PERCEPTIONS AND ATTITUDES OF THE STUDENTS OF YUAN ZE UNIVERSITY ABOUT THE USE OF BIOGAS PRODUCED BY HUMAN WASTE

PERCEPÇÕES E ATITUDES DOS ESTUDANTES DA UNIVERSIDADE YUAN ZE EM RELAÇÃO DO USO DO BIOGÁS PRODUZIDO PELA EXCRETA HUMANA

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Abstract

Energy demand is increasing following the expansion of the world population. Approximately 1.1 billion people worldwide do not have access to electricity, mostly living in developing countries. This article aimed to evaluate the perception of the students of Yuan Ze University about the use of biogas produced from human waste. A sample of 110 students from different faculties of the university was randomly chosen to be interviewed on this subject through a questionnaire with both closed and opened questions. The analysis of the data was processed with the R software in order to calculate the p-value of the questions and socio-demographic data, with the significant level set at 0.05. This work found that 54.5% of the students have already heard that human waste can be used to produce biogas, while 89.1% of the respondents thought this alternative is possible. When asked whether they would use this gas, the percentage dropped to 55.5%. Most of the students stated that they would use only biogas produced with their own excreta (52.0%). The main barriers presented by the respondents for not using this gas were health risk (40.0%), bad smell (26.4%), and fear (10.9%). This work found that the use of human waste in the production of biogas was regarded as a viable alternative by the students of Yuan Ze University, with health risk being the major concern.

Keywords: Reuse of human waste; students' perception; biogas.

Resumo

À medida que a população mundial aumenta, com ela cresce a demanda de energia. Cerca de 1,1 bilhão de pessoas no mundo não têm acesso a eletricidade. A maioria deles vive em países em desenvolvimento. Este artigo teve como objetivo avaliar a percepção dos estudantes da Universidade Yuan Ze sobre o uso de biogás proveniente de excreta humana. Um total de 110 estudantes de diferentes faculdades foi escolhido aleatoriamente para ser entrevistado sobre esse assunto, por meio da utilização de questionário com perguntas fechadas e abertas. A análise dos dados foram processadas no software R para calcular o valor-p, a fim de determinar o nível significativo estabelecido em 0,05 para as perguntas e as características sociodemográficas. Constatou-se que 54,5% dos estudantes já ouviram falar que a excreta humana pode ser usada para produzir biogás, 89,1% dos entrevistados pensaram que essa alternativa é possível. Quando perguntados se usariam esse gás, o percentual caiu para 55,5%. A maioria dos estudantes afirmou que usaria apenas biogás produzido com suas próprias excretas (52,0%). As principais barreiras apresentadas pelos entrevistados para não usar esse gás foram risco à saúde (40,0%), mau cheiro (26,4%) e medo (10,9%). Conclui-se que o uso de excremento humano na produção de biogás foi visto como uma alternativa viável pelos estudantes da Universidade Yuan Ze, mas o risco à saúde foi a maior preocupação deles.

Palavras chaves: Reuso de excretas humanos; percepção dos estudantes; biogás.

1 INTRODUCTION

After the industrial revolution, many countries such as the United States, Japan, Germany, France, United Kingdom, Italy, and Canada became rapidly very rich. This group of seven countries (G7) represents more than 62.0% of the global net wealth. Other countries have lost this

time of great economic mobility but have seized other revolutionary period to change their status from developing countries to developed ones. The last group, formed by low-income countries, has been still left behind and remained employing preindustrial and prehistoric energy practices, such as the use of wood to cook their meals. Some countries depend often on others for their energy power, a fact that raises significantly the cost of energy consumption. Other countries have enough oil to boost their economies but the know-how and equipment required for the extraction are still big issues. With the amplification of industries and huge urbanization, the demand for electricity and water is inevitable at the global level. Many developing countries face serious problems of water stress, energy shortage, and lack of food. In 2013 the global energy consumption was estimated in more than 22,000 TWh, with 66.0% being consumed by ten countries (NOURREDINE and JEAN-CLAUDE, 2015).

Regarding the energy issue, the world is divided in two groups. In the first category, there are countries with unlimited access to energy sources, such as water, nuclear, wind, tidal, and solar power, as well as fossil fuel. In contrast, in the other one, low-income countries still do not have enough energy access and use as energy source the traditional biomass, especially in some rural areas. At least 80% of the energy used in the low income and developing countries comes from traditional biomass (GOLDEMBERG and JOHANSSON, 2004). About three (3) billion people living in developing countries rely on solid fuels traditional biomass, and coal (WHO and UNDP, 2009). It was estimated that about 1.1 billion people in the world did not have access to electricity in 2016 (IEA, 2017).

In the sub-Saharan Africa, the number of people without access to electricity and modern energy sources is similar, being respectively 560 and 625 million people, whereas in East Asia and in the Pacific almost 1.1 billion people rely on solid fuels for cooking (WHO and UNDP, 2009). Water plays a major role in the electricity produced from fossil and renewable energy sources (NOURREDINE and JEAN-CLAUDE, 2015) and this is one of the main causes of water stress in the world. The global demand for water is expected to rise by 30% and the demand for food and energy both by 50% in 2030 (RAWORTH, 2012). Energy is one of the basic needs of mankind and this widespread need acts as a clue to development enabling economic growth, affecting the manufacture of goods, transportation, education, hospital health, and so on. Lack of access to electricity in a country is obviously a sign of poverty. Having access to electricity is one of the primary needs in modern society, but it is one of the major challenges the world faces today affecting all aspects of our lives (WHO and UNDP, 2009). In 2010, a study reported that the global coal reserves of coal are expected to last 118 years (NONAKA; HIRAJIMA and SASAKI, 2013). Regarding oil wells, even though they are available worldwide providing 50,000kWh of energy every year (DEUBLEIN and STEINHAUSER, 2008), crude oil reserves are expected to be depleted by 2025 (CHENG, 2009).

Fossil fuel is largely used all over the world to produce energy, but it is one of the main contributors to greenhouse gas emissions. The use of non-renewable energy sources was responsible for almost 80% of the greenhouse effect in the European Union (EUROPEAN COMMISSION, 2010). The global energy uptake does not stop increasing following global population, being about nine (9) times higher than the one of the Industrial Revolution period.

Due to the anthropogenic activities and lack of awareness, we are facing now some dire environmental concerns that did not exist 200 centuries ago. The environmental decomposition of waste in the environment releases carbon dioxide and methane, which are two potential greenhouse gases. The transport sector, mainly aircraft and cars, is probably the main source of air pollution in the world. This sector was the largest emitter of carbon dioxide in the UK in 2018, with approximately 33.0% of all this gas (National Statics of UK, 2018). The amount of air carbon dioxide has increased in more than 40% since the beginning of the industrial revolution, which means it was about 280 parts per million (ppm) in the 1800s and is currently 415 ppm (KWEKU *et al.*, 2018). In some places wastewaters are directly discharged into the environment, without any prior treatment. Environmental pollution is among the causes of health problems, air contamination, ecosystem degradation, and climate change.

Waste released in the environment affect negatively human health through the contamination of lakes, rivers, sea, and groundwater, which allow the dissemination of diseases like cholera, diarrhea, dengue, and so forth. Recent data about the global burden of disease, published by IHME (Institute for Health Metrics and Evaluation) in 2016, revealed that

3.4% of diseases (80 million people according to the Disability-Adjusted Life Year - DALY) is attributed to lack of adequate water supply and sewage systems (WEIDEMA and FANTKE, 2018).

The climate change has been one of the most important environmental challenges since the last decade. In the beginning of May 2019, due to pressure from the Labor Party, the parliament of the United Kingdom declared ecological and climatic urgency. Less than two weeks later, the Irish parliament did the same. The Paris agreement aimed to limit the increase of temperature at 1.5 °C, being adopted by at least 195 states in 2015. These were right decisions in the permanent struggle against climate change at the local and global levels.

Climate change, environmental pollution, and energy supply are amongst the major uncertainties that the 21st century is dealing with. The death of many people worldwide, especially elderly people, is caused by climate change, whether too hot or too cold. This issue has also harmful impacts on the agricultural activities. Climate change also affects hydropower, river flow, agricultural yield etc. Regarding energy production and use, the costs involved and the emission of pollutants might result in considerable impacts. Given these concerns, new alternative initiatives targeting the energetic transition should be adopted.

Instead of fossil fuels (oil, natural gas, charcoal etc.), which leads to a very fast depletion of natural reserves for many generations, the use of renewable energy sources for energy production is a relevant option. Bioenergy presents a range of advantages (e.g. greenhouse gas displacement, energy self-sufficiency, and regional economic benefits), but its widespread use is a point of contention and political debate (ZURBA and BULLOC, 2019). Gasification is a sustainable solution to produce fuel and one of the best ways to meet the energy demand without causing damages to the environment and to human health. The use of biogas is a documented energetic transition, a way of reclaiming the importance of organic wastes and to reduce the CO_2 concentration in the atmosphere.

The reuse of some wastes might reduce the use of synthetic fertilizers, which have negative impacts in lakes, rivers, and seawater resulting in eutrophication. Many researchers like François *et al.* (2019); Lienert *et al.* (2003); Matsebe; Moilwa (2007); Duncker; Matsebe (2008); Mariwah; Drangert (2011); Nimoh *et al.* (2014a); Nimoh, *et al*. (2014b); Okem *et al*. (2013); Mugivhisa; Olowoyo (2015); and Simha *et al*. (2018) have investigated the perception of people about the reuse of human urine as fertilizer in agriculture. Some other authors such as Phuc *et al.* (2006); Matsebe; Moilwa, (2007); Moya *et al*. (2017) have investigated about the acceptance of reuse of human waste in agriculture.

The analysis of the literature shows that some wastes are used to produce either energy, fertilizers or both of them. Almost all biomass sources (agricultural wastes, forestry residues, leftovers of food and animal manure etc.) present great potential for methane production. Lueangwattanapong *et al. (*2019) carried out a research in which they selected agave, ananas, suphorbia, kalanchoe, and opuntia as raw material for the production of methane under mesophilic temperature. In Taiwan, pig wastes are used to produce biogas, fertilizer, and clean water. Utilization of waste for energy production might be performed through an anaerobic digestion process in order to produce biogas. Anaerobic digestion is the most common digestion process used to convert any organic matter in biogas, whose main components are methane and carbon dioxide. Converting biomass to energy is an environmentally friendly alternative to fossil fuels, which is a non-renewable energy source. Biogas technology is viewed as a way to diminish the rural poverty and to increase development (MUKUMBA *et al*., 2013). Poocheera *et al*. (2014) reported that biogas presents a heating value of 24,336 MJ/Nm^3.

No gas is produced during the process of biogas production, and the released fractions of methane and carbon depend on the feedstock used. Biogas is generally used for cooking, lighting, electricity and may even be used as vehicular fuels after its purification. Human feces is one source of biomass and may be used for the production of biogas and fertilizer through anaerobic digestion process. According to Andriania *et al (*2015), human stools presents a potential similar to cattle manure regarding biogas production. However, the acceptance of this practice could meet difficulties due to norms, religion, habits, etc. of specific groups. Environmental sanitation practices have included several factors such as social attributes, economic factors and demographic age, income, gender, education, domestic characteristics, and context conditions (MUGIVHISA and OLOWOYO, 2015; DARAMOLA and OLOWOPOROKU, 2016). To our knowledge, there are no or few studies in the literature about the behavior (the conduct), attitudes (the expressions of feeling or thinking), or

perceptions (the mental image) of people about the acceptance of the gas produced by human waste. However, knowing the three interconnected factors is critical for planning any action to reuse this material or convert it into a new product. Attitude is considered as the main point for understanding human conduct (ABDELHAMID, 1987), and it varies between cultures and educational levels. Thus, to better understand what people think about this resource, the present study intended to assess the perception of the students of the Yuan Ze University about the acceptance of the biogas produced from human waste for cooking food.

2 MATERIALS AND METHODS

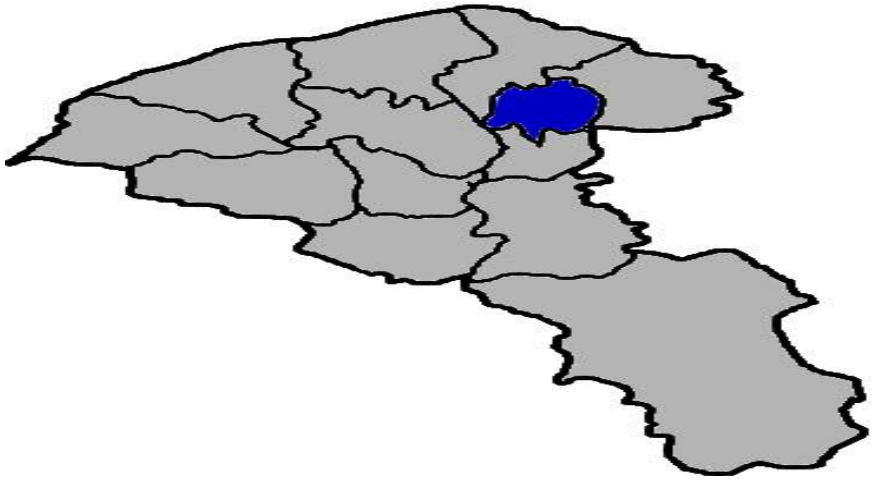
2.1 Description of the area

The object of this work was to assess the perception of the students of the Yuan Ze University (YZU) about the use of biogas produced from human waste for cooking. In 2016, YZU had more than 9000 students with a 2:1 ratio between undergraduate and graduate students in the campus. It has five colleges (Engineering, Informatics, Management, Humanities, Social Sciences, and Electrical and Communications). This university is situated in the city of Neili, in the municipality of Zhongli, in the Taoyuan district (Figure 1). This district is located between $24^0 27' 25'' \text{ N}$ and $121^0 13' 25'' \text{ E}$, being distant 46.0 Km from the capital of Taiwan (Taipei). The average annual temperature of Taoyuan is $17\ ^0\text{C}$, with $4.8\ ^0\text{C}$ in January and $28.4\ ^0\text{C}$ in July.

2.2 Data collection

A semi-structured questionnaire with open-ended and closed-ended questions was used to collect the data via face-to-face interviews. The questionnaire had seventeen (17) questions grouped in three (3) categories. The first consisted in questions about sociocultural data, such as gender, age, course, educational status etc. The second section provided information about the fuels they used for cooking, such as the kind of fuels that are used in their house, the amount used in a week and so on. The final section was about their perception and attitudes about the use of biogas produced from human feces, for instance whether they have ever heard that human waste is a source of biomass, if they believed it could be converted into biogas, whether they would use it to cook foods, the kind of food they would cook using this gas, their concerns in case they would not use this fuel etc. The questionnaire was originally written in English and then translated into traditional Mandarin by a local Master Degree student. The translation was certified by two (2) other students (one in a Master Degree and the other in Doctorate). Papers were used for data collection and 110 students were chosen randomly to be interviewed regardless of their sexes, educational status (Bachelor Degree, Master, or Doctorate) and courses. The main criteria were to be a Taiwanese and a student of that university. In order to preserve their identities, letters from the English alphabet were used combined with numbers from 1 to 9. The average length of the interview was 10 minutes.

Figure 1: Location of the Taoyuan district.



Source: Wikipedia, 2020.

The choice of the university for this survey was made taking into account the ease of access for students, and proficiency in English by some of them, mainly the graduate and postgraduate ones. The target public was the undergraduate, graduate, and postgraduate students, regardless of their courses.

2.3 Data analysis

In order to facilitate the analysis of closed-ended questions, the letters 'Y' and 'N' were used for positive and negative answers, respectively. For the open-ended questions, numbers from '0' to '9' were employed. The data were processed and statistically analyzed testing for proportion checking if there are significant differences among the socio-demographic answers to the questions, using the R software (version 3.4.3). The significant level was set at p-value=0.05.

3 RESULTS AND DISCUSSION

Table 1 showed the socio-demographic characteristics and fields of study of the respondents. Most of them were female, less than 20 years old, with a bachelor degree, had no religion and studied Chemical Engineering. The other participants studied Mandarin, Finance, Management, and other courses.

Table 1: Socio-demographic characteristics and fields of study of the participants.

Characteristics		Quantity	Percentage (%)
Gender	Female	61	55.45
	Male	49	44.5
Range of age (years)	Until 20	77	70.0
	21 to 30	31	28.2
	31 to 40	1	0.9
	41 to 50	1	0.9
Religion	Catholicism	3	2.7
	Islam	1	0.9
	Christian	4	3.6
	Taoism	32	29.1
	Buddhism	6	5.5
	No religions	64	58.2
Educational Status	BA*	92	83.6
	MS*	14	12.8
	PhD*	4	3.6
Field of study	Inf.*	8	7.3
	Chem.& M*	41	37.3
	Elect*	13	11.8
	Bus*	14	12.7
	Art*	8	7.3
	Others	26	23.6

BA*: Bachelor degree, MS*: Master degree, PhD*: Doctorate, Inf.*Computer Science, Chem* & M*: Chemical Engineering and Materials Science, Elect.*Electrical Engineering, Bus*: Business administration, Art*: Art and design.
Source: The author, 2019.

When questioned about the type of gas they used at home to cook food, all answered natural gas, but the volume used varied, depending on the number of people that lived in their houses. Some of them answered they did not know exactly, because they prefer to eat in restaurants. When they do not eat in restaurants, they cooked beans, rice, vegetables, soup, meat, pumpkin, stinky tofu, fried chicken, dan bing, braised pork over rice, shrimp ball with pineapple, hakka little stir-fry, noodle in scallion, oil gong-wan-tang, corn, soup, banana etc.

3.1 Perception of the students about the use of human waste to produce biogas

Only 54.5% answered positively about knowing that human waste could be used to produce biogas. However, about 89.0% of the respondents believed that human stools can be used to produce energy. Among the female and male interviewed, 90.2 and 87.8% respectively believed that it is possible to convert human waste into natural gas (table 2).

Most of the participants have already heard that human waste can be used to produce natural gas. Only 10% of female were unaware of this potential, whereas approximately 80.0% of the males answered they have never known that human poop is a substrate that could be used for biogas production. Thus, there was no significant difference between males and females on this perception. About the belief that human waste is a resource to produce gas, 55.7 and 53.1% of females and males respectively thought it is possible. No significant difference was identified between both of them at this level. The belief of the respondents about turning human waste into biogas is shown in Table 3.

Table 2: Sociodemographic characteristics of the respondents

Sociodemografic characteristics		Percentage (%)	p-value
H.Ex.F	Female	90.2	0.77
	Male	87.7	
B.Ex.F	Female	55.7	0.68
	Male	53.1	

H.Ex.F*: Heard that human waste can be used to produce fuel, B.Ex.F*: Believed that human waste can be used to produce fuel

Source: Elaborated by the author, 2020.

Table 3: Students that believed human waste could be used to produce fuel.

Characteristics		Quantity	Percentage (%)
Religion	No religion	55	84.6
	Taoism	30	93.8
	Others	13	100.0
Educational Status	BA*	82	89.1
	MS*	12	85.7
	PhD*	4	100.0
Field of study	Inf.*	8	100.0
	Chem & M*	35	85.4
	Elect*	11	84.6
	Bus*	13	92.9
	Art*	7	87.5
	Others	24	92.3

Source: Elaborated by the author, 2020.

Regardless of religion, the belief that human waste can be used to produce biogas or fuels was above 84.0%. All Christian, Buddhist, and Islamist students had positive beliefs about this issue. Approximately 84.6% and 93.8% of non-religious and Taoist students, respectively, thought that is possible to produce gas via human stools. There was no significant difference between religions regarding their belief that human waste can be used to produce fuel.

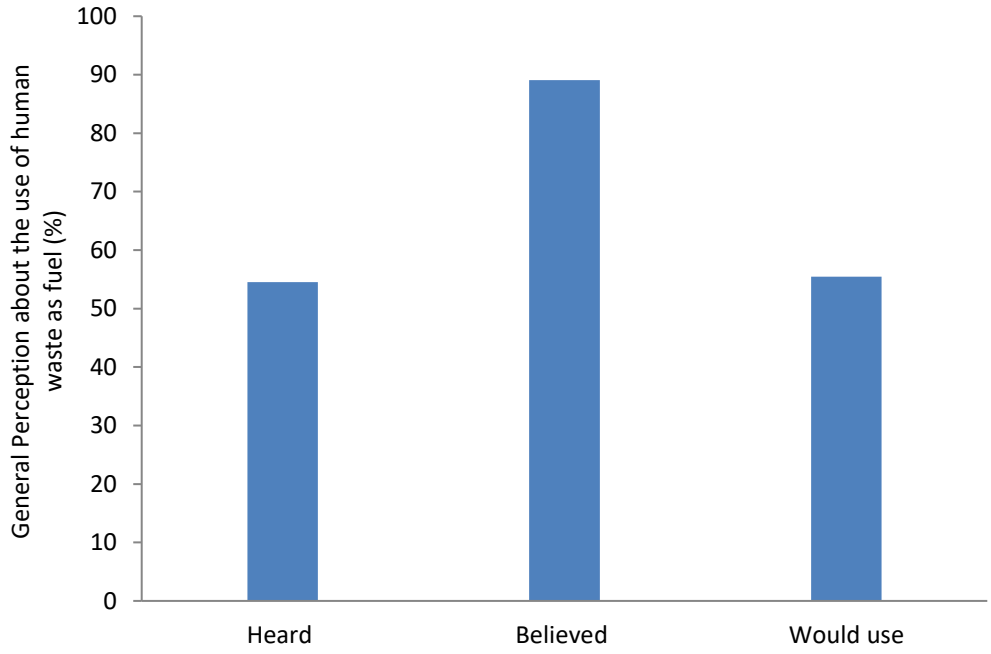
Regarding the educational status, 100.0% of Ph.D, 89.1% of Bachelor Degree, and 85.7% of Master Degree students were aware that producing biogas from human waste is possible. The level of students does not affect their belief that human waste can be used for fuel production.

The positive belief of the participants concerning the transformation of human excreta into fuel varied according to their fields of study: 100.0% of the students in Computer Science; 85.4% in Chemical Engineering and Materials Science, 84.6% in Electricity, 92.9% in Business Administration, 87.5% in Art and Design, and 92.3% in other areas, such as Mandarin language etc. Despite the fact that the transformation of human excreta into biogas or other fuel is a biochemical process, the percentage of students in Chemical Engineering that were aware of this potential was lower than the ones who studied Informatics, Business Administration, Art and

Design, and other areas. This may be due to the fact that most of them were undergraduates and might be in their first or second semesters, but no significant differences were found between the study fields regarding their viewpoints.

The knowledge that human excreta can be used for biogas production is not well known by the respondents. Only 54.5% of the participants were aware that this is a viable process, while 89.1% of the interviewees believed that it is a feasible alternative. However, the percentage that would use the gas produced that way to cook food is approximately the same (55.5%) of those who were aware that this alternative exists (Figure 2). There is frequently a huge difference between the belief or consideration that something can be used and its acceptance. The same observation was identified in the work of Simha *et al*. (2018) about the opinion of consumers about recycling human urine as fertilizer (55% against 44% of the respondents).

Figure 2: Knowledge, belief, and willingness to use gas produced from human waste.



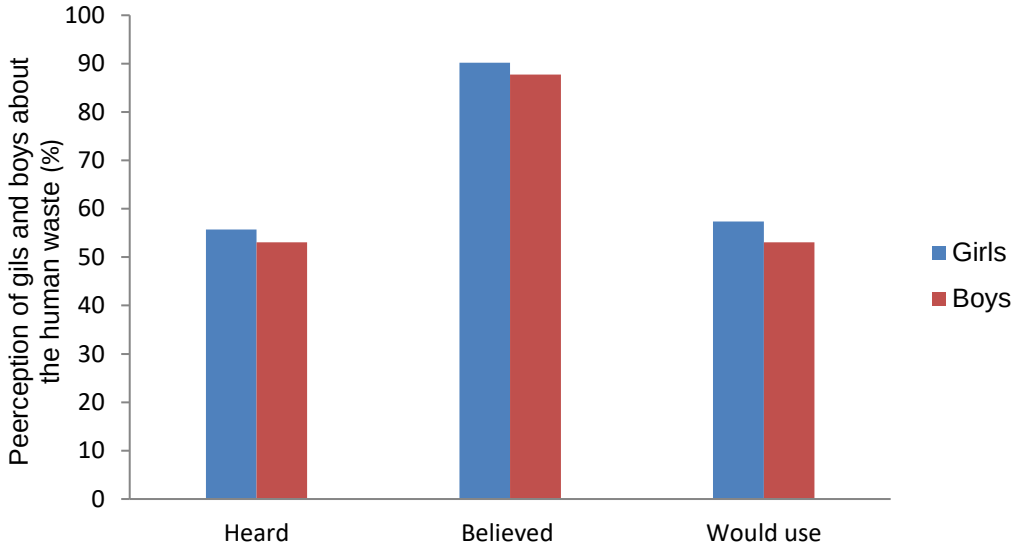
Source: Elaborated by the author, 2020.

There was no significant difference between the number of respondents that were aware that human waste can be used as substrate to produce fuel and the number that would use it to cook food. Nevertheless, there were significant differences between those that have already heard about this practice and the ones who would use the fuel produced from this type of raw materials (p-value=0.00001), as well as between students that would use this fuel and those who believed human waste can be turned into fuel (p-value=0.00001). Those gaps may be due to lack of information about this fuel or its use.

Most of the respondents that heard, believed and would use biogas from human waste were female and the percentages were respectively, 55.7%, 90.2%, and 57.4% (Fig.3). There is no significant difference between male and female answers, neither in hearing the human excreta as substrate for fuel, in belief that it can be used, nor in possibility to use gas derived from it, but the proportions of the girls were slightly superior.

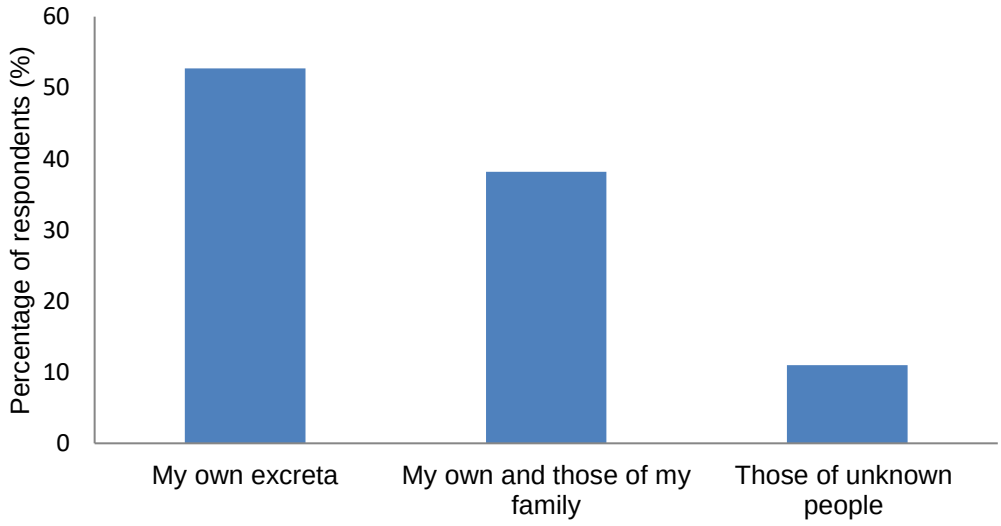
The acceptance of the use biogas derived from human excreta varied according to its origin. About 52.0% of the respondents would use only the fuel produced from their own stools, 38.2% would use this fuel only from their own waste and from their family excrements. Only 10.0% would not have any concern to use biogas produced from excrements of unknown people (Fig. 4). This result is similar to the one found by François *et al*. (2018), in which they pointed out that 66.7%, 41.4%, and 8.6% people was willing to use respectively their own urine, urine of their family, and from unknown people in agriculture.

Figure 3: The willingness to use human waste according the gender of the participants.



Source: Elaborated by the author, 2020.

Figure 4: Acceptance to use gas from human waste according to its origin.

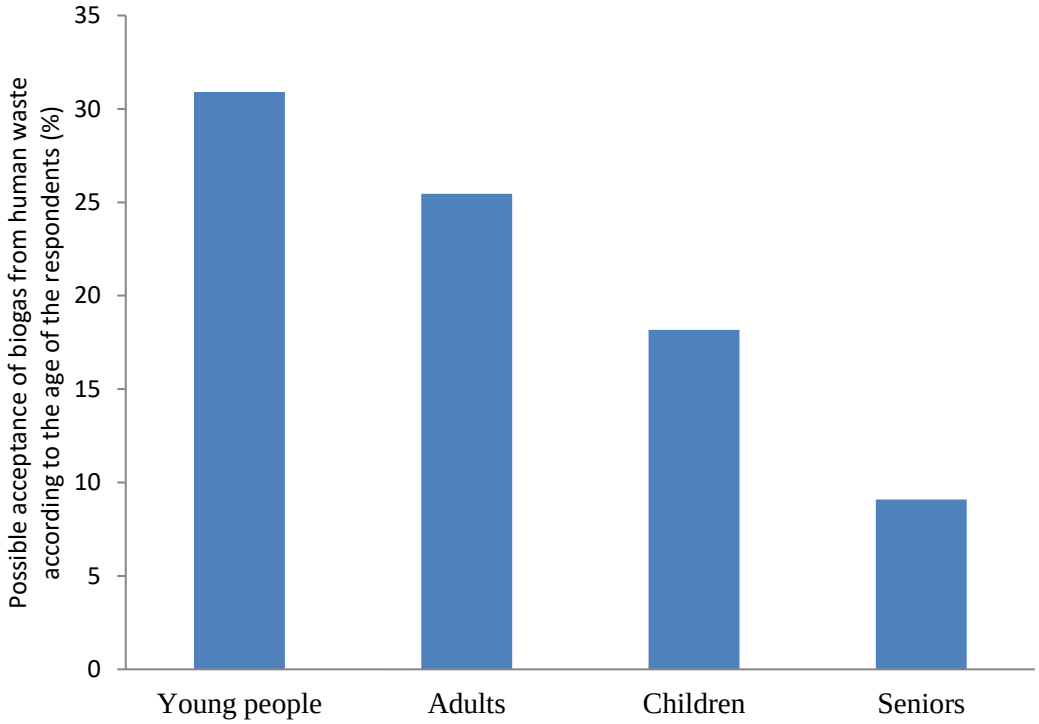


Source: Elaborated by the author, 2020.

In many places of the world people are more flexible to use their own waste than those of others. The acceptance to use products derived from human excrement is always influenced by psychological factors. According to Drangert (2004), people often think that their own excrement is less disgusting than that of others. The same situation was found regarding the perception of the students of YZY University about this issue. When the waste of their family was included in the question the percentage of acceptance decreased and continued decreasing when they were questioned about waste of unknown people. There is a statistically significant difference between students that would use fuel produced only from their own waste and that produced from their family and their own (p-value= 0.03). Also, a significant difference was found between the willingness to use this type of fuel produced from waste of their family and their own and that produced from the unknown people (p-value= 0.00001). Those differences may give rise to some concerns they previously had but did not reveal.

Besides the origin of the stools, the age of the waste producers would also have an impact on the acceptance of this fuel (Fig. 5).

Figure 5: Possible acceptance of fuel produced from human waste according to the age of the producers.



Source: Elaborated by the author, 2020.

The biogas derived from waste of young and adult people would have an acceptance of 30.91% and 25.5%, respectively. However, if it comes from children and seniors, only 18.2% and 9.1% will be accepted, respectively. Some respondents thought that waste from the seniors have bad smell and could even affect the quality of the gas. Significant differences were identified only between the acceptance of fuel produced from waste of young people and children (p-value=0.02); young people and seniors (p-value=0.00001); and adults and seniors (p-value=0.001). The percentages of acceptance of fuel produced from adult and children waste are different than those found by François *et al*. (2019), in a research carried out in Serrinha-BA (Brazil) about the use of urine from young people in agriculture. This study found that 45.7% and 51.0% of the respondents would agree to use urine of adults and children, respectively. This could occur due to cultural differences between both countries or to the fact that both wastes (urine and feces) do not have the same properties, or because stools are usually more contaminated than the urine. There is no significant difference between young and adult people about their acceptance of fuel derived from human waste.

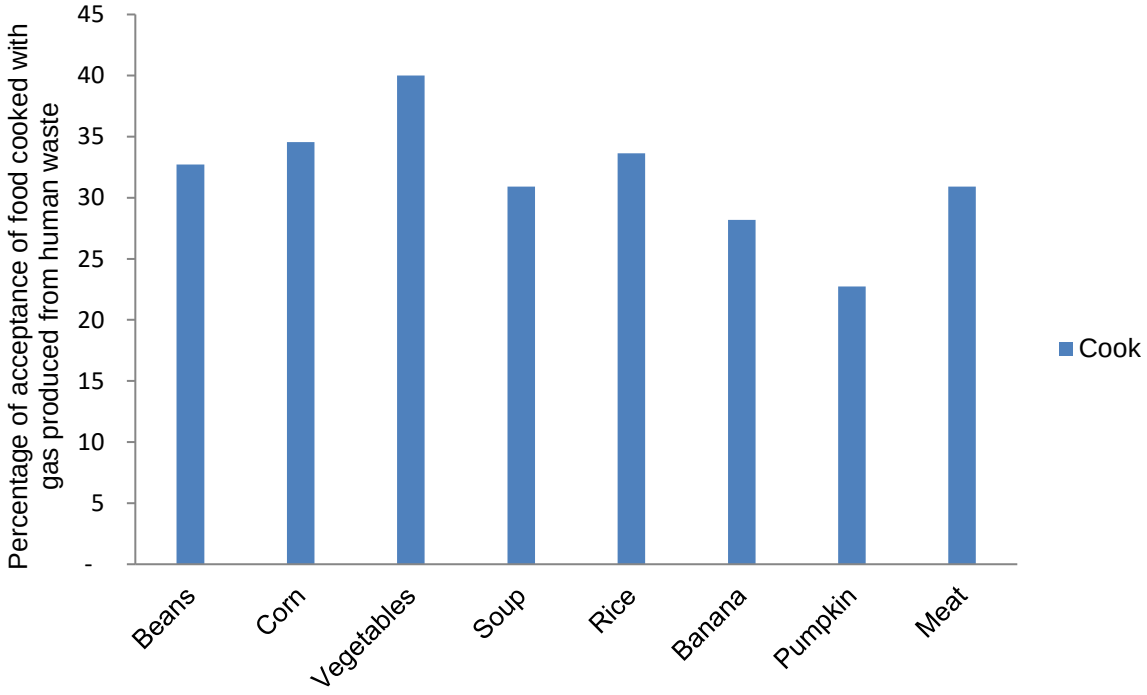
The approval to cook foods with gas produced from human feces varied from one type of food to another, following this sequence of approval: beans (32.7%), corn (34.5%), vegetables (40.0%), soup (30.9%), rice (33.6%), banana (28.2%), pumpkin (22.7%), and meat (30.9%) (Figure 6).

Forty percent of the respondents would cook vegetables with this gas. A significant difference was identified only between the people that would accept to cook vegetables in general and pumpkin (p-value=0.005). Some students revealed some concerns about the use gas such as health risk (40.0%), fear (10.9%), food disgust (4.6%), bad smell (26.4%), and taboo (3.6%) (Figure 7).

Health risk was the major concern of the students about the use of this type of fuel. Some of them stated that this fuel could represent a threat to health, but when questioned about the type of threat, they were not able to provide an answer. The second major concern was bad smell. Even though they told they have never used this kind of gas or have known someone who have used it, they assumed it had a bad smell. Bad smell is also linked to health risk. Some students reported that they were afraid of waste and if they knew that a type of fuel is derived from it, they would reject it. Finally, the concerns of disgust and taboo represented both together around 8.2% of the answers. This work identified significant differences between health risk and bad smell (p-

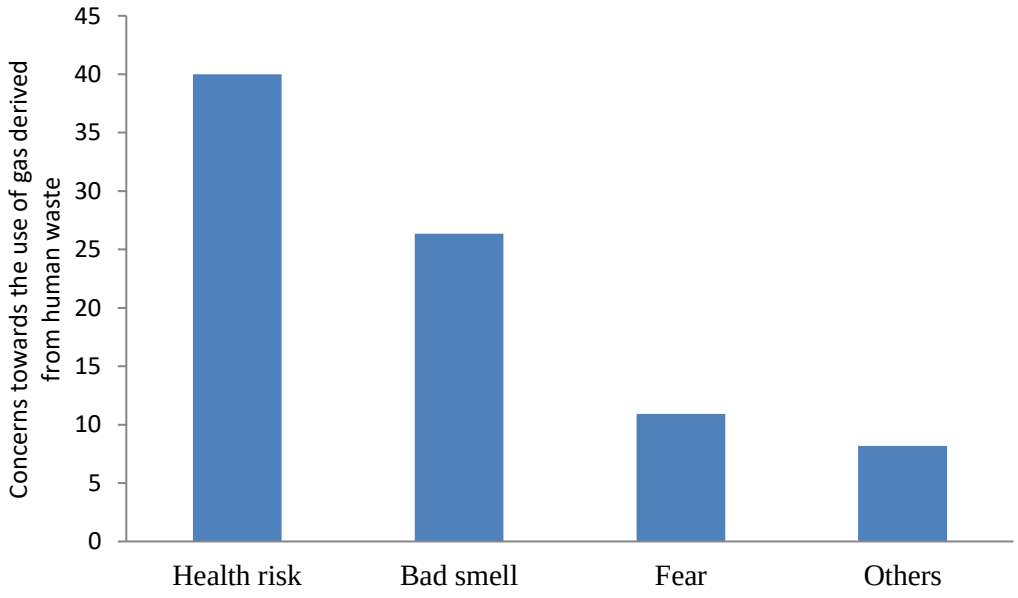
value=0.03); health risk and fear; bad smell and others (taboo and disgust); fear and others (p-value varies from 0.00001 to 0.003). The acceptance of human excrement is highly influenced by psychological aspects revealing a perception that considers the use of products derived from waste produced by other people as more dangerous than products that come from their own waste, even after undergoing biochemical transformations. The disgusting aspect they evoked is also related to fear, bad smell, and health risk. According to Rosenquist (2005), the feeling of disgust is directly associated to contamination.

Figure 6: Types of food that would be accepted to be cooked with gas produced from human waste.



Source: Elaborated by the author, 2020.

Figure 7: Concerns of the respondents regarding the use of gas produced from human waste



Source: Elaborated by the author, 2020.

The approval of a product retrieved from waste, presented in Figure 7, is similar to the one found in investigations that have been carried about the acceptance of human urine in agriculture by François *et al*. (2019), Mugivhisa and Olowoyo (2015), and Simha *et al*. (2018), in which the acceptance was approximately 65.0%, for each one.

In the present research it was not possible to identify a significant difference between males and females, neither between students in bachelor degree and those in master degree, regarding the health risk represented by fuel produced from human waste (Table 4).

Table 4: Socio-demographic aspects vs fuel derived from human waste represents risk for health

Sociodemographic characteristics		Percentage (%)	p-value
Gender	Female	44.26	0.3
	Male	34.69	
Educational Status	BA	42.39	0.6
	MS	35.71	

Source: Elaborated by the author, 2020.

However, males were less concerned than females about the health risk of this gas. The rejection of biogas produced from human excrements was more frequently observed in the bachelor degree students than those from master degree. This may indicate that the level of education has a decisive influence about this issue among students.

CONCLUSIONS AND RECOMMENDATIONS

More than half of all students (54.5%) had already heard that human feces could be used for biogas production. Questioning about their beliefs if such alternative was possible, the percentage was 89.1%. When questioned if they would use biogas produced from human waste, this percentage decreased and was slightly higher (55.5%) than hearing about this practice.

The socio-demographic characteristics did not have much influence on the perception of the respondents about the use of human waste. However, girls and students at the bachelor degree level were more worried and less flexible regarding any eventual alternative of using human waste as biomass to produce gas for cooking. The major factors to avoid the use of gas retrieved from the biochemical transformation of human waste were health risk (40.0%), bad smell (26.4%), and disgust (10.9%). Therefore, this work concludes that the use of human waste is viable alternative to produce biogas. It is suggested that publishing more research papers about this topic and doing an experimental research in which the investigator(s) would present different samples of natural gas to the participants and ask them to choose one which they would use to cook their food could help breaking down those barriers. The use of human waste (excreta) is a good option to produce energy for cooking and heating. It is also an alternative to reduce the environmental pollution and to produce electricity in countries where the population is expanding.

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