treat waste from cane sugar. There was a decrease in NDF, ADF and hemicellulose waste as a function of treatment with sodium sulfide.

The work of Pires (2003) was the sorghum silage which was treated with 2.5% sodium sulfide. The authors observed the presence of fungi in some parts of the silo after its opening. The sodium sulfide caused no changes in the parameters studied.

VI. COMPARISON BETWEEN TREATMENTS

Analyzing the data items set forth above, were mounted graphics to compare the efficiency of each treatment on biomass for use in animal diets. The articles have shown diverse results according to the treatment period or the content of additives used. Therefore, for assembling the graphs, the results were chosen higher efficiency of treatment.

Percentage reduction of neutral detergent fiber (NDF)

The graph of Figure 1 shows the percentage reduction of NDF after treatment, the biomass treated with various reagents. Most cited articles used as biomass waste from sugarcane, were also cited articles that used the *Brachiaria brizantha* and cane sugar. Pires et al. (2006b) treated the *Brachiaria brizantha* with ammonia; Ribeiro et al. (2009) treated sugarcane with sodium hydroxide and Balieiro Neto (2007) used calcium oxide for treating sugarcane.

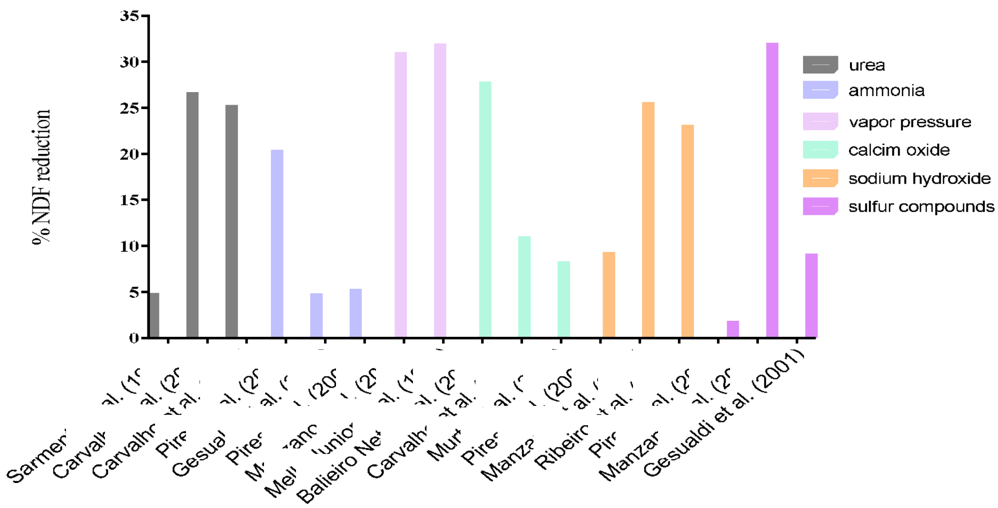

Figure 1. Comparison of percentage reduction of NDF among the articles analyzed

According to the graph in Figure 1 the three best results for reducing NDF biomass was for treatments with sulfur compounds (31.59%) and vapor pressure (31.54 and 30.58%) held by Manzano (2000), and Mello Junior (1989) respectively.

The difference between the results of the articles that used sulfur compounds is due to the fact Manzano (2000) have used the chemical sulphide in alkaline solution (NaOH) with a vapor pressure of 12 kgf/cm2 for 8 minutes and Pires (2004) and Gesualdi (2001) only in aqueous solution. It is concluded that the use of sodium sulphide combined with the compound increases the efficiency of the treatment with respect to the parameter NDF when compared to isolated use of the sulfur compound.

Sarmento (1999) used 10% urea based dry matter and stored in the silo ammoniated by getting 97 days, after this period, a decrease of 4.4% NDF. Carvalho (2006) and Carvalho (2007) added 7.5% urea and achieved a much higher percentage of reduction after 110 days, as shown in Figure 1.

Pires (2004), treated waste from cane sugar with 4% ammonia for 10 months, reducing almost 5 times more NDF content compared with Gesualdi (2001) who used the same percentage of the additive and 30 days storage. Pires (2006b) reported no treatment period.

Among the articles that treated biomass with calcium oxide, Balieiro Neto (2007) was the use of the additive the lowest percentage (2%) and achieved the highest percentage reduction of NDF 27.39% after 84 days of storage. Carvalho (2009) used 3.75% calcium oxide and up to 36 hours of storage, reaching a reduction of 10,58% NDF. Murta (2009) added 2.25% calcium oxide and obtained 7.84% reduction was not mentioned in the article storage.

Manzano (2000) 7% added sodium hydroxide mixed with 9% hydrogen peroxide waste in cane sugar and obtained a reduction percentage of NDF almost three times greater than Pires (2006a), which added 7.5 % sodium hydroxide solution. Ribeiro (2009) dealt with the cane sugar with 2.25% NaOH, based on natural matter and also managed to reduce the NDF almost three times more than Pires (2006a).

Percent reduction of acid detergent fiber (ADF)

Some articles cited in Figure 2 studies conducted with *Brachiaria brizantha*, the cane sugar and the tip of the cane sugar, although the authors of these articles Pires (2006b), Ribeiro (2009), and Gesualdi (2001). Since Gesualdi (2001) used the tip of the cane sugar to treatment with ammonia, already on treatment with sulfur compounds was used waste from cane sugar. Balieiro Neto (2007) also used the cane sugar in the studies. All other articles analyzed used only waste from cane sugar to the research.

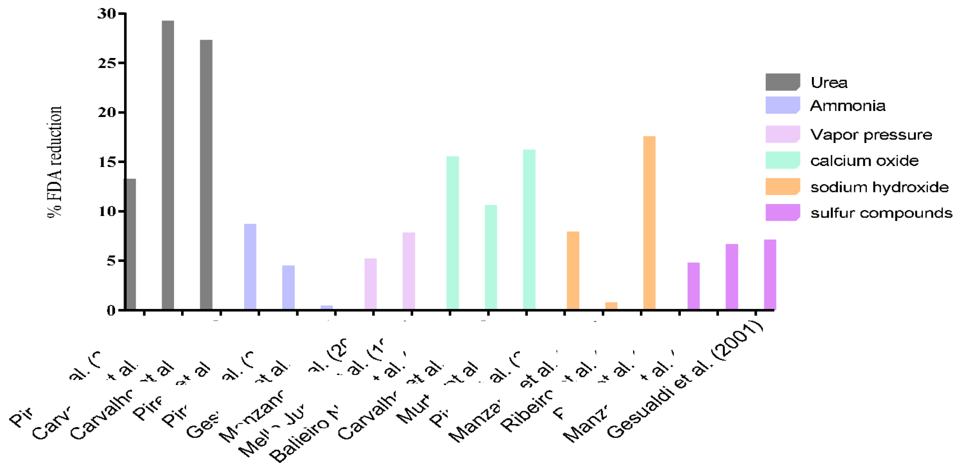

Figure 2. Comparison of percentage reduction between the FDA analyzed articles

According to the graph in Figure 2 the best results obtained for reduction of biomass was FDA for the treatment of waste cane sugar using urea as an additive, 28.83% and 26.89%, made by Oak (2006) and Carvalho (2007) respectively. Pires (2006b) added 3% urea in Brachiaria hay and got half the percentage reduction compared with FDA Carvalho (2006) and Carvalho (2007), which added 7.5% urea waste in cane sugar

Pires (2004) treated waste from cane sugar with 4% ammonia for a period of 10 months, getting double reduction when compared to FDA Pires (2006b) using 3% ammonia to treat hay *Brachiaria*. Pires (2006b) did not mention in the article the treatment period waste. The percentage reduction FDA tip sugarcane, when Gesualdi (2001) treated with 4% ammonia for 30 days was not significant (0.04%).

Manzano (2000) and Mello Junior (1989) treated waste from sugarcane with a vapor pressure under the same conditions (17 Kg/cm2 for 5min) and obtained results similar reduction FDA, 4.78 and 7.42 %, respectively.

Pires (2006a) treated waste from sugarcane with 7.5% sodium hydroxide and obtained a reduction of 7.51% of FDA. Ribeiro et al. (2009) added in 2.25% NaOH cane sugar and managed twice the reduction FDA, as shown in Figure 2. Manzano et al. (2000) did not achieve significant results for this parameter using sodium hydroxide

The articles referred to the treatment of the crushed cane sugar with sulfur compounds had similar outcomes, to reduce FDA. Likewise, Balieiro Neto (2007) and Murta (2009) who treated biomass with calcium oxide reduction achieved similar results, 15.12 and 15.79% respectively. Carvalho (2009) used 3.75% of CaO and obtained a result somewhat smaller than the latter two authors (10.22%).

Percent reduction of the hemicellulose

The graph of Figure 3 shows the percentage reduction of hemicellulose, after treatment, the biomass treated with various reagents. Pires (2006b) used for the treatment Brachiaria brizantha, Ribeiro (2009) and Balieiro Neto 2007) to cane sugar.

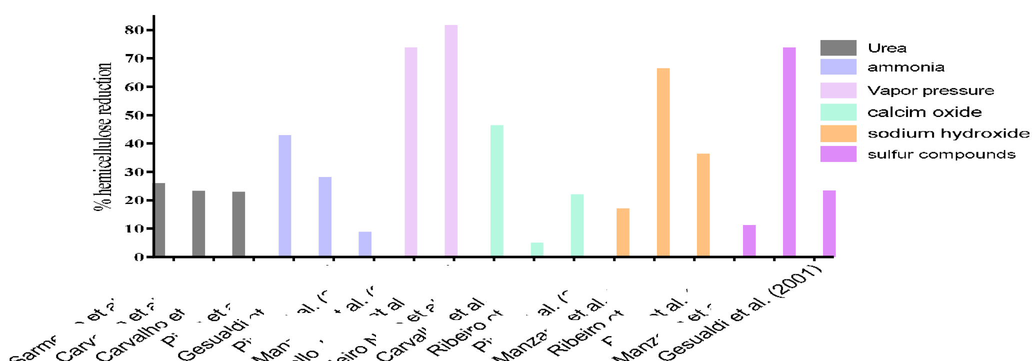

Figura 1. Comparação da porcentagem de redução da hemicelulose entre os artigos analisados

The graph in Figure 3 shows that the best results obtained for reduction of biomass hemicellulose was for treatments of waste sugar-pressure steam (72.35 and 80.25%) and sulfur compounds (72.35 %) carried out by Manzano (2000), and Mello Jr. (1989). compounds used. And Manzano (2000) utilized a 4% Na 2 S diluted in a solution containing 6% NaOH and steam pressure of 12 kgf/cm2 for 8 minutes. Pires (2004) and Gesualdi (2001) used the sulfur compound in aqueous solution. As the parameter for NDF, the use of sodium sulphide combined with the compound increases the efficiency of treatment for hemicellulose as compared to using the sulfur-containing compound alone.

Manzano (2000) treated waste from cane sugar with 7% sodium hydroxide combined with 9% hydrogen peroxide achieving a reduction of hemicellulose four times Pires et al. (2006a) using 7.5% sodium hydroxide in aqueous solution. Ribeiro (2009) treated sugarcane with 2.25% NaOH and succeeded in reducing the hemicellulose content of more than twice Pires e (2006a).

For treatment with calcium oxide factor determining the difference between the papers was probably the treatment time. Balieiro Neto (2007) stored silage of cane sugar for 84 days. The reduction of 44.9% was achieved after nine days of the silo opening. The other two articles cited stored biomass treated for a maximum of 36 hours.

The percentage reduction of the hemicellulose sugarcane tip when Gesualdi (2001) treated with 4% ammonia for 30 days was almost half that achieved by Pires (2004) who treated waste from cane sugar with 4% ammonia for a period of 10 months. Pires (2006b) used 3% ammonia to treat hay *Brachiaria*, not being mentioned in the article, the period of treatment. The percentage of reduction was 7.37%.

Sarmento (1999), Carvalho (2006) and Carvalho (2007) treated waste from cane sugar with 10 and 7.5% urea and obtained results similar reduction of hemicellulose, 24.4, 21.8 and 2149% respectively.

Percent reduction in lignin

The graph in Figure 4 shows the percentage of reducing lignin after treatment, the biomass treated with various reagents. Pires (2006b) used for the treatment Brachiaria Brizantha, Rose (1998) used the *B. decumbens* hay, Ribeiro (2009) and Balieiro Neto (2007), cane sugar and Pires (2003) treated sorghum silage. All other authors cited in Figure 4 used the forage waste from sugarcane.

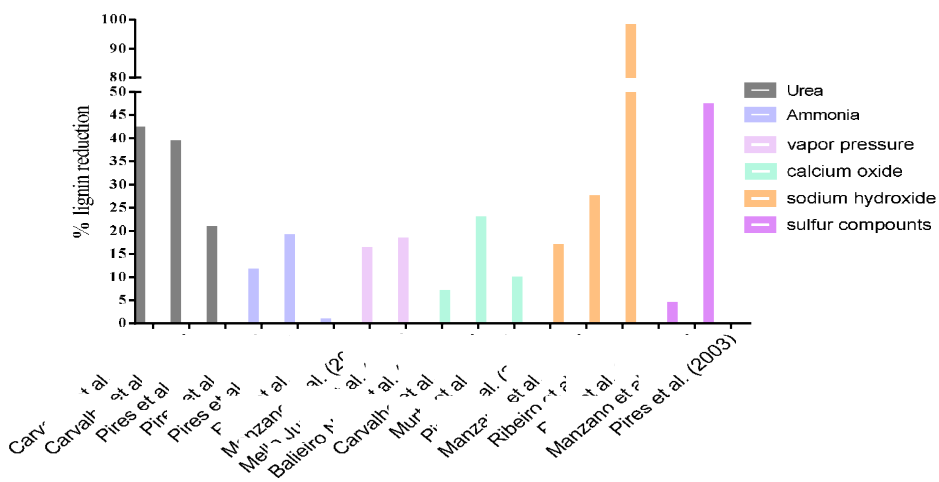

Figure 4. Comparison of percentage reduction of lignin between the analyzed articles

The graph in Figure 4 shows that the best results for reducing the lignin present in the biomass was in the treatment with sodium hydroxide (97.47%) and sulfur compounds (46.82%) held by Ribeiro (2009) Manzano (2000), respectively.

There is a big difference between the results of the articles that used sulfur compounds. Manzano (2000) utilized a 4% Na_2S diluted in a solution containing 6% NaOH with a vapor pressure of 12 kgf/cm2 for 8 minutes. Pires (2004) 2% Na2S used in combination with 4% NH3. Pires (2003) added only 2.5% Na_2S and not obtained a reduction of lignin. It can be concluded that the combination of sodium hydroxide and sulfur-containing compound in vapor pressure increases the treatment efficiency for the reduction of lignin when compared to use of the sulfur compound alone.

Ribeiro (2009) shows that sugarcane treated with 1.5% NaOH for 24 hours and were able to reduce the lignin content of 97.47%. Manzano (2000) treated waste from cane sugar with 7% sodium hydroxide combined with 9% hydrogen peroxide reducing the lignin content in 26.98%. Pires (2006a) used 7.5% sodium hydroxide aqueous solution and obtained a reduction of 16.47% lignin.

Manzano (2000) and Mello Junior (1989) treated waste from sugarcane vapor pressure and obtained results similar reduction of lignin, 15.87% and 17.86% respectively.

Pires (2004) treated waste from cane sugar with 4% ammonia and achieved a reduction percentage of lignin slightly smaller than Pires (2006b) who used 3% ammonia to treat hay *Brachiaria*. Rose (1998) used the same percentage that Pires (2006b) but could not meaningful result for this parameter.

Balieiro Neto (2007) added 2% CaO and stored ensiling of sugarcane Carvalho (2006) added 7.5% urea waste in cane sugar and kept stored for 110 days, thus successfully reduce lignin content in 41.77%, double Pires (2006b) that added 3% urea in Brachiaria hay. Carvalho. (2007) also added 7.5% urea waste in cane sugar for 110 days, and obtained a similar result de Carvalho (2006).

Balieiro Neto (2007) added 2% CaO and stored ensiling of sugarcane for 84 days and achieved a reduction of 6.56% lignin. Carvalho (2009) treated waste from sugarcane with 1.25% CaO by at most 36 hours, and reduced lignin content in 22.37%. Murta (2009) added 2.5% additive and no mention of the treatment period, the lignin content is reduced by 9.4%.

Percentage increase in vitro digestibility (IVDMD)

The graph in Figure 5 shows the percentage increase IVDMD after treatment, the biomass treated with various reagents. Pires et al. (2006b) used in the research *Brachiaria brizantha*, Rose et al. (1998) used the *B. decumbens* hay, Ribeiro et al. (2009) and Balieiro Neto (2007) treated the cane sugar and Souza (2001) used coffee pods. The other The other authors mentioned used waste from sugarcane as forage.

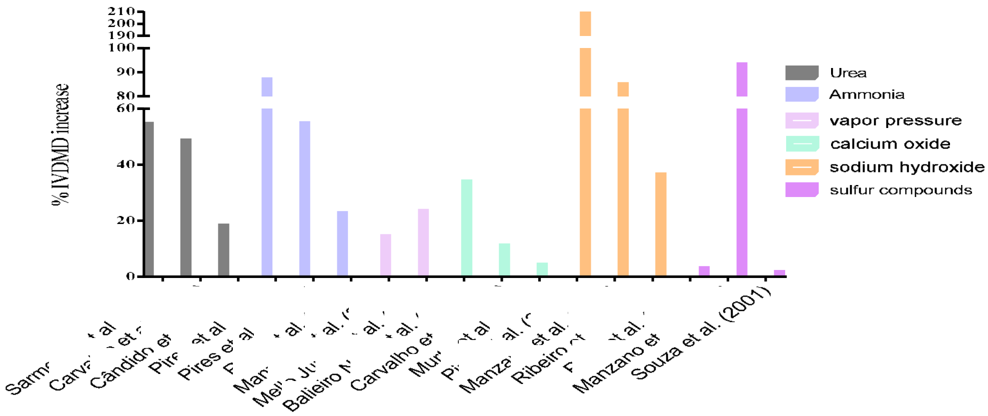

Figure 5. Comparison of the percentage increase in IVDMD between the analyzed articles

The graph in Figure 5 shows that Pires (2006a) obtained the best results in vitro digestibility (209.3%). Pires (2004) and Manzano (2000) also achieved good results IVDMD. Among the items cited for the treatment of biomass with sulfur compounds Manzano (2000) achieved the highest percentage of IVDMD. As for the other parameters mentioned above, Manzano (2000) achieved good results by having used the compound sulphide in alkaline solution (NaOH) under steam pressure.

According to Pires (2006a) showed a quadratic effect of increasing doses of NaOH on IVDMD. The author has managed an increase of over 200% for this parameter. Manzano (2000) by adding 7% of sodium mixed with 9% hydrogen peroxide and IVDMD increased more than twice Ribeiro (2009) which added 7.5% sodium hydroxide. Sarmento (1999), treated waste from cane sugar for 97 days with 10% urea based on dry matter obtained after this period, an increase of 53.99% IVDMD. Carvalho (2006), added 7.5% urea and achieved an increase in digestibility of 47.98% after 110 days of storage. Candido (1999) obtained a result three times lower than Sarmento (1999) using 8% urea for a period of 42 days.

Pires (2004) treated waste from cane sugar with 4% ammonia for 10 months, increasing four times more digestibility compared to Rose (1998) using 3% additive and 45 days of storage. Pires (2006b) is also added 3% of ammonia, but does not mention the treatment period, reaching more than double the increase IVDMD compared with the result of Rose (1998).

Balieiro Neto (2007) used 2% of calcium oxide and achieved the greatest percentage increase in VDMD (33.38%) after 84 days of storage compared to Carvalho (2009) who used 3.75% calcium oxide and than 36 ours of storage and Murta (2009) which added 2.25% of calcium oxide and 7.84% increase achieved.

VII. ANIMAL PERFORMANCE

Bulle (2002) tested diets with three levels of sugarcane waste (BIN), (9, 15 and 21% DM) in young bulls by 139 days. Among the three increasing levels of fiber studied was no difference in weight gain. The animals in the treatment of BIN 15% dry matter showed an increase greater (1,36 kg / day) the animals of the treatment BIN 9% (1.20 kg / day). The animals were fed a diet with 15% BIN consumed 7.93 kg DM / day, consuming more than animals treated with 9% of BIN in the dry matter consumed 6.85 kg DM / day. Among the three levels of fiber, feed conversion efficiency was the same of 0.176, 0.172 and 0.169. A greater intake for animals fed diets with higher content of BIN.

Pires (2004), used waste from sugarcane waste in *natura* and treated with sodium sulfide and / or ammonia fed to heifers. It is effective for daily gain and total observing greater gains for treatments with NH_3. The mean values for weight gain in the period were 40.0, 39.0, 58.5, and 57.3 kg and average daily gain, 702, 684, 1026 and 1005 g / head, respectively, for untreated waste was treated with Na2 treated with NH3 and treated with NH_3 over Na_2S. The intake in kg / day was higher for the animals that received waste treated with NH_3 (6.81 kg / day) and treated with NH_3 over Na_2S (6.38 kg / day). DM intake, due to the metabolic weight, depending on body weight were 76.72, 82.46, 100.18, and 97.44 gDM/kg, respectively for control, Na_2S, NH_3 and NH_3 more Na_2S, showing the superiority of the material ammoniated. In turn, feed conversion was not affected by treatments, registering values of 7.26, 7.73, 6.69, and 6.33, respectively, for the treatments witness, Na_2S, NH_3 and NH_3 plus Na_2S.

Pereira(2008), evaluate the effect of the addition of 2, 4 and 6% NaOH weight weight on nutrient digestibility of waste from cane sugar in diets for growing rabbits. It was observed that the addition of NaOH did not significantly affect the coefficient of digestibility (CD) MS waste, ranging from 23 to 28%. Similar behavior was observed for the CD NDF, where the addition of soda was not effective in the process of delignification of waste fiber fraction.

However, significant difference was between the CD Observed from the FDA in the different treatments showing a negative linear response between the concentration of NaOH and the CD's FDA (y = -2.7615 x + 20.042, R2 = 0.984). Thus, the treatment was ineffective and harmful, because with the Increase of the percentage of soda was a worsening in the digestibility of acid detergent fiber.

Murta (2009) evaluated the weight gain and carcass characteristics in sheep feeding treated hydrolyzate of sugarcane waste with increasing levels of CaO (0.75, 1.5 and 2.25%, based on dry matter). Increased linearly in weight gain during the period of confinement (GPP) and average daily gain (ADG), with the use of pre-hydrolysis with CaO in waste cane sugar. There was no effect of treatments for the variables related to carcass characteristics.

Carvalho (2007) noted that treatment of waste sugar-urea causes improvement in ruminal degradation of dry matter, neutral detergent fiber, acid detergent fiber and hemicellulose.

VIII. CONCLUSION

As was observed during the study, several methods of treatment of waste are being studied. However, we can not say which is the best because each has its advantages and disadvantages.

The use of waste treated physically or chemically, for use in animal diets has brought positive results when it comes to consumption and weight gain. The results varied according to the treatment used.

Was possible with the literature, several studies raise the treatment of waste and learn, then the differences, advantages and disadvantages that each case presents.

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