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FROM TRANSPORT AND STORAGE TO CONTROL OF THE PROCESS: THE CHALLENGE OF BIODIGESTION FROM DRAWINGS OF SWINE IN AGROINDUSTRIAL SCALE

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ABSTRACT

Biomass is one of the largest sources of energy available in agribusiness activities. Anaerobic biological degradation of organic matter, present in swine manure, produces a gaseous mixture of methane (CH4) and carbon dioxide (CO_2).

Anaerobic biodigestion is one of the most effective methods for the treatment of manure, obtaining as biogas products; Substitute for some fuels; and biofertilizer; Rich in nutrients and applied in agriculture.

The conceptual simplicity of biodigestors does not bring light, the great complexity of chemical and physical processes. One of the main reasons for this complexity is the expressive amount of variables that must be monitored to guarantee better efficiency of these equipments. Among these variables, the values of biomass temperature, amount of gas generated, pH, residence time, among others, stand out.

Aspects related to the Logistics of transport and storage of biomass to Process Control methods, plus Cultural aspects, Professional Training, Creation of public policies, Maintenance of biodigesters, are challenges in the application of biodigestion for energy generation from waste Pigs on an agroindustrial scale.

The objective of this article is to analyze some factors that represent challenges to the application of biodigestion process for energy generation from swine waste on an agroindustrial scale, thus contributing to important reflection on the design and installation of biodigesters in agroindustrial activities.

Keywords**:** biomass, energy, animal waste, agro-industry, biogas

1. INTRODUCTION

Brazil has one of the largest swineherds in the world, which consequently generates large amounts of organic waste in the production chain. In view of this scenario, the biodigestion process presents itself as an alternative for the treatment of these wastes, because in addition to reducing the polluting potential and sanitary risks of the waste, it allows the generation of two products: biogas, which can be used as Source of renewable energy and biofertilizer that can be used as fertilizer in agriculture. Largely employed in small farms, the application of the biodigestion process in agroindustry presents some difficulties.

In this context, this article presents the analysis of some factors that represent a challenge to the application of biodigestion process for energy generation from swine waste on an agroindustrial scale.

2. RESEARCH METHODOLOGY

As for its purpose, this research is classified as Applied Research, because the knowledge acquired will be used for practical application focused on the solution of real problems.

As to nature, this research is classified as Abstract of Subject, because it is based on more advanced works.

From the point of view of its objectives, this research is classified as Exploratory, since it aims to provide more information about the subject under study. As for the object, this research is classified as Bibliographic research, since it was elaborated from material already published.

3. REVIEW OF THE LITERATURE

3.1. Pig waste: an environmental issue

The production of swine animal waste is a major issue to be solved along the production chain of Agroindustry. Exposed to high temperature these waste produce highly polluting and harmful gases to society and to the environment.

To get an idea of the size of this problem Diesel et al. (2002), reports that a swine head produces a volume of waste (liters/day) equivalent to the volume generated between 10 to 12 people, and its polluting power in Biochemical Oxygen

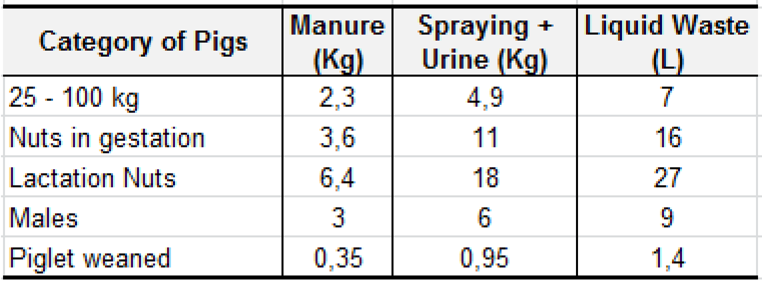
Demand, corresponds to the production of domestic sewage of 100 people.

According to Lima (2011), the amount of substrate varies according to the economic activity and the scale of production of a rural property (animal waste and crop residues) or an agroindustry (effluent with high organic material load and diversified composition).

For Diesel et al. (2002), swine manure, urine, water wasted by drinking fountains and sanitation, feed residues, hair, dusts and other materials resulting from the breeding process. The substrate in turn consists of animal faces, which contains organic matter, nitrogen, phosphorus, potassium, calcium, sodium, magnesium, manganese, iron, zinc, copper and other elements included in animal diets.

According to Oliveira (2004) in the following table, we can observe the average daily production of manure, mixture of manure and urine and liquid waste by pigs in each production phase.

Table 1: Average daily production of swine manure per phase



Category of Pigs	Manure (Kg)	Spraying + Urine (Kg)	Liquid Waste (L)
25 - 100 kg	2,3	4,9	7
Nuts in gestation	3,6	11	16
Lactation Nuts	6,4	18	27
Males	3	6	9
Piglet weaned	0,35	0,95	1,4

Source: Adapted from Oliveira (2004)

It is observed that for pigs the average daily production of waste can reach 18 kg per animal. For cattle, it is estimated that every 1 liter of cows produce 3 kg of waste.

Considering a large rural property, we can have the dimension of urgency to reuse this biomass as a raw material to reduce environmental impacts and the urgency to face the challenge of waste with intelligence and ecologically correct actions.

According to Oliveira (2004), one of the major problems in animal confinement systems for slaughter is the amount of waste produced daily in a reduced area. The disposal of waste from animal facilities has lately been a challenge for breeders and specialists, since it involves technical, health and economic aspects.

Such waste, if handled improperly, can cause negative impacts to the environment.

For Seganfredo (2000) the excess of waste in the soil can cause accumulation of nutrients, generating chemical imbalance resulting in a fall in cereal productivity, intoxication of animals by certain nutrients in forage (for example, copper is harmful to sheep), fall In the quality of vegetables by heavy metals and excess of nitrogen in the soil.

Lima (2011) states that the environmental damages are even greater when these organic wastes are dragged into the watercourses because they have a high Biochemical Oxygen Demand (DBO), reducing the oxygen content of the water. In addition, the various nutrients contained in these residues, mainly Nitrogen (N), Phosphorus (P) and Potassium (K), stimulate the growth of aquatic plants and the accumulation of decomposing organic matter in water bodies (Eutrophication).
According to Perdomo (2001), the discharge of untreated pig effluents from soil, rivers and lakes is a potential risk for the appearance of diseases such as verminoses , Hepatitis, hypertension, stomach cancer, among others; Besides the discomfort of the population due to the proliferation of flies, rubber trees, bad smells and degradation of natural resources, due to fish and animal death, plant toxicity and eutrophication of water resources.

In view of this scenario, it is necessary to treat these wastes by removing or transforming these pollutants so that they can be reused in the soil or disposed of safely. For Kunz et al. (2004), before considering any treatment system, attention must be paid to the production system, where waste treatment must be seen as an integral part of the production process, so everything that is done inside agroindustrial facilities can Have positive or negative influences in the treatment of waste. Factors such as dilution of waste, nutrition of animals with low feed conversion ratio, use of antibiotics and detergents, training of personnel responsible for the operation of the systems, has a direct influence on the treatment of waste.

The treatment of the waste can be carried out in a physical or biological way. For Diesel et al. (2002), the physical treatment promotes the separation of the liquid portion from the solid portion of the waste. This separation can be done by decantation, centrifugation, sieving and / or pressing, and dehydration of the liquid part by wind (forced air or heated air). On the other hand, the biological treatment consists of the biological degradation of the substrates by aerobic and anaerobic microorganisms, resulting in a stable material and free of pathogenic organisms. For solid waste, composting is an example, and for liquid waste the stabilization, digestion and biodigestion lakes can be highlighted.

3.2. Characterization of swine animal waste

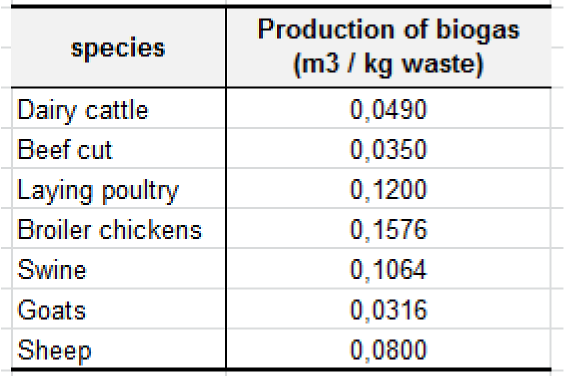
According to Lima (2011), the use of swine animal waste is economically feasible to produce energy and fertilizer, but adequate for the management of this waste, adequate planning, within the scale of production.

According to Cortez et al. (2008), the characterization of the substrate must be performed by a series of physical, biochemical and chemical parameters, aiming to identify a series of parameters to evaluate the organic load of the substrate and its behavior during the degradation stages of organic matter, when submitted to Anaerobic digestion process, allowing to determine the production of methane and also to model the efficiency of the process.

For Lima (2011), among the physical parameters, the most important are quantity, density, size, viscosity and solids content. The amount of substrate varies according to the economic activity and scale of production of a rural property or an agroindustry.

According to Lucas Júnior et al. (2003), the availability of agricultural residues in Brazil has increased in the last decade due to the evolution of animal protein production. The following table shows the approximate yield of the biogas production, according to the type of substrate.

Table 2: Methane production for different substrates



species	Production of biogas (m3 / kg waste)
Dairy cattle	0,0490
Beef cut	0,0350
Laying poultry	0,1200
Broiler chickens	0,1576
Swine	0,1064
Goats	0,0316
Sheep	0,0800

Source: Lucas Júnior et al. (2003)

It can be observed that the best yield (m3 / kg) is for the manure of dairy cattle, due to its confinement, the pigs have a yield of 4 times less, about 0.1064 m3 / kg.

Density is another important physical parameter. For Lima (2011), its knowledge is important for the sizing of the system of pumping and storage of liquid substrates.

Another parameter is the size of the particles, as it allows evaluating the distribution and the dilution of the substrate in water, as well as the percentage of dissolved particles, in suspension. This data varies according to the type and the handling given to the substrate. Also for Lima (2011), the factors that affect the size of the animal waste particles are diet, age, and species and breed (subspecies) animal, as well as the place of creation. The inadequate site may favor contamination of the substrate with the presence of dust, feed residue, hair, and sawdust, shavings, among other contaminants, as well as the management and storage of the waste.

The viscosity which, as well as the density, is also directly related to the substrate handling and the design of the pumping system from the substrate origin site to the anaerobic reactor, allows to know their respective flow rates according to the amount of dry matter Diluted in the substrate.

Finally, for the value of the solids content, according to Lima (2011), this allows to identify the materials dispersed in liquid mixtures or to know the percentage of Moisture in solid materials. The classification of the solids content may be physical or chemical. Physically, they are classified according to their dimensions.

According to Diesel et al. (2002) to determine, the quality of the substrate should be used reliable and significant parameters, the Biochemical and Chemical parameters allow evaluating the digestibility of the substrate, which directly affects the efficiency of an anaerobic biodigestor. For pork, the main parameters are: Biochemical Oxygen Demand (DBO), Chemical Oxygen Demand (DCO), Total Organic Carbon (COT) and Dissolved Oxygen (OD).

- DBO (biochemical oxygen demand - mgO2 / L): corresponds to the need for oxygen that purifying bacteria need to digest polluting loads in water.

Oliveira (1993) states that pollution of the environment in the swine producing region is high because, while the DBO content for domestic sewage is 200 mg.L-1, the DBO value of swine manure can vary from 30,000 to 52,000 Mg.L-1, that is, pollutant potential of up to 260 times higher than domestic sewage.

- DCO (chemical oxygen demand - mgO2 / L): to determine the amount of oxygen needed to oxidize organic and inorganic matter present in water, without the intervention of microorganisms.

According to Kunz and Oliveira (2006) for swine effluents the DCO reference value used should be 66,900 ± 13,500 mg.L-1 of DCO.

- COT (Total Organic Carbon): the COT analysis allows the identification of the amount of carbon originating from living organisms present in the substrate.

According to Lima (2011) the objective of this parameter is to quantify the Carbon element present in a substrate; Be dissolved and / or suspended. In relation to the DBO and DCO analyzes, the COT analysis is performed in a shorter period of time and at a lower cost, however, its result does not replace the importance of the DBO and DCO analyzes, since they are complementary for determination of the load Of a substrate.

- OD (Dissolved Oxygen): According to Von Sperling (2005), dissolved oxygen (DO) is a fundamental element for the maintenance of Organisms. It is a parameter of characterization of the effects of the pollution of the water bodies by organic matter releases. The presence of organic matter in aquatic systems favors the development of microorganisms that will consume the OD until it is exhausted, creating anaerobiosis conditions.

According to Von Sperling (2005), determining the percentage of OD in the substrate that will be consumed by the microorganisms, before starting the anaerobic digestion process, is fundamental to evaluate the initial speed of the anaerobic digestion process, since its presence in the Substrate is characterized as inhibiting element of the process.

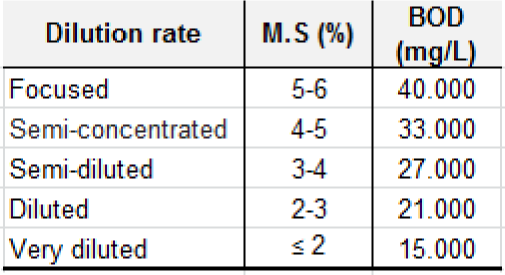
Still according to Diesel et al. (ST - mg / L), Volatile Solids (SV - mg / L) and Total Nitrogen (NT - mg / L), should also be considered in the characterization of swine manure.

- Total solids (ST - mg / L): correspond to the solid matter contained in the waste after removal of moisture;

- Volatile solids (SV - mg / L): Corresponds to fraction of organic material;
- Total Nitrogen (NT - mg / L): corresponds to the nutrients present in the waste, such as nitrate, nitrite, ammonia and organic nitrogen.

The following table shows the variation of DBO as a function of the material content.

Table 3: Variation of DBO of liquid waste as a function of dry matter content



Dilution rate	M.S (%)	BOD (mg/L)
Focused	5-6	40.000
Semi-concentrated	4-5	33.000
Semi-diluted	3-4	27.000
Diluted	2-3	21.000
Very diluted	≤ 2	15.000

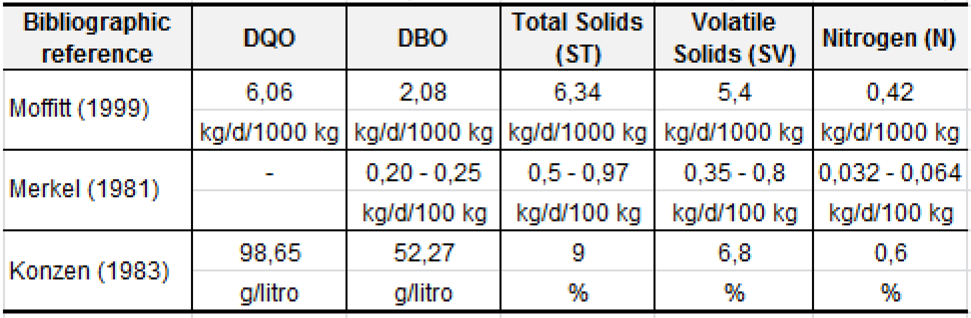
Source: Adapted from Dartora et al. (1998)

For Dartora et al. (1998) the production system used in each farm is that it characterizes the degree of dilution of the waste, the volume, as well as its physical, biochemical and chemical properties, before identifying and designing a waste treatment system, one must do an analysis of the farm, taking.

Consideration of how to feed the animals, types of drinkers, handling and cleaning system.

The following table presents references in the literature for parameters of pig substrates:

Table 4: References for some parameters for finishing substrates of pigs



Bibliographic reference	DQO	DBO	Total Solids (ST)	Volatile Solids (SV)	Nitrogen (N)
Moffitt (1999)	6,06	2,08	6,34	5,4	0,42
	kg/d/1000 kg	kg/d/1000 kg	kg/d/1000 kg	kg/d/1000 kg	kg/d/1000 kg
Merkel (1981)	-	0,20 - 0,25	0,5 - 0,97	0,35 - 0,8	0,032 - 0,064
		kg/d/100 kg	kg/d/100 kg	kg/d/100 kg	kg/d/100 kg
Konzen (1983)	98,65	52,27	9	6,8	0,6
	g/litro	g/litro	%	%	%

Source: Adapted from Moffitt (1999), Merkel (1981) and Konzen (1983)

Pigs weighing between 18 and 100 kg, with a mean production of 63,40 kg / d / 1000 kg, with an average moisture content of 90%, are considered to be finishing pigs.

3.3. Routes of conversion biodigestion: Concept, process and history

For Alves et al. (2010), the biodigester is an equipment where the fermentation of the organic matter by the bacteria happens in a controlled way, reducing the environmental impact and generating fuel of low cost. The process of decomposition of organic matter results in two products: biogas and biofertilizer. The process of anaerobic digestion is divided into 4 steps: hydrolysis, acidogenesis, acetogenesis and methanogenesis.

In the first stage of the process, called Hydrolysis, according to Li et al. (2012) involves the reduction, through enzymes, of complex organic polymers to simple soluble molecules.

According Li et al. (2012), bacteria are not able to assimilate particulate organic matter, the complex organic matter is transformed into simpler soluble compounds, a process that occurs by the action of the extracellular enzymes excreted by the fermentative bacteria. In parallel proteins are hydrolyzed to form amino acids, sugars are formed from hydrolysis of carbohydrates and soluble lipids are hydrolyzed to fatty acids.

Still second, Li et al. (2012) states that hydrolysis is a critical rate limiting step that determines the biomass feedstock conversion efficiency.

Eckenfelder (2000) argues that the reduction in the size and complexity of the particles does not imply a reduction of organic load, since the monomers are converted to fatty acids with small amounts of H2.

In the second stage of the process, called Acidogenesis, the biodegradation of bacteria occurs, which may be obligatory anaerobic or facultative anaerobic, known as acidogenic.

For Versiani (2005), the main products formed are acidic, butyric acid, acetic acid, lactic acid, carbon dioxide, hydrogen sulfide (H2S), hydrogen (H2), and new microbial cells. According to (BOHRZ, 2010) most acidogenic bacteria are strict anaerobes, but about 1% of them consists of facultative bacteria, which can oxidize the organic substrate aerobically. This important fact, except that the dissolved oxygen, possibly present in the medium, could become a toxic substance for the later stage of degradation.

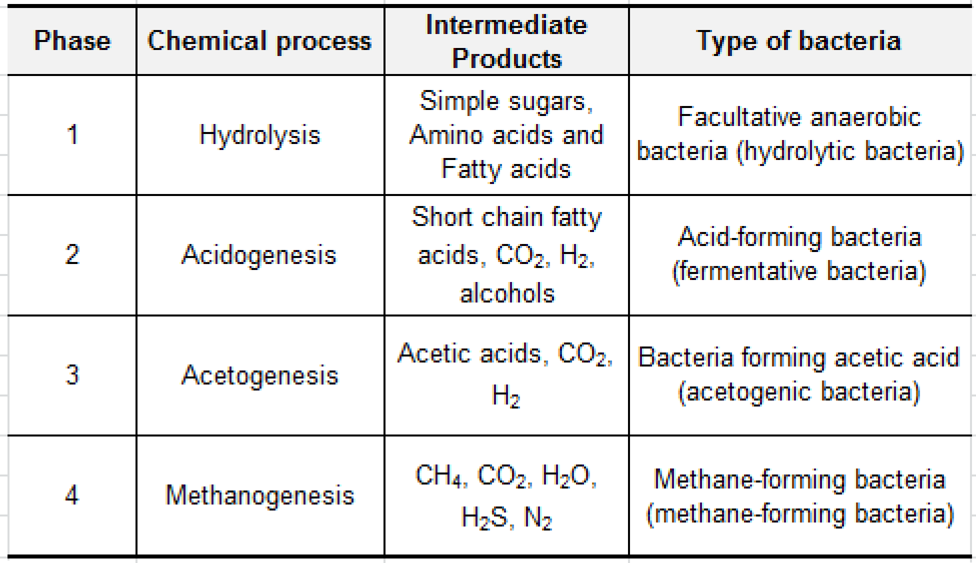
In the third stage the Hydrogenogenesis or acetogenesis according to Oliva (1997) is the stage where the volatile acids and the alcohols are metabolized, producing acetate and H2 by means of acetogenic bacteria producing H2. H2-acting or homoacetogenic acetogenic bacteria convert part of H2 and CO2 that do not combine to form methanol and acetate.

In the case of methanobacteria, the presence of hydrogen peroxide and carbon dioxide in the acidic phase of the methanobacteria is the main cause of the reaction.

Finally, the stage of Methanogenesis, according to Chernicharo (1997), is the final stage of the process of anaerobic degradation of organic compounds in methane and carbon dioxide, being carried out by means of methanogenic microorganisms. Due to its substrate affinity and magnitude of methane production. Methanogens are divided into two main groups, one that forms methane from acetic acid or methanol, and the second that produces methane from hydrogen and carbon dioxide.

The following table summarizes the steps in the biodigestion process:

Table 5: Phases of the biogas production process



Phase	Chemical process	Intermediate Products	Type of bacteria
1	Hydrolysis	Simple sugars, Amino acids and Fatty acids	Facultative anaerobic bacteria (hydrolytic bacteria)
2	Acidogenesis	Short chain fatty acids, CO_2, H_2, alcohols	Acid-forming bacteria (fermentative bacteria)
3	Acetogenesis	Acetic acids, CO_2, H_2	Bacteria forming acetic acid (acetogenic bacteria)
4	Methanogenesis	CH_4, CO_2, H_2O, H_2S, N_2	Methane-forming bacteria (methane-forming bacteria)

Source: Adapted from Eder and Schulz (2007)

3.4. Control Parameters of the biodigestion process

The anaerobic processes alter with environmental changes, being necessary to control the factors that affect the performance of the bacteria, thus optimizing that of the biodigestion process of organic residues.

Among the several factors that influence the activity of methanogenic bacteria, it is possible to highlight the amount of water content (dry matter), nutrient concentration, pH, internal temperature of the digester, retention time, solids concentration Volatiles, the carbon / nitrogen ratio and the presence of toxic substances inside the biodigester.

According to Neves (2010), the amount of water used should be about 90% of the total biomass content, depending on the type of biomass. The dilution ratio should be around 1: 1 to 1: 2. The excess or lack of water is harmful to the system.

For Neves (2010) the lack can cause clogging in the pipeline and the excess can disrupt the hydrolysis process, because a high biomass load is required for it to be correctly processed.

For Nutrient Concentration, Neves (2010) warns that improved efficiency of biological processes requires the availability of essential nutrients for microbiological development in adequate proportions. Minimal nutritional requirements can be estimated from the empirical composition of microbial cells.

Pinto (1999) states that the process of bacterial degradation will also be related to the availability of nitrates, phosphates and sulfates. The presence of essential nutrients, such as iron, and micronutrients, such as nickel and cobalt, in appropriate concentrations improve the process and biogas production, also when the residue to be degraded presents a higher Chemical Oxygen Demand (DCO) The knowledge of the chemical composition and the type of biomass, by means of its correct characterization, is very important, since it can be enriched with fertilizers and chemical activators, if necessary, denominated inoquos, acting as accelerating element and correcting properties of the substrate.

With respect to Ph-control, changes during the process considerably affect the bacteria involved in the digestion process. Among the interference factors of anaerobic digestion, acidity and alkalinity are important factors, since microorganisms are living beings that need to be in a medium that favors their development and performance.

For Neves (2010), there is no ideal pH for the performance of the microorganisms in the biodigestion process, however it is recommended that the pH be in the range of 6 to 8, and it may be considered optimal in the range of 7 to 7.2, which normally occurs when the digester is working well.

For the temperature factor of the digester, Denis and Burke (2001) states, that temperature is a very important variable during anaerobic digestion, influencing the whole process of bacterial performance. The higher the temperature, higher biogas production and may influence the concentration of biogas components. When the temperature is adequate, the activity level of the microorganisms is higher and the organic components decompose rapidly.

According to Neves (2010), the bacteria responsible for biodigestion are very sensitive to sudden changes in temperature (variations of 3ºC are enough to cause the death of most digestive bacteria), there is no consensus between the exact temperature for each group of bacteria.

For Neves (2010) retention Time is the time at which any substrate passes inside a digester, ie the time between the inlet and outlet of the different materials of the digester. The retention or digestion time varies depending on the characterization of the substrate, such as biomass type, grain size, digester temperature, biomass pH, etc.

According to Neves (2010), the retention time can vary from reaction to reaction. Usually it takes from 30 to 45 days, but in some situations, it is possible the existence of the biogas soon in the first week of hydraulic retention in smaller proportions; Phenomenon observed, mainly in continuous biodigesters.

According to Pinto (1999), the production of biogas and the process of organic matter degradation are directly affected by the composition of the residue, for a higher concentration of volatile solids, implying a greater amount of matter Degradation, thus increasing the amount of gas produced.

The carbon / nitrogen ratio according to Lenz (no date) is an important parameter and it is related to the conditions in which the biological process of the fermentation takes place, being the carbon / nitrogen ratio ideal for an optimal digestion values between 20 to 30: 1, I.e., 20 to 30 parts of carbon to one of nitrogen. Most strains of animals, including pigs, present low C / N ratios because they have a lot of nitrogen and must be corrected with vegetable residues such as straws, sawdust, sawdust, etc. to reach the ideal point.

3.5. Products generated from the biodigestion of the pig substrate

The products that are generated from biodigestion are: biofertilizer and biogas.

The biofertilizer is a product of the biodigestion process, which optimizes the use of the pig substrates, adding value to the agroindustrial chain.

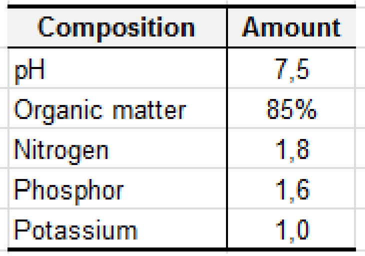
Barichello, et al. (2011) states that after the biogas production, the fermented biomass leaves the interior of the biodigestor in liquid form, with a large amount of organic material, that can be used for soil fertilization. With the application of this biofertilizer in the soil, there is an improvement in the biological, chemical and physical properties of the soil, surpassing any other alternative of chemical fertilizer.

Barichello, et al. (2011), further states that due to the process that occurs in biodigestion, organic matter (biomass) loses exclusively carbon, in the form of methane gas (CH_4) and carbon dioxide (CO_2), increasing the nitrogen and other nutrients content . As it works as a soil acidity broker, biofertilizer, unlike chemical fertilizers, improves soil quality, better absorbing soil moisture, resisting long periods of drought.

For Rodrigues (2010) the biofertilizer can be disposed to the soil "in natura" or processed. The advantage of the processing is in storage and transport gains, since it stops storing and transporting water, which part returns to the process in the correction of the moisture of the incoming waste and part goes to the atmosphere in the form of water vapor.

The composition of the biofertilizer may vary according to the type of biomass used in the biodigester. The following table presents this composition for swine manure.

Table 6: Components of the biofertilizer from swine



Composition	Amount
pH	7,5
Organic matter	85%
Nitrogen	1,8
Phosphor	1,6
Potassium	1,0

Source: Adapted from Barichello (2011)

The value of the benefits of biofertilizer in farming is as important as the application of biogas in agro-industrial processes.

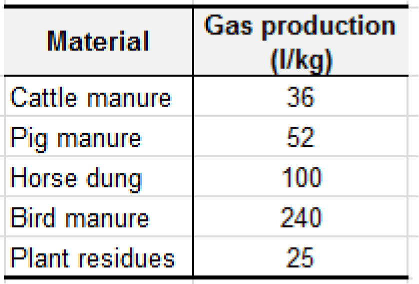
For Alves (2010) the biogas is constituted by a mixture of gases, whose type and percentage vary according to the characteristics of the residues and the working conditions of the digestion process. The main constituents of biogas are methane and carbon dioxide. The characteristic composition is approximately 60% methane, 35% carbon dioxide and 5% of a mixture of hydrogen, nitrogen, ammonia, hydrogen sulfide, carbon monoxide, volatile amines and oxygen.

For Deublein and Steinhauser (2008); Other gases, such as nitrogen (N_2), oxygen (O_2), traces of hydrogen (H_2) and hydrogen sulphide (H_2S).

Alves (2010) describes methane as a highly combustible and flammable gas, producing a light blue flame and its burning produces little or no pollution. It is a colorless gas, being one of the final products of the anaerobic fermentation of substrates of animals like pigs. In energy terms, the larger the amount of methane, the better the gas.

The following table shows the average values of biogas production per kilo of fermented material. The materials included in this table are only the materials of greater availability in the rural environment.

Table 7: Biogas generation capacity



Material	Gas production (l/kg)
Cattle manure	36
Pig manure	52
Horse dung	100
Bird manure	240
Plant residues	25

Source: Adapted from Barichello (2011)

It is observed that the gas production potential of pigs is only lower than the potential of equines and birds, but the availability of this waste is much higher.

According to Arruda (2002), biogas can have its energy power used in the same process, as in cooking, heating, cooling, lighting, incubators, feed mixers, motor fuels, refrigerators, stoves, water heaters Electricity, among others. The production of biogas, starting from the biomass, begins to take place around 20 days.

4. CHALLENGES IN THE APPLICATION OF BIODIGESTÃO IN AGROINDUSTRIAL SCALE

The first applications of biodigestion in Brazil began in the 70's, these experiments demonstrated that it was possible to produce biogas and biofertilizer, using simple technologies. In the following decade, with the creation of the PME (Energy Mobilization Program), incentives for the installation of biodigesters, through financing or even donations of the necessary resources to the installation; Intensified the application of biodigestion.

According to Palhares (2008), at the time, some factors were responsible for the failure of the application of this technology, among which we can mention:

- Underestimation of the biogas production potential;
- Inadequate management of crops and crops;
- Lack of technical knowledge and design errors;
- High cost of implementation and maintenance;
- Lack of adequate equipment;
- Materials used in construction with a low useful life;
- Lack of specific environmental legislation.

It is clear that after more than forty years the scenario is not as bad as in the past, but still today there are bottlenecks to be overcome for the consolidation of biodigestion as an alternative for the generation of energy.

For Palhares (2008) are some of the challenges in the application of biodigestion in Agroindustrial scale:

- **Cultural**: The process of anaerobic biodigestion for swine extract is efficient; Research can be carried out to increase this efficiency; however, the biodigestion process, by itself, does not solve the environmental problems of swine farming; And which are not the only available technology; That before proposing the technology, there should be a feasibility study.

• **Professional Training**: There is still a shortage of training for the operation of biodigesters, for technicians and producers, in order to enable the correct use of these and to ensure efficiency.

Professional training is directly related to the management and efficiency of the process. An organic matter may have a potential for generation, but it does not mean that it will be generated with this potential; it depends on some factors, like the correct handling and operation.

• **Public policy-making**: For Sant'ana (2013) it is the government's job to create favorable conditions for the improvement of energy efficiency in industry, either through policies, programs or promotion actions. For Palhares (2008) actions the provision to the environmental agencies of the states, with all the information necessary for them to know the technology, with its advantages and disadvantages, in order to assist in the environmental licensing processes of the properties; Regulation of the use of biofertilizers as fertilizer, throughnutrient management; Implementation of projects aimed at producing energy from swine and other animal waste, with the construction of plants in regions of animal concentration.

Barreira (2011) lists two more challenges to be overcome in the use of biodigesters:

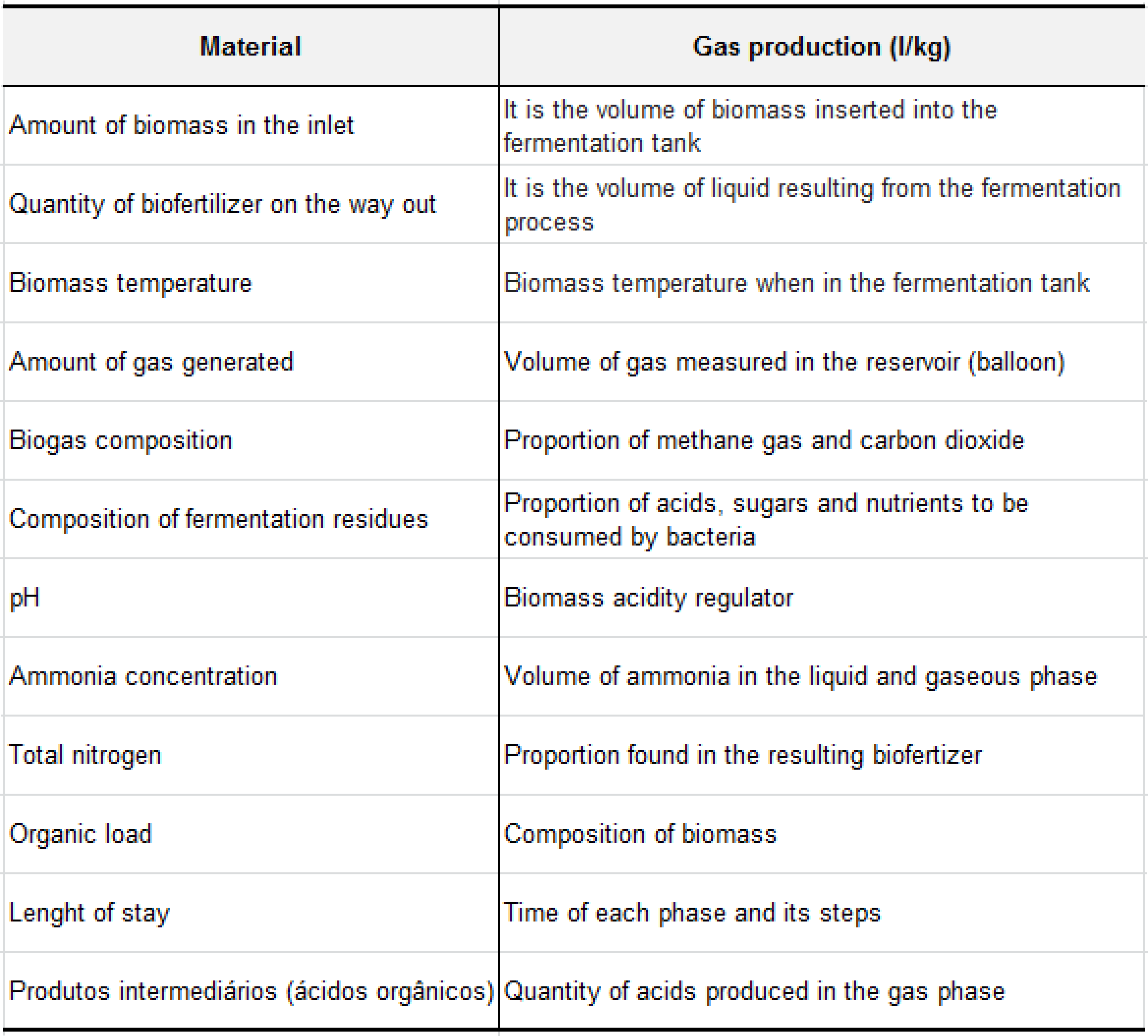
• **Maintenance of biodigesters**: Proper operation of a biodigestor depends on good maintenance. Potential leaks or clogs in the gas outlet pipes and hoses may cause internal pressure changes in the digesters, increasing the risk of explosions. In addition, oxygen may be introduced into the system, inhibiting and retarding methanogenic activity.

• **Control of the process**: Among the variables can be controlled the values of biomass temperature, amount of gas generated, pH, dwell time, among others.

The function of process control is to monitor and detect possible instability and establish actions to eliminate or mitigate them. Ideally, it should be online, automated and robust, detecting the first signs of instability in the process.

The following table presents some parameters that can be monitored in the anaerobic digestion process:

Table 8: Monitoring parameters in anaerobic digestion



Material	Gas production (l/kg)
Amount of biomass in the inlet	It is the volume of biomass inserted into the fermentation tank
Quantity of biofertilizer on the way out	It is the volume of liquid resulting from the fermentation process
Biomass temperature	Biomass temperature when in the fermentation tank
Amount of gas generated	Volume of gas measured in the reservoir (balloon)
Biogas composition	Proportion of methane gas and carbon dioxide
Composition of fermentation residues	Proportion of acids, sugars and nutrients to be consumed by bacteria
pH	Biomass acidity regulator
Ammonia concentration	Volume of ammonia in the liquid and gaseous phase
Total nitrogen	Proportion found in the resulting biofertizer
Organic load	Composition of biomass
Lenght of stay	Time of each phase and its steps
Produtos intermediários (ácidos orgânicos)	Quantity of acids produced in the gas phase

Source: Adapted from Barichello (2011)

According to Bohrz (2010) the monitoring and control of the biodigestion process allows the optimization of the efficiency of the system. When these factors are properly monitored, they can contribute to the optimization of bacterial activity, thus increasing methane production.

There is no doubt that the German technology used in the production and operation of biodigesters is recognized as the cutting edge, giving the environment where biodigestion is taking place, the necessary conditions for it to occur in the most efficient way possible.

• **Transportation and storage**: Another important challenge to be overcome in the production of energy through the biodigestion process is the transportation and storage of biomass. The disposal of animal waste has, lately, been one of the major

Creators and specialists, as well as for the bidding process as it involves technical, sanitary and economic aspects.

According to BRIDGWATER (2011), in animal confinement systems because biomass is a dispersed resource, it has to be harvested, collected and transported to the conversion facility. If the conversion facility is far from the point of biomass collection and storage, such as biomass density, it may be so low, transportation costs will be high, and the number of vehicles moved for large-scale processing will be very high, And with consequent environmental impact.

5. CONCLUSION

The analysis of the challenges to the application of biodigestion on an industrial scale from strains of bovine animals allows some conclusions:
The first is that there is no single technology to solve the environmental problems of swine farming. From biomass production conditions, social, environmental and cultural conditions, one must propose the best technology.
The consensus on which technologies to treat swine manure are more adequate and how to control the pollution of these creations will not exist, as there are technologies more suitable for each productive characteristic.

The second is that no solution should be based solely on the economic, for example, with the objective of selling carbon credits, because it will not perpetuate and will not solve the environmental issue.

Currently, the challenges to be overcome for the diffusion of biodigestors technology in Brazil in the agroindustry stem from cultural issues, professional training, public policymaking, maintenance, process control, transportation and storage.
The elimination or at least mitigation of these factors, allowing the use of biogas, as well as the use of biofertilizer in the swine properties, will add value to the waste treatment process and reduce the costs of production, thus allowing a holistic view under the Environmental management point of view.

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