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By-products of sugar cane industry in ruminant nutrition

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ABSTRACT

The diversity of agro-products from sugarcane generates many alternative foods, which can be widely used for animal nutrition. In sugarcane areas, waste from industries can be accumulated in plants with the end of the harvest and have favorable prices, helping to reduce feed cost and increased profitability in ruminant production. The cane sugar is important as forage for ruminants and high forage yield potential of sugar cane in Brazil is due to their large production capacity of dry matter (DM) per hectare and the highest energy content per DM unit. In addition, sugar cane harvesting coincides with the shortage of pastures and by-products are available at critical times of the year. In this article, some information available concerning the by-products of industrialization of sugar cane, as well as the characteristics and nutritional properties of these foods on rumen dynamics and performance of animals was reviewed.

INTRODUCTION

The issue of bioenergy (seeking a source of renewable energy), is a serious issue in Brazil and has led to a big rush to increase ethanol production, which in turn has increased the size of areas planted with sugar cane; thereby leading to the production of more waste from distillation. Within this new scenario, it creates the need for more detailed nutritional information on the use of such waste in ruminant feed (Barros et al., 2009).

To improve animal productivity, it is important to use proper food handling technique (especially in the dry seasons of the year) and adopt intensive systems of exploitation, such as confinement or semi-confinement; making it necessary to rely on food of good nutritional value and low cost. One way to achieve this is the use of agro-products, but most of these foods have not been studied, and their compositions and appropriate concentrations for economic and biological use in animal production are not known. This leads to the need to study the feasibility of inclusion of several alternative food sources and quantify the responses of animal production.

Sugar cane Bagasse

Sugar cane bagasse is the fibrous product resulting from the crushing of cane sugar in the extraction or direct transformation of alcohol. Bulle et al. (2002) emphasized that the use of bagasse from sugar cane in animal feed, on a commercial scale, has been poorly studied, leading to accumulation of large quantities in industry. This creates problems due to the lack of storage space and also reduce consumption by animals, since there may be contamination of the pulp by fungi and bacteria.

According to Pereira et al. (2008), a factor that limits the use of sugarcane bagasse for animal feed is the low digestibility of dry matter, which is usually less than 50%. However, its nutritional use can be sufficiently increased by physical, chemical or enzymatic treatment. The fibers in cane sugar contains about 40% cellulose, 35% hemicellulose and 15% lignin, the latter being responsible

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for their low use in ruminant feed.

According to Sarmento et al. (2001) although the cellulolytic enzymes present in the rumen are able to hydrolyze the cellulose, there is however, great difficulty of access to the same points at which the cellulosic polymer rupture occurs. To improve the nutritional value of sugarcane bagasse in nature, researchers have made efforts to improve its use in animal feed (Torres et al., 2003). Because of the undesirable features present in the bagasse, its use has been improved using chemical, physical or enzymatic treatment.

Torres et al. (2003) pointed out that due to low crude protein content in dry matter, approximately 90% of the nitrogen may be unavailable as it is associated with fiber; and the acid fiber content of bagasse has values between 58 and 62%. This results in lower digestibility (25 to 30%) and makes it a food source with low nutritional value.

Leme et al. (2003) evaluated different levels of inclusion of sugarcane bagasse in nature in diets of beef cattle confined with high levels of concentrate diets. The diets evaluated were formulated with fresh sugar cane bagasse as the only source of roughage, in the values of: 15, 21 and 27%. Leme et al. (2003) did not find out differences in performance between the different levels of inclusion of bagasse, being values of 1.51, 1.49 and 1.38 kg/head/day to the inclusions of 15, 21 and 27% of bagasse in nature.

The effects of adding content growing levels of calcium oxide (0.75, 1.5 and 2.25%) in the crushed cane sugar that were given to the sheep of Santa Inês breed in order to analyzed the weight gain and carcass characteristics, were studied by Murta et al. (2009). The animals received concentrate containing corn, soybean meal and urea, and bagasse with portion of CaO. The slaughter of animals was performed after 67 days of confinement. The authors noted that there was no treatment effect on the average weight of hot carcass, cold carcass, hot carcass produce and cold carcass produce. Person et al. (2009) studied the effect of the combination of cactus to bagasse cane sugar and the urea on nitrogen compounds balance and microbial protein production in dairy heifers supplemented or not. The Nitrogen balance was not influenced by the diets and presented an average of 49.3 g/day. The authors observed that the association of cactus pear to bagasse cane sugar and urea without the use of supplements, allowed microbial efficiency of 105 g CPmic/kg of total digestible nutrient (TDN) consumed. The crushed cane sugar treated by pressure and steam has been used as forage or as one part of the fiber in the diet of ruminants, and when used in diets for feedlot; has provided good performances. However, Pessoa et al. (2009) reported that among the peculiarities of this ingredient, (it can be noted) reduced particles sizes, low stimulation of rumination and the short length of stay of neutral detergent fiber in the rumen can generate metabolic problems and impair animal performance.

Filter cake

The filter cake is a poorly studied potential as forage for ruminants. According to Moreira et al. (2002), there are two types of filter for the extraction of residual sucrose: the press type and rotary vacuum (the most current). Although they are more efficient in the industry, rotary vacuum filters produce material with moisture content lower than 25-30% compared to the press type. In addition, they show higher fiber content (this is because bagasse is added to the rotary vacuum process and its purpose is to act as a porous layer on the surface of the filter.

The filter cakes use in animal feed must be dried in the sun or in special dryers (hot air or steam) until it gets to 12% moisture in order to be kept stored. Rapidly drying it is recommended to prevent fermentation of the filter cake, which usually occurs within 6-12 h after filtering. Almeida et al. (2007) highlighted the drawback of high moisture content and dehydration that requires additional spending that may prevent the use of filter cake (outside the mills), and this makes its use in nature to become feasible. Almeida et al. (2007) also reported that the predominant form of nitrogen in the filter cake is the protein and crude protein which is 9.4, 7.8 and 12.8% for the rotary filter cakes vacuum and 15.5% in pies filter press. They then stated that the digestibility of the protein filter cake is less than 20% and digestibility of dry matter is about 35%.

According to Ramalho and Amaral (2001), the storing of the filter cake must be strictly controlled since this material has a high biochemical oxygen demand that has potentially polluting effect. The filter cake is rich in phosphorus and can have 1 to 2% of the element available. It has high moisture content, organic matter concentration around 50 to 60% and a carbon/nitrogen ratio of 1:20 with high Ca and P and low levels of K. Its production ranges from 20-40 kg per tonne of processed cane.

The lipid fraction of the filter cake is 15% as was previously reported by Almeida et al. (2007). He also reported that this fraction is composed of waxes that involve food particles, reducing their digestibility.

Ramalho and Amaral (2001) report that the high mineral content of filter cake which range between 10 and 30%, interfere with the voluntary intake of food.

In a study to evaluate the digestibility of the filter cake dried in an oven or air, Almeida et al. (2007) found out that the digestibility coefficients of crude protein (CP), crude fibre (CF), ethereal extract (EE), nitrogen free extract (NFE), organic matter and TDN in diets with 48% filter cake were 24.3, 35.5, 26.1, 52.2, 42.8 and 39.64% respectively. In diets with inclusion levels of 38% filter cake, the digestibility coefficients were 33.1, 40.1, 50.6, 56.7, 49.7 and 47.81% for CP, CF, EE, NFE, organic matter and TDN, respectively.

In studies using sheep fed with filter cake at levels of 58 to 95%, Ramalho and Amaral (2001) observed that the higher consumption of protein and dry matter and higher values of digestibility coefficients of these components occurs in diets with smaller percentage of the filter cake. With cattle, Ramalho and Amaral (2001), using diets with 35, 45 and 50% of filter cake; found no significant differences in dry matter intake.

Almeida et al. (2007) observed that weight gains of cattle were significantly lower when fed diets with 30% of filter cake, compared with diets without food. Using increasing levels of the pie, they reported that the consumption of dry matter (kg/day and g/day/$BW^{0,75}$) decreased significantly. Ramalho and Amaral (2001), testing increasing levels of filter cake in diets for cattle, found out that with high grade product, the animals showed higher consumption but lower performance.

The nutritional value of diets with different levels of mixing filter cake with hay Coast Cross (*Cynodon dactylon*) using adult sheep, were evaluated by Almeida et al. (2007). The results showed that the intake of dry matter, crude protein, crude fiber, nitrogen free extract, decreased linearly with increasing percentage of filter cake in the rations. The they then inferred that based on the voluntary intake of dry matter, the filter cake can be used in the maximum proportion of 40% and the digestibility and TDN value showed no significant differences by the use of variable portions of the filter cake rations, probably due to the drop in intake.

Straw and tip of the sugar cane

Cosentino and Souza (2007) emphasized that numerous studies aimed at an alternative use with non-energy purposes of this by-product wasted almost in its totally, because it is still burned. In fact, by-product constitutes the straw itself and the tips of the rods that are cut and left in the plantations denominate various studies.

According to Aguiar et al. (2007), in order to reduce dramatically the ecological effects and economic impacts, the harvest of sugarcane with the total use of straw and tip should be accounted for. With the harvest of sugarcane raw, one more by-product arises and it becomes an important value in reducing costs and utilization of the crop of cane sugar. However, to make possible the harvest of raw sugarcane it is necessary to have equipment capable of performing the operation with a low operating cost and high dairy efficiency.

The material collected after baling and chopping can be used in the composition of the diet of ruminants. However, these crop residues are not properly harnessed, since this material could be used, without doubt, in ruminant feed.

In a study by Cosentino and Souza (2007) the widespread practice of burning cane fields before harvest, can affect the nutritional value of the tip of cane for ruminants. Cosentino and Souza (2007) also showed that weight gain of crossbred steer fed with tipped cane sugar (fresh and burned, supplemented with molasses-urea (10%) and corn meal), was not statistically different, being 0.687and 0.777 kg / head/days, respectively.

Aguiar et al. (2007) used the tip of cane sugar in the diet of sheep, where it represented 50% of forage dry matter of diet. They reported intake of 956.8 g/day, 3.5 live weight (LW) and 80%, 6 g/day for metabolic weight (MW). The rates of gain in weight exceeded 100 g/day. Aguiar et al. (2007) noted that the value of cane sugar in whole, without the tip, consist of with lower fiber content and higher energy value. Cosentino and Souza (2007) also using Nelore young bulls, with average age of 26 months and weighing 352 kg; in confinement for a period of 112 days. They evaluated the performance of the animals receiving burned sugarcane, soybean straw and cottonseed meal, in the proportions: A=65:35:0, B=68:29:3, C=71:23:6 and D=74:18:8. The gains in weight/head/day were: A=0.098, B=0.320, C=0.459 and D=0.611 kg. The intakes of dry matter/00 kg bw/day were: A=1.88, B=1.94, C=2.05 and D=2.17 kg. Statistical analysis showed significant differences for weight gain among all treatments.

Gesualdi et al. (2001) studied the bromatological composition and the conservation of by-products of sugar cane treated with 0, 1, 2 and 4% (N-ammonia in dry matter) in anhydrous ammonia, urea and sulfate ammonium. To the tip of sugarcane treated with ammonium sulfate they detected decrease in the level of neutral detergent fiber and acid detergent fiber. The treatments resulted in an increase in crude protein content of the tip of the cane, depending on the levels of ammonia. The Ammonium sulfate contributed to the decrease of insoluble nitrogen in acid detergent and higher retention at the tip.

Gesualdi et al. (2001) highlighted that in most treatments the periods after opening the silos did not alter the levels of total nitrogen in the by-products. The benefits promoted by the treatments persisted until the 24th day for the tip. There was a decrease in hemicellulose content of the tip, due to the treatments. The ammonization with ammonium sulfate showed greater efficiency in reducing the level of acid detergent fiber (ADF) end. The content of acid detergent insoluble nitrogen (ADIN) in the tip treated with anhydrous ammonia was reduced, but did not alter the content, due to other sources of ammonia. To solve the problem of excess moisture, the authors suggested reduction of the humidity of the sugarcane tip, through dehydration, and/or reduce the amount of water used to dissolve the urea and ammonium sulfate, thereby avoiding the appearance of fungus.

The cane tip and the panicle of sorghum saccharin were tested by Magalhães et al. (1999) with respect to the feasibility of fattening cattle in confinement. Treatment A consisted of cane tip and fresh crushed provided with 4 kg/head/day of ground sorghum panicle, 120 g/head/day of urea cattle and 30 g/head/day of mineral mix (*ad libtum*). Treatment B consisted of tip of fresh crushed cane provided with 6 kg/head/day of ground sorghum panicle, 120 g/head/day of urea cattle and 30 g/head/day of the mineral mix. The authors concluded that the cane tip, when supplemented with urea and sorghum panicle crushed, allowed weight gains of 0.712 kg/head/day, comparable to a good quality pasture, the increase in panicle of sorghum to feed crushed at levels higher than 4 kg, the highest gain in weight, but reduced the intake of dry cane tip.

Use of non-fibrous by-products of sugar cane

Yeast, vinasse or stillage, and molasses stand out among non-fibrous by-products from industrialization of sugar cane for ruminants. The use of these residues of cane sugar in the diet of ruminants is dependent on the technical and economic viability, taking into account the advantages and limitations of its nutritional value.

Yeasts

The yeast used in ethanol production (*Saccharomyces cerevisiae*) has a by-product with the potential for animal feed, due to its high protein and vitamin content. Among the microorganisms studied, yeasts appear to meet the more favorable characteristics for using in animal feed.

Moreira et al. (2002) reported that the content in crude protein is variable (30 to 60%), the total nitrogen is about 80% of amino acids, 12% of nucleic acids and 8% of ammonia. Approximately 7% of total nitrogen occurs as free amino acids and in other compounds, such as flutationa, lecithin, Adelino acid, vitamins, enzymes and coenzymes in small quantities. Carbohydrates constitute 15 to 60% of the dry weight of yeast, being represented averagely as 33% trehalose, 27% glucans, 21% mannans and 12% glycogen.

Meneghetti and Domingues (2008) reported that they recovered about 2.5 kg of dried yeast per hectoliter of alcohol produced. The yeast presented high content of lysine and threonine and deficiency of methionine and cystine. It is also considered as rich in vitamins B and D. According to Moreira et al. (2002), dry yeast can be achieved in three distinct ways: Tapping the milk yeast, bottom vat and vinasse. After obtaining the wet product, there are two drying techniques: A rotating rolls (LSRR) and, more recently, the technology "spray-dryer (SCYSD). Due to the differences in the two drying processes, the technology "spray-dry", theoretically, would provide a better quality product, due to a lower temperature and a shorter processing. However, this can not be stated with certainty, given the limited literature of studies with this new product. Regarding protein digestibility and energy of yeast found in literature, values varied considerably. This unevenness of data can be explained not only because of the manufacturing regions, but also due to the different processes for collecting and drying the product highlighted Moreira et al. (2002).

Alcohol industry is concerned with processing the yeast in order to preserve its nutritional properties, such as enzymes, nucleotides and metabolites of fermentation, which are of fundamental importance in improving animal performance. Despite the seasonal production, concentrated between the months of May and November, the sugar mills ensure the supply of yeast for 12 months. Blumer (2002) stated that in the rumen, the yeast appear to increase consumption by increasing the rate of fiber degradation, causing an increase in the number of anaerobic bacteria and more stable ruminal environment. They do this by reducing diurnal variations of pH, ammonia and volatile fatty acid.

Blumer (2002) studying the feasibility of using yeast in ruminants, emphasized that yeasts promote stimulation of cellulolytic bacteria, increase the microbial population, increase utilization of lactate, increase the use of ammonia, balance the pH of the ruminal, increase weight gain and milk production on average by 5%, increase fiber digestion, present growth factors of prophylactic action and improves the quality of the coat and hooves because of the B vitamins. For cattle, it is Moreira et al. (2002) recommendations is that, start using using the ration at 50 g/head/day for 1 to 4% (0.5 to 2% in mineral) and increase concentration to reach 250 g/head/day.

Spring et al. (2000) reported that the carbohydrate components of the yeast cell wall, despite not being digested, have an important role in intestinal metabolism. The yeast cell wall is known as mannan-oligosaccharides, although mannan comprises of less than 30% of products available for animal feed and are in the form of polysaccharides. These products contain more protein and β-glucan than mannan. The mannan present in cell walls of yeast are effective against a large number of pathogenic species because of its ability to adsorb bacteria that normally would bind fimbrial (the intestinal wall) isolating the intestinal tract and preventing the production of toxins.

In accordance with Possenti et al. (2008), yeast cultures may act by modifying rumen fermentation, basically in two ways: by providing stimulatory factors for rumen bacteria and absorbing the oxygen that enters the rumen. The main stimulatory factors appear to be dicarboxylic acids supplied by yeast cultures, particularly malic acid, which can promote the growth and activity of bacteria that use lactic acid and prevent dangerous fluctuations in rumen pH. The affinity of yeast cultures by oxygen improves the conditions for ruminal anaerobic microorganisms.

Yeasts seem to be related to reduce the production of methane in the rumen by promoting increased competition between methanogenics and acetogenics bacteria. Possenti et al. (2008) affirms that in diets for ruminants, yeasts have been used to improve the symbiotic relationship between rumen microorganisms and their host, improving rumen fermentation processes in animals given diets rich in starch.

Santos et al. (2006) reported that some researches indicate that cows under heat stress receiving diets rich in starch respond better to this type of additive. The use of *S. cerevisiae* cultures, or its extracts can improve weight gain and milk production with an intensity similar to ionophores (7.0-8.0%), arising from the response the increase in dry matter intake.

Among the factors that could affect the response of cattle supplemented with yeast culture, there is the type of forage, the large proportion: concentrate ratio, the timing and level of supplementation. Santos et al. (2006), on provide supplementation of 10 g of yeast culture / animal / day to steers fed 50 or 100% forage, dry mass basis, observed increase in rumen pH after 4 hours of feeding with 50% concentrate and significantly decrease in acetate: propionate ratio without changes in total concentration of volatile fatty acids.

Gattass et al. (2008) evaluated the effects of adding yeast culture (*S. cerevisiae* 1026) on the parameters of rumen fermentation of beef cattle fed 50% forage-based sorghum silage and 50% concentrate containing soybean hull pellets, sorghum grain, urea and mineral protein (% dry mass), two treatments were used, which consisted of the inclusion or not of *S. cerevisiae* (1 g/100 kg BW) to the diet in two of four daily meals.

Franco et al. (2004) working with steers fed diets containing 27 or 37% neutral detergent fiber (NDF) (40 or 60% alfalfa hay, dry mass basis, respectively) and provide 10 g of culture yeast/animal/day, increased their concentration of propionate in both NDF levels, although the total concentration of volatile fatty acids and ammonia were changed. Moreover, Greene (2002), working with diets with a higher proportion of roughage to concentrate, found no significant changes in rumen fermentation of the diets studied when provided a yeast culture. Results favored by the use of yeast (15.0 g/animal/day) were not confirmed by Franco et al. (2004), in steers fed grass hay, supplemented with concentrate and yeast culture. The inconsistency of results in literature regarding the use of yeast culture for ruminants makes the decision of using yeast in the diet difficult, especially considering the relatively high cost of commercial products available.

Miranda et al. (2001) had no response to the supply of 5.0 g/animal/day of yeast in Simmental steers. Weight gain and DM intake average of 1.54 kg/day and 2.14% of body weight. The yeast, however, promoted an increase (6.3%) in weight gain. In an experiment of digestion and metabolism, led by Greene (2002), steers were fed 9.8 kg DM/day of a diet containing 90.0% concentrate and zero or 0.26% yeast in DM. The digestibility of DM (79.2×77.8%), crude protein (74.7×75.1%) and ADF (42.0×36.3%) showed no significant differences, but the pH of the rumen increased (5.8×6.5) with the addition of yeast. They also noted that the yeast increased the utilization of calcium and phosphorus in the diet.

Aiming to evaluate the effect of supplementation level of living yeast (*S. cerevisiae*) on the average daily consumption of concentrate and the average daily weight gain of lambs on creep-feeding system, Neumann et al. (2008) tested the following treatments: T1 – 0 g animal/day, T2 - 0.4 g animal/day and T3 - 0.8 g animal/day. 27 lambs *Ile de France* from single birth (18 males and 9 females) with average weight of 19.5 kg and mean age of 40 days were used. The creep-feeding consisted of three periods of 21 days, totaling 63 days of supplementation. Neumann et al. (2008) observed no significant interaction between supplementation and evaluation period regarding the concentrate intake, average daily weight gain and feed conversion of gram of concentrate per 100 g of weight gain. There were no differences in live yeast supplementation level ranging from 0 to 0.8 g animal/day on intake (635.7 g/day) and weight gain (418 g/day) from *Ile de France* lambs born birth simple creep-feeding system, depending on the level of supplementation of living yeast. Results that favored the use of yeast has not been confirmed by Pereira et al. (2001) in the digestibility study using steers diets based on cane sugar. The average DM intake was 89.1 g/kgBW0, 75 or 2.13% of body weight. The average digestibility of DM, CP, EE, NDF and total carbohydrates (CHOT) were 49.6, 54.3, 71.0, 31.6, and 50.9% respectively. They concluded that the use of yeast does not influence the consumption and digestibility.

Vinasse

Waste from sugar alcohol production industries are available in large quantities for use as substrates and they have favorable characteristics for development of microorganisms. According to Oberling (2008), the stillage (vinasse, distillery restil or syrup) results from the production of alcohol, after fermentation and distillation of grape wine. It is a material with about 2 to 6% of solid constituents, which highlights the organic matter in greater quantity. In terms of minerals, they present appreciable amount of potassium and average amount of calcium and magnesium. The nutritional value of this material is based on the origin of the worth to be fermented. If the grape has molasses, higher concentrations of potassium, calcium and magnesium, the constituents decay considerably when it comes from a mash of sugar cane, as is the case of independent distilleries.

Ordinance number 322, published in November 1978 by the Ministry of Agriculture, forbids the direct and indirect release of vinasse in any collection by distilling water, forcing agribusinesses to submit projects for implementation of systems using rationalized vinasse. Among several alternatives to the use of vinasse in a rational manner, the manufacture of animal feed ingredient with the stillage is a good option (Oberling, 2008).

The stillage can be used in animal feed, through the synthesis of microbial protein with the culture of *Torula utilis,* whose final product is rich in protein (45-50%) and vitamins. Almeida et al. (2007) recalls that similar surveys conducted in various parts of the world, point yeasts *Torulopsis utilis* or *Candida utilis,* as they offer better results in the production of protoplasmic protein of high biological value, plus vitamins B.

According to Freire and Cortez (2000) fermentation of stillage, for the production of protein through the aerobic biological activity of *T. utilis* yeast or other microbial species, is more an alternative use for such waste in animal feed. However, the stillage is typically deficient in phosphate and nitrogen, and it should be supplemented with salts of ammonia and phosphorus.

Cazetta and Celligoi, (2005) evaluated the capacity for growth and synthesis of lipids and proteins by *S. cerevisiae, Rhodotorula mucilaginosa, Candida lipolytica*, a yeast isolated from stillage ponds and *Corynebacterium glutamicum*, in 10% molasses and crude sugar cane as vinasse cane. All organisms grew in both molasses and vinasse. In crude vinasse, the yeast that showed the greatest growth was *R. mucilaginosa,* with 7.05 g/L. The highest protein content of biomass was obtained in vinasse *S. cerevisiae* (50.35%).

With the cultivation of microorganisms, the stillage can increase their nutritional value to in turn increase microbial protein, phosphorus, potassium and B vitamins, (important growth factors for animals). The use of concentrated vinasse at 60° Brix, according to Freire and Cortez (2000), makes the residue stable, capable of being stored for the period between harvests of sugar cane and makes possible their use in balanced rations. The use of these waste in liquid form, would further increase the intake of complete feeds, allowing greater use of forages due to the presence of vitamins, minerals, protein and energy. The same author reports that, although the information about the use of concentrated vinasse feed is positive, there are few specific research papers on the use of this component, mainly in the dry state in animal feeds, except with the prior development of microorganisms, as previously mentioned.

Tests with stillage in ruminant seem to have started in Brazil with the work of Cazetta and Celligoi, (2005), by substituting molasses vinasse concentrated at levels of 0, 7, 14 and 21% of dry matter in beef steers in scheme confinement. In this work, there was a linear reduction in dry matter intake and weight gain, but weight gains were considered satisfactory, especially at 7 and 14% replacement. The authors point out that at the end of the experimental period, the gains presented themselves better, up from 0.800 kg/day, suggesting adaptation problems.

The vinasse in their natural state, presents dry matter content extremely low, 4-6%, which, from a nutritional standpoint, is a serious limitation, besides the high contents of mineral matter. Cazetta and Celligoi (2005) recorded dry matter of 77.21% organic matter and 10.28% crude protein. Almeida et al. (2007), stated that from the sugarcane industry's waste, slop, in addition to its high water content (94-96%) is corrosive and therefore of limited use when given to animals in nature.

Supplying l, 5 kg per head per day of concentrated vinasse cattle feed, Almeida et al. (2007), had live weight gains of about 0.940 kg/day. In another study, by substituting molasses vinasse concentrated, no differences between the digestibility of dry matter and crude protein diets containing molasses and vinasse combined, or only concentrated vinasse was observed. The consumption of feed containing only concentrated vinasse was lower than the other two, containing more molasses and molasses plus stillage, and these provided similar intakes. The authors concluded that the feasibility of replacing the concentrated vinasse molasses, cattle feed is possible, with no reduction in consumption levels by 33 to 66%. Authors palatability appears to be the predominant factor in limiting the substitution.

In general, good results are not indicated with vinasse concentrated, with a tendency of reduction in animal performance.

However, Cazetta and Celligoi (2005) found beneficial effects of vinasse plus net buffering compounds, replacing the water for feedlot cattle. They also evaluated the liquid stillage to replace the water in terms of ethological habits and some biochemical components of bovine blood groups and genetic Canchim Nellore in feedlot.

Almeida et al. (2007) concluded that the treatment did not affect animal behavior or the metabolic profile, with average values within the normal ranges. They confirmed this form of restricted use for the mills and distilleries, because any other attempt would be impossible due to transport costs and problems with conservation.

Freire and Cortez (2000) evaluating the nutritive value of straw and soy beans in combination with concentrated vinasse, determined 71.69% organic matter, 12.07% crude protein and gross energy 3450 kcal/kg in the dry slop matter, determining the difference in TDN vinasse showed values of 56.2%.

They reported that compared with the filter cake and bagasse, stillage residue is richer in organic nutrients, particularly potassium, which also has calcium, magnesium, phosphorus, manganese and organic nitrogen. Its ratio of carbon/nitrogen is above 15, which characterizes it as a material rich in protein.

Molasses

Molasses is a by-product or end product of sugar cane (*Saccharum officcinarum* L.) or sugar-beet (*Beta vulgaris* L. *var. Conditiva*) resulting from the manufacture of raw or refined sugar. It is a viscous liquid and heavily condensed to separate into a low degree, of which not all of sugar can be crystallized by the usual processes. It can be found in the market in liquid or solid (powder). Molasses contains an average of 5% protein, but is rich in energy, and a very palatable laxative (EMBRAPA, 2015).

Valadares Filho et al. (2002) pointed out that molasses should be used, diluted in water at a ratio of 1:1 to 1:2, and given together with dried forages and concentrates, properly supplemented with protein. Molasses, by weight, has 67% of energy from corn, but offers the advantage of stimulating the multiplication of bacteria in the rumen, therefore leading to the digestion of fibrous feed. Since the cost of molasses is not more than 60% of the cost of corn, it can be mixed in a ratio to 1/3 of concentrated feed and the gradually introduced in the diet.

Molasses has been used widely as a food supplement in the diet of ruminants with good results, and the percentage composition of the feed used in cattle-will depend on the stage of the flock and the type of pasture (nutritional value of pasture).

Najafpour and Shan (2003) asserted that molasses can vary from 85 to 92° Brix. The Brix content measured (in degree Brix), are very close to the concentration of sucrose in the product, 25 to 40% sucrose from 12 to 35% of reducing sugars, 2.5 to 9% crude protein, 7-15% ash, 3100 kcal/kg gross energy and 80% TDN. According to these authors, there are differences in the chemical composition of molasses produced from sugar cane grown on organic soils in relation to those of mineralized soils and it is possible that these differences may produce different effects when fed to animals.

Molasses is an energy supplement used in order to stimulate consumption in feed for ruminants and as a reduction of powder to substitute other ingredients for the same purpose, provided it price is competitive. There are reports of supply of sugarcane molasses for cattle since 1890, originally used pure. This product has entered the match in the 30's and then to urea in 50 years. With time, other nutrients were added to the formulations true protein, lipids, minerals, vitamins, additives and even homeopathic ingredients (Freitas et al., 2003). High prices of protein food and alternative sources to providing adequate nitrogen for the animals has become necessary in order to minimize production costs in feed. Urea is a source of non-protein nitrogen and it has been frequently used in ruminant feed. However, for the best utilization of urea by ruminants, it is important to increase energy source. Molasses is a good alternative, besides improving the palatability of urea, it improves intake. It has been shown that when provided in adequate amounts, molasses is a good source of energy, improves the palatability of food, stimulates the activity of microorganisms in the breakdown of cellulose and is good source of trace minerals. Molasses can be an excellent binder for making up rations and is a good solvent for urea, vitamins and other ingredients (Freitas et al., 2003).

Najafpour and Shan (2003) showed that the aroma of molasses and the use of low quality residues such as straw, cobs and hay mae them a food with higher nutritional quality, increasing weight gain and improving the fur of animals as well as causing the increase of food consumption by 30%. They also stated that the dose of molasses for sheep should be 100 to 250 g for lambs and adults per head.

The methods of use of molasses are mixed; the best is around 2% in the diet, or 200 g/day when mixed with chopped grass, hay and straws in general. In beef cattle in confinement, 350 g/day molasses should be used (mixed into fodder). Feeding creep-feeding system in the molasses is a good alternative, since this increases the palatability of the diet, causing the animal to increase the consumption of feed, allowing greater rumen development.

There is the possibility of linking the urea to molasses. When urea is used for the first time, it should follow an initial period of adjustment. The following mixtures are suggested: the first week, 500 g of urea (5%) to 9.5 kg of molasses, in the second week, 1 kg of urea to 9 kg of molasses. The urea should be well mixed with molasses to form a homogeneous mixture, which can be attained by rubbing the mixture between fingers without having the feeling that there is "sand" in the molasses (EMBRAPA, 2015).

Within these troughs and floating on the molasses, a grid of wooden slats should be placed with two-inch mesh. The function of the grid is to force the animals to lick the molasses and prevent excessive intake of the mixture in a short space of time. If the urea plus molasses is associated with a bulky (for example, chopped elephant grass), this causes a slow intake of urea (prevent the risk of poisoning). For cattle in fattening, the recommendation limit of molasses per head is 6.0 kg/day (EMBRAPA, 2015).

Valadares Filho et al. (2002) pointed out that rumen microorganisms utilize urea nitrogen, carbon, hydrogen, oxygen and energy required for molasses, forming the microbial protein. In this way urea associated with an energy component of easy degradation is potentially capable of producing 2,875 kg true protein per kg consumed. Wastes from the sugarcane industry have nutritional characteristics suitable for inclusion in the diet of ruminants, however care should be observed for possible deleterious effects and levels in the diet of ruminants. A careful study for the safe introduction of these by-products in animal feed is recommend.

CONCLUSION

The use of by-products of sugar cane industry in ruminant nutrition is feasible, since the food has 70% to 80% of production costs. So, there is a need for more studies to know which feed is the best alternative use in different species and different physiological states of animals, in order to provide energy, protein, vitamins and minerals necessary for their development and production weight.

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