# GRAVIMETRIC CHARACTERIZATION OF THE SELECTIVE COLLECTION OF BAURU (SP) IN THE WASTE SORTING COOPERATIVE – COOPECO

## CARACTERIZAÇÃO GRAVIMÉTRICA DA COLETA SELETIVA DE BAURU (SP) NA COOPERATIVA DE TRIAGEM – COOPECO

## CARACTERIZACIÓN GRAVIMÉTRICA DE LA COLECCIÓN SELECTIVA DE BAURU (SP) EN LA COOPERATIVA DE CRIBADO - COOPECO

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**ABSTRACT:** The objective of this study was to perform the gravimetric characterization of dry recyclables from the selective collection in the city of Bauru, state of São Paulo as well as their residues and other qualitative aspects. The study site was in the *Cooperativa Ecologicamente Correta de Materiais Recicláveis de Bauru* (Ecologically Correct Cooperative of Recyclable Materials) - COOPECO. For the analysis and qualitative characterization, the method of homogenization and quartering of the samples was used, in which the dry residues of the selective collection were sampled in four days of the week. The percentages of dry recyclables obtained in the sum of the four days of the selective collection were: paper/cardboard (30.28%); glass (26.34%); plastic (19.62%) followed by residue (19.19%). The percentages of the residues from the conveyor were: 20.82% plastic and 10.48% paper, as well as the presence of organic components (10%), referring to training and environmental education.

**Keywords**: Urban solid waste. Selective collect. Reverse logistic. Environmental education. Bauru.

**RESUMO:** Este trabalho objetivou realizar a caracterização gravimétrica dos recicláveis secos da coleta seletiva da cidade de Bauru-SP, bem como seu rejeito e outros aspectos qualitativos. O local do estudo foi na Cooperativa Ecologicamente Correta de Materiais

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Recicláveis de Bauru (COOPECO). Para a análise e caracterização qualitativa utilizou-se o método de homogeneização e quarteamento das amostras, sendo amostrados os resíduos secos da coleta seletiva em quatro dias da semana. Os percentuais de recicláveis secos obtidos na soma dos quatro dias da coleta seletiva foram: papel/papelão (30,28%), vidro (26,34%), plástico (19,62%) seguido por rejeito (19,19%). Os percentuais sobre os rejeitos da esteira foram 20,82% de plástico e 10,48% de papel, bem como a presença de componentes orgânicos (10%), remetendo à capacitação e educação ambiental.

**Palavras-chave**: Resíduos sólidos urbanos. Coleta seletiva. Logística reversa. Educação ambiental. Bauru.

**RESUMEN:** Este trabajo tuvo como objetivo realizar la caracterización gravimétrica de los reciclables secos de la recolección selectiva en la ciudad de Bauru-SP, así como sus residuos y otros aspectos cualitativos. El lugar de estudio fue en la Cooperativa Ecológica Correta de Materiales Recicláveis de Bauru (COOPECO). Para el análisis y caracterización cualitativa se utilizó el método de homogeneización y despiece de las muestras, siendo muestreados los residuos secos de la recolección selectiva en cuatro días de la semana. Los porcentajes de reciclables secos obtenidos en la suma de los cuatro días de recogida selectiva fueron: papel/cartón (30,28%), vidrio (26,34%), plástico (19,62%) seguido de residuos (19,19%). Los porcentajes de relaves de faja transportadora fueron 20,82% plástico y 10,48% papel, así como la presencia de componentes orgánicos (10%), referente a capacitación y educación ambiental.

**Palabras clave:** Residuos sólidos urbanos. Recogida selectiva. Logística inversa. Educación ambiental. Bauru.

## INTRODUCTION

Nowadays, urban solid waste (USW) is a concern regarding the problems caused to the environment, particularly caused by the inadequate destination of its components (DHAR *et al*., 2017; SAIKIA and NATH, 2015). In developing countries such as Brazil, the rapid urban growth combined with financial and management incapacity, affect the establishment of the necessary basic infrastructure, which is reflected in the population's quality of life (JACOBI and BESEN, 2011). The correct USW management and proper disposal (which includes household waste and waste from public cleaning) are the responsibility of the government and according to the National Solid Waste Policy (PNRS in Portuguese) – by means of the Law No. 12.305 of 2 August 2010 – aims to prioritize the physical integrity of the population and minimize the impacts on the environment provided by the correct destination, reuse, recycling and adequate allocation of its waste. As stated in item XV of the 3rd article of the same law:

> Residues: solid waste that, after all the possibilities of treatment and recovery by available and economically viable technological processes, has no other option than the environmentally adequate final disposal.

There is a great challenge in relation to materials that haven't been considered viable in the recycling and composting process (organic matter). These processes, according to Nascimento *et al*. (2015), occur at low annual growth rates. The difference between recycling and reuse is that in the recycling process, methods that transform the physical, chemical, or biological composition of materials are used, aiming at a new product or input. The National Solid Waste Policy (PNRS in Portuguese) also emphasizes that reuse and recycling of solid waste can generate income and work especially for low-income people, providing the development of citizenship (BRASIL, 2010). Despite the great importance of these institutions regarding the environmental role, in practice, many organizations face some difficulties with the lack of support from the public, private and civil spheres (SOUZA *et al*., 2012).

The selective collection is an essential element for cooperatives to fulfill their role by carrying out sorting for the recycling and selling of the materials. This type of collection can be carried out on a door-to-door basis or also at voluntary delivery points (VDPs) or ecopoints, with the following advantages: reduction of common waste; higher-quality materials intended for cooperatives and formation of possible partnerships with schools, waste pickers, companies, among others. As for the disadvantages: the need for special vehicles and the synchronization of collection days, as well as a suitable place to sort the material (MANO *et al.*, 2010). Greater possibilities of partnerships between cooperatives, companies, and public authorities were listed and can be preponderant in the feasibility of projects to solve problems related to waste management. We can observe some case studies in Aguiar and Phillippi (2000) and their respective experiences in the cities of Embú (SP), Campinas (SP), Goiânia (GO), and Santos (SP).

Regarding data on selective collection programs carried out by Brazilian municipalities, 87% are concentrated in the south and southeast regions of the country. There was also an increase in the period from 1994 to 2014 from 81 to 927 municipalities with operating selective collection programs; however, it seems that despite the growth, the national coverage is still small, evaluated at 22% in 2018 with 1227 municipalities (COMPROMISSO EMPRESARIAL PARA RECICLAGEM, 2019). According to ABRELPE, in 2018, the Southeast region disposed of 72.7% of its waste in sanitary landfills (77.045 t/day); 17.2% in controlled landfills (17.051 t/day), and 10.4% still being allocated in landfills, which represents more than ten thousand tons daily (ASSOCIAÇÃO BRASILEIRA DE EMPRESAS DE LIMPEZA PÚBLICA E RESÍDUOS ESPECIAIS, 2019).

Although cooperatives provide the use of recyclable materials, the amount of waste accumulated on the premises of these companies can be large, waiting for the logistics of municipal transport to be disposed of in landfills. The problem may be aggravated when the vehicles of the fleet of these municipalities are damaged or under maintenance, as in the city of Bauru. The concern about the accumulation of residues in this open area also

focuses on the attraction of disease vectors, such as the dengue mosquito and other insects; proliferation of poisonous animals such as scorpions, rodents, and bad smell as well.

The objective of this work was to carry out the gravimetric analysis of the dry recyclables resulting from the selective collection program in the city of Bauru, state of São Paulo in a sorting cooperative (COOPECO) according to the use of materials, as well as to characterize the materials of the residues resulting from the horizontal conveyor and other qualitative aspects.

## MATERIALS AND METHODS

### Local characterization

Bauru is a municipality located in the mid-western region of the state of São Paulo with 343,937 inhabitants and an HMDI of 0.801. Bauru ranks the 262nd place out of 645 municipalities in the State of São Paulo with 28% of urban households on public roads with adequate urbanization. All the data cited are from the 2010 census (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2021). The place chosen for the study was the Cooperativa Ecológicamente Correta de Materials Recicláveis de Bauru (COOPECO), located at 16 Santa Beatriz da Silva Avenue, Square 6, Ferradura Mirim, Bauru-SP. The cooperative receives approximately 80 tons/month of USW and sells recyclable materials to recycling companies such as KAPER (paper and cardboard), SUCATAS URUBATÃ (plastic types: PET, HDPE, PP, PVC) RECICLAR (various materials), and GERDAU (for scrap purchase). The cooperative also maintains partnerships in the collection of recyclable materials, such as the partnership with Banco do Brasil.

### Procedures for gravimetric characterization

Our methodology was elaborated considering the quartering procedure with homogeneous mixing of the waste plots, as described in Soares (2011). Also, for the sample collection, we used a 100-liter bin as seen in Vilhena (2018). A 100-liter polypropylene bin was then used to remove the four samples, one at the top of the waste pile, the other at the bottom center, and two at the bottom sides of the pile (Figure 1a), totaling approximately 24 kg of initial residues per assay. The quartering method consisted of allocating the material for homogenization on the top of a spread canvas with pieces of wood to form a 2 X 2-m square and 4-m² partitions (Figures 1b and 1c). Next, the residues of the two opposite quartiles were separated for a new homogenization and another removal of the opposite quartiles that had not been discarded. The final two quartiles were used for the gravimetric analysis of the materials. To find the percentage of each component in the sample, the weight value of the component plot (plastic, paper/cardboard, metal, glass, styrofoam, waste, etc.) was divided by the total sampled. Finally, this value was multiplied by 100.

The weight of the materials was measured using the Prix 3 Fit scale, with a maximum and minimum capacity of 15 kg and 2 g, respectively.


**Figure 1.** Images of the site where the gravimetric characterization was performed at COOPECO Cooperative, Bauru-SP.
(a) General overview of the cooperative yard with arrows pointing to the locations where samples were collected. (b) Assembly of the 2x2m wooden quadrant on a tarpaulin. (c) Homogenization and quartering of materials for gravimetric analysis. (d) Horizontal conveyor where the materials are sorted where arrows point to the direction and accommodation of the residues in the bag.

In Table 1, the recyclable materials that possibly reach the cooperative for sorting and their respective conditions of use were listed.

**Table 1.** Household waste generated in Bauru-SP and sent to the *Cooperativa de Triagem* (Sorting Cooperative) – COOPECO, 2019.

| Materials | Use | |
|---|---|---|
| | **Recyclables** | **Non-recyclable** |
| **Plastic** | Glasses – only clean glass (PS)*<br>Bottles and packages (PET)*<br>Bags<br>Containers of the products (PEAD)*<br>Jars (PP)*<br>Outlets<br>Pipes (PVC)* | Panhandles<br>Stickers<br>Foam<br>Metallic packages (biscuits/ snacks) |
| **Paper** | Newspapers, magazines, and flyers<br>Directories<br>Sulfite paper/draft<br>Fax paper<br>Boxes in general (corrugated cardboard)<br>Envelops<br>Old posters<br>Notebook paper | Adhesive labels<br>Carbon / cellophane paper<br>Crepe tape<br>Toilet paper<br>Waxed coated, laminated, and metallic paper<br>Photographs<br>Napkins |
| **Metal** | Bottle caps<br>Can<br>Pesticide bottles<br>Canned products<br>Pans without handles<br>Hardware<br>Steel wool<br>Wire/ nails<br>Hardware/steel plates | Clips<br>staple<br>Paint cans (with paint)<br>Varnish cans (with varnish) |
| **Others** | Rubber hose<br>Foam (block)<br>Tetra Pak<br>X-rays films | Fabric<br>wood<br>Leather<br>White plastic (milk)<br>Construction debris<br>Hospital waste<br>Foam (trays)<br>Organics<br>Pruning of trees debris |

Source: CORAL (2019).

Observation: the table's content is an adaptation of the information from the site ECOPLUs, on the subject "Selective Collection: what can be selected and what cannot be selected".

*(PS) = polystyrene.

*(PET) = poli(ethylene terephthalate).

*(PEAD) = high density polyethylene

*(PP) = polypropylene.

*(PVC) = poli(vinyl chloride).

At first, USW was sampled on four days of the week, namely: Monday, Tuesday, Wednesday, and Thursday (May 2019). This separation according to days of the week

was important because waste from different neighborhoods of the city arrives at the cooperative's warehouse on different days, then four (04) samples per day of the week (Neighborhoods) are computed.

An average was also performed in relation to two tests of the wastes that fell directly into the bag placed at the end of the conveyor (Figure 1d), accounting for eight (08) samples. Finally, four (04) samples of the most common types of plastics found in the cooperative, and four (04) samples were evaluated for the physical situation of the glasses, whether broken or not.

The gravimetric analysis was considered according to the use of materials, that is, the material that could not be used by the recycling companies was treated as waste. So, the aid of the cooperative's employees was essential to classify the conditions of the materials according to the preference of the buyers.

Note: Because of the cleaning of the space in the cooperative, lack of materials, and the destination of recyclables for sale, sampling tests for the dry residues on arrival were not carried out on Friday.

Regarding the procedures of homogenization, separation, and accommodation of the materials used in the gravimetric analysis, potentially hazardous materials such as varnishes and solvents used for painting, pesticides, repellents, and others from gardens and backyards; brake fluids and lubricating oils resulting from automotive materials, in addition to other items, such as aerosols, batteries, and fluorescent lamps, could be found among the material. Therefore, the use of personal protective equipment was necessary not only as a precautionary measure but also to prevent the risks of contact with contaminated materials and transmission of diseases (SILVEIRA, 2004).

## RESULTS AND DISCUSSION

The results in relation to the gravimetry of the most common materials such as plastic, paper/cardboard, metal, glass, styrofoam, and residues were obtained through the tests carried out at the cooperative, using the waste from the selective collection on arrival.

Table 2 shows the values in percentage and standard deviation according to the days of the week of each material evaluated in these tests and Figure 2 presents the same data in percentage observed in Table 2; however, in an illustrated way for better visualization.

**Table 2.** Gravimetry of dry recyclables on the arrival (May 2019) at Cooperativa COOPECO, Bauru-SP according to their use.

| Materials | Days of the week | | | | | |
|---|---|---|---|---|---|---|
| | (1) Monday | (1) Tuesday | (2) Wednesday | (3) Thursday | Mean | SD* |
| **Plastic** | 19.92% | 20.69% | 16.50% | 21.37% | 19.62% | 2.162 |
| **Paper/cardboard** | 38.73% | 29.28% | 26.02% | 27.08% | 30.28% | 5.796 |
| **Metal** | 2.14% | 3.86% | 4.72% | 5.65% | 4.09% | 1.492 |
| **Glass** | 20.87% | 31.79% | 32.66% | 20.06% | 26.34% | 6.806 |
| **Styrofoam** | ... | ... | 1.50% | 0.41% | 0.48% | 0.708 |
| **Residue** | 18.34% | 14.38% | 18.60% | 25.43% | 19.19% | 4.587 |

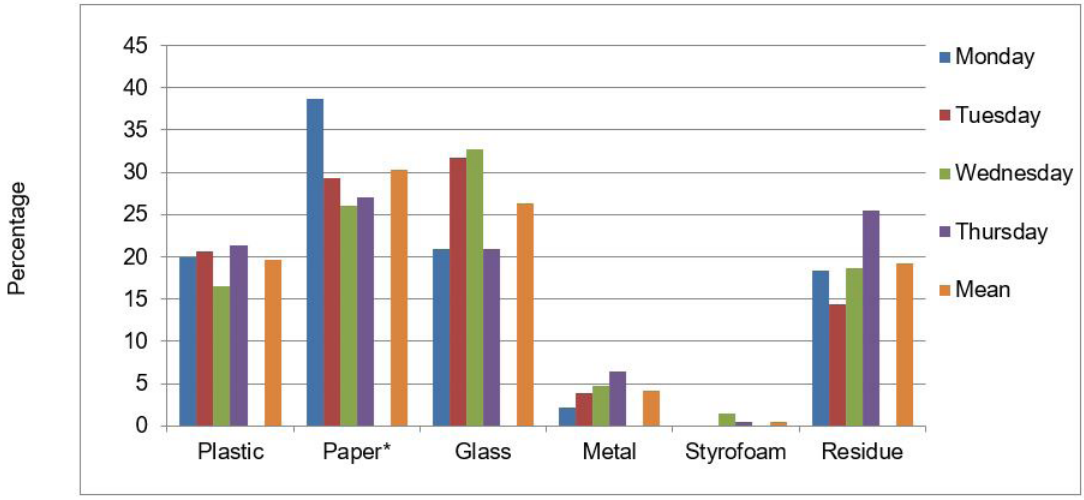
Source: Authors.

(1) Most valued residential neighborhoods in the city.

(2) Most valued neighborhoods in the city with some shops.

(3) Least valued neighborhood with the predominance of households.

* Standard deviation $(s = \sqrt{v})$




Source: Authors.

**Figure 2.** Gravimetric characterization of the components of dry recyclables on the arrival at the COOPECO cooperative, Bauru-SP (May 2019).

*Paper and cardboard are included.

In addition to these tests on arrival dry recyclables, two tests were carried out on materials that are generally not used, that is, those materials that in the sorting process ended up going to the bag at the end of the horizontal belt conveyor. These bags containing residues (material not used for recycling) are sent to the external land of the cooperative's main shed, where they will be waiting for transport to the sanitary landfill in the city of Piratininga, state of São Paulo, which is a nearby city.

Table 3 presents the mean values of these tests related to the collected materials that, for the reasons already mentioned, are commonly not used. These two trials were carried out on the 14th and 29th of May 2019.

**Table 3.** Mean of the components surveyed in the tests on the sorting conveyor residue at Cooperativa COOPECO, Bauru-SP in May 2019.

| Materials rejected by the conveyor | Percentage |
|---|---|
| Plastic | 20.82 |
| Styrofoam | 2.57 |
| Fabric | 22.07 |
| Metal | 7.67 |
| Paper | 10.48 |
| Rubber | 8.44 |
| Glass | 5.11 |
| Organic | 10.00 |
| Others* | 12.84 |

Source: Authors.

*Fragments of wood, vinyl records, used light bulbs, leather, synthetic material, the paper used in personal hygiene, etc.

On October 24, 2019, two different tests were also carried out, totaling four (4) samples each. One test was carried out to analyze the composition of the types of plastics in the samples (Table 4) and another to evaluate the physical condition of bottles and glass jars (Table 5).

**Table 4.** Test carried out to evaluate the proportion between the most common type of plastics found at COOPECO cooperative, Bauru-SP in October 2019.

| Types of plastic | Percentage |
|---|---|
| PET | 33.7 |
| PEAD | 19.6 |
| Mixed plastics | 38.6 |
| PP | 8.1 |

Source: Authors.

**Table 5.** Test carried out to evaluate the physical integrity between bottles and glass jars at the COOPECO Cooperative, Bauru-SP in October 2019.

| Condition of the glasses | Percentage |
|---|---|
| Not broken | 70.4 |
| Broken | 29.6 |

Source: Authors.


**Figure 3.** illustrates some of the fractions of dry recyclables and components evaluated in this work. (a) "plastic" fraction, (b) "paper" fraction, (c) "metal" fraction, (d) fabric "fraction", (e) "rubber" fraction, (f) "glass" fraction, (g) "styrofoam" fraction and (h) "others" fraction.

The collection locations according to the day of the week with the total weight, that is, each test carried out on the dry waste on the arrival resulting from portions of waste from a particular neighborhood or location, transported by a cage truck and unloaded in the entrance yard of the cooperative are listed below.

- Monday: 680 kg – Jardim América;
- Tuesday: 1080 kg – Jardim Estoril;
- Wednesday: 970 kg – "Fixed point" (Samambaia condominium, companies, downtown, and region of Getúlio Vargas);
- Thursday: 550 kg – Gasparini Living Center.

Over the years, consumerism behavior has spread due to massive advertising through the media, without, however, a proper self-awareness on the disposal and accommodation of consumers' waste (POLLETO, 2008). For the best use of dry recyclables and reduction of waste, there should have been a synchronization between the level of information on the

selective collection and the level of use of the sale of recyclables in cooperatives. Materials that are mistakenly not considered recyclable are therefore added to household organic waste, which is not ideal for the use of waste, as well as sending unused materials to the cooperatives' sorting yard. The trend in some countries is to separate organic (wet) material from dry material, however, not all dry material is recyclable, and not all wet material is compostable. The population needs to clarify themselves or get information about what is or is not capable of being recycled and considering that there is a selective collection program in their city, some procedures also include washing and drying materials with food waste for their disposal. Some specific materials may be used, for example, in the case of COOPECO, X-ray plates, where buyers were found for this type of material, albeit in small quantities. It is also expected that other materials that were not being used can find buyers, as is the case of rubber slippers and soles. It can be seen in Table 3, for example, that rubber obtained a percentage of 8.44% in the mean of waste from the reject. Some plastic bottles used for filling and selling food such as milk have a dark material that covers the plastic packaging. This type of material is not used by the cooperative and becomes waste. This is an example of how companies need to rethink how to carry out their reverse logistics and at the same time satisfy the needs and aspirations of their consumers, as illustrated in an article in Folha de São Paulo with the title: "Non-recyclable plastic bottles of milk bother consumers" (BATISTA, 2017).

On Tuesdays and Wednesdays, 31.79% and 32.66% of glasses were characterized, respectively. The consumption pattern in these neighborhoods, considered more valued and with a high index of shops, demonstrates the frequent use of disposable products, such as alcoholic beverages such as longneck beers, as it can be seen in the region of Getúlio Vargas street. There is a relative difficulty in relation to the integrity of some materials coming from the selective collection, from the moment they are discarded until their arrival and accommodation in the cooperative's entrance yard, as is the case of glass (Table 5), which can impair the recycle of some whole glasses, whose price is more valued for sale. The issue of a suitable place for sorting in the COOPECO cooperative has already been raised. It was claimed that instead of the existing pavement (slatted floor), a ditch could provide more efficient segregation of on-arrival waste (DORO and SAMPAIO, 2020). It was also observed that aluminum cans rarely appear in the cooperative, regardless of the neighborhoods evaluated, which suggests commercialization by the consumers themselves, street pickers, or others, probably due to the sale value of this material in the recyclables market. The metals that arrive are sometimes aggregated with some type of material, such as rigid plastic components of automotive parts and other sources, and are generally discarded as waste. Some materials that could be recycled often go to the residue bags depending on the speed of the horizontal conveyor, requiring attention on the relationship between the number of employees on the conveyor and its speed.

In Soares (2011), it was reported that there is a difference in consumption between different social classes in the city of Nova Iguaçu, state of Rio de Janeiro, where the glass comes more from neighborhoods with high purchasing power, which coincides with the data of our work, considering that these results are projected for the selective collection program. Also, according to the author, it is pointed out that because of a diet with more industrialized

food, the high prevalence of organic material in high purchasing power classes is not common. Regarding Thursday's waste, coming from a less valued residential neighborhood, it was estimated that 25.43% of the materials were not used for sale as recyclables. In a situation converging to the one previously observed, it was seen that in regions with less education level and purchasing power, a higher incidence of organic waste was detected (MENEZES *et al.*, 2019). This fact may show to be a facilitator in the mixing of organic plots with dry recyclables, which was confirmed in this study particularly in the test of Thursday's samples.

It has to be remembered that kitchen waste, such as tomato sauce, vegetable oil, automotive lubricants, waxes, materials used in home renovations such as paint or thinner can make it impossible to use the portions of materials assigned for cooperatives. The main reason for that is the requirement from buyers on the material's integrity and appearance. Recyclable materials that contain certain quantities of the product cannot be used either, as is the case with yogurt jars, toothpaste tubes, among others.

Regarding the average gravimetry in the tests on the reject of the horizontal conveyor, there was a significant result for fabrics (22.07%) and for some materials such as plastics (20.82%), paper (10.48%) as well as material of organic origin such as kitchen leftovers (10%) and "others" (12.84%), where it was found several materials such as wood fragments, vinyl records, used light bulbs, leather, synthetic material, the paper used in personal hygiene, etc. Some materials possibly found in the residues could be recycled if they were not contaminated by some substance or even those with insufficient size (REMÉDIO *et al*. 2002). In the case of fabrics (22.07%), it is believed that some of this percentage could be reused as a form of voluntary donation or social programs such as the clothing campaign, however, fabrics that people discard through selective collection usually end up going to the residues for not having a value as recyclable, for lack of a specific buyer. According to Table 2, dry recyclables styrofoam, metal, and plastic obtained, the lowest standard deviation between the sampling days (0.708; 1.492 and 2.162, respectively), while the residue, paper/cardboard, and glass obtained a standard deviation of 4.587; 5.796 and 6.806, respectively which indicates that the first group of recyclables showed greater sampling balance between the days of the week evaluated.

Some municipalities, for example, Bauru in the state of São Paulo, maintain contracts with companies responsible for the collection and accommodation of waste that was not used in environmental programs. In 2019, SEMMA (Municipal Secretariat for the Environment) extended for another year a contract with the private sanitary landfill in the city of Piratininga, also in the state of São Paulo, neighboring the municipality (NAVARRO, 2019). The renewal was agreed at the same value as the previous year, which had been in force since 2016 at 83.50 Reais/t. The value of transport and collection carried out by the municipal company EMDURB (Bauru Urban and Rural Development Company) was in force at 133.90 Reais/t, with the transport of waste, collection, and final destination, which cost to the municipality of Bauru, at the time, an annual expenditure of almost 20 million reais. Idealizing and maintaining environmental programs, such as recyclables associations and cooperatives, are viable alternatives for all parties and need constant coordination, besides the political and organizational interests to obtain benefits from both sides.

The VerdeAzul Municipality Program (PMVA) was launched by the Government of the State of São Paulo in order to promote environmental management measures, assisting São Paulo municipalities in carrying out public policies and adopting mechanisms to support sustainable development (BAURU, 2017). In the municipality of Bauru, an action was developed focusing on "awareness and mobilization for selective collection" together with SEMMA (Municipal Secretariat for the Environment). As it was observed a reduction in the volume of recyclables received at the cooperative in 2019, in the same year in July, COOPECO carried out the collection of household waste in the Mary Dota, using 11 of the 29 tons of waste collected in 11 days of work. On that occasion, COOPECO promoted a campaign to develop citizenship in relation to the correct disposal of waste in the Mary Dota, Bauru 2000, and Beija Flor neighborhoods. The photos of this environmental action in the neighborhoods of Bauru-SP can be seen in Appendix A in this paper.

## FINAL CONSIDERATIONS

To solve some of the municipal problems caused by the production of household USW, composting and the use of dry recyclables are seen as fundamental elements within the environmental management of waste. The selective collection is a valuable instrument and we see the importance, according to the data presented, of making this process more efficient, by raising the awareness of the population through environmental education in schools in the neighborhoods. Cooperatives play an important role in society, which is to assist the public power in adequate waste management. On the other hand, they need to support and afford a staff (cooperators) like any other company. Generally, these cooperative members are low-income people seeking a rise in their quality of life and better opportunities, and to make this happen, educational measures and constant training are necessary. The Cooperative also finds assistance in the joint commercialization of recyclables through ASCAM (Association of Work Cooperatives of Bauru) and in addition to other actions, it can add value, such as through the processing of some types of plastics. The percentages of dry recyclables obtained in the sum of the four days of selective collection sampling are 30.28%, 26.34%, and 19.62% for paper/cardboard, glass, and plastic, respectively, followed by residue (19.19%). Also, the percentages found in the tests on waste from the conveyor are 20.82% and 10.48% for plastic and paper, respectively. The presence of organic components (10%) corresponds to professional training and environmental education.

## REFERENCES

AGUIAR, A.; PHILIPPI A.J. A Importância de Parcerias no Gerenciamento de Resíduos Sólidos Domésticos. In: **XX Congresso Brasileiro de Engenharia Sanitária e Ambiental.** 2000. p. 1910-1919. Disponível em: <https://www.researchgate.net/profile/Alexandre_Aguiar3/publication/304837464_A_importancia_das_parcerias_no_gerenciamento_de_residuos_solidos_domesticos_Importance_of_partnership_in_domestic_solid_wastes_

management/links/577c64c308aece6c20fcd402.pdf> Acesso em: 28 out. 2019.
ASSOCIAÇÃO BRASILEIRA DE EMPRESAS DE LIMPEZA PÚBLICA E RESÍDUOS ESPECIAIS. (ABRELPE). **Panorama dos resíduos sólidos no Brasil 2018/2019.** Disponível em: https://abrelpe.org.br/download-panorama-2018-2019/ Acesso em: 18 julho 2021.
BATISTA, E. L. **Garrafas plásticas 'não recicláveis' de leite incomodam consumidor**. Outubro de 2017, São Paulo. Folha de São Paulo. Disponível em: <https://www1.folha.uol.com.br/seminariosfolha/2017/10/1924736-garrafas-plasticas-nao-reciclaveis-de-leite-incomodam-consumidor.shtml> Acesso em: 23 out. 2019.
BAURU (Município). **SEMMA realiza reunião sobre Programa Município VerdeAzul,** Bauru, SP: Prefeitura de Bauru, 2017. Disponível em: <http://www2.bauru.sp.gov.br/materia.aspx?n=27388> Acesso em: 26 out. 2019.
BRASIL. **Lei Federal nº 12.305, de 2 de agosto de 2010**. Institui a Política Nacional de Resíduos Sólidos; altera a Lei no 9.605, de 12 de fevereiro de 1998; e dá outras providências. Diário oficial da União, Brasília, 3 ago. 2010. Disponível em: <http://www2.mma.gov.br/port/conama/legiabre.cfm?codlegi=636> Acesso em: 17 out. 2019.
COMPROMISSO EMPRESARIAL PARA RECICLAGEM. (CEMPRE). São Paulo, 2019. Disponível em: <http://www.cempre.org.br/> Acesso em: 26 out. 2019.
CORAL, G. C. **Coleta seletiva:** o que pode e o que não pode. Ecoplus, 2015. Disponível em: <https://www.ecoplus.ind.br/23-coleta-seletiva-o-que-pode-e-o-que-nao-pode> Acesso em: 10 mar. 2019.
DHAR, H.; KUMAR, S.; KUMAR, R. A review on organic waste to energy systems in India. **Bioresourcetechnology**, v. 245, p. 1229-1237, 2017. Disponível em: <https://www.sciencedirect.com/science/article/pii/S0960852417314736> Acesso em 28 out. 2019.
DORO, João Lucas Piubeli; SAMPAIO, Aloísio Costa. Research in Bauru recyclable cooperatives. **Revista Ciência em Extensão**, v. 16, p. 5-20, 2020.
INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE), 2021. **Panorama**. Disponível em: https://cidades.ibge.gov.br/brasil/sp/bauru/panorama Acesso em: 29 mai. 2021.
JACOBI, R. J.; BESEN, G. R. Gestão de resíduos sólidos em São Paulo: desafios da sustentabilidade. **Estudos avançados**, v. 25, n. 71, p. 135-158, 2011. Disponível em: <http://www.scielo.br/pdf/ea/v25n71/10.pdf> Acesso em: 12 mar. 2019.
MANO, Eloísa Biasotto; PACHECO, Élen B.A.V.; BONELLI, Cláudia M. C**. Meio ambiente, poluição e reciclagem**. 2. ed. São Paulo: Blucher, 2010.
MENEZES, Rosana Oliveira *et al*. Análise estatística da caracterização gravimétrica de resíduos sólidos domiciliares: estudo de caso do município de Juiz de Fora, Minas Gerais. **Engenharia Sanitaria e Ambiental**, v. 24, p. 271-282, 2019.
NASCIMENTO, V. F. SOBRAL, A. C.; ANDRADE, P. R.; OMETTO, J. P. H. B. Evolução e desafios no gerenciamento dos resíduos sólidos urbanos no Brasil. **Revista Ambiente & Água** - An Interdisciplinary Journal of Applied Science, v. 10, n. 4, 2015.Disponível em: <https://www.redalyc.org/pdf/928/92842552017.pdf> Acesso em: 29 out. 2019.
NAVARRO, T. **SEMMA renovará com aterro e EMDURB**. Jornal da Cidade. Bauru,

2019. Disponível em: <https://www.jcnet.com.br/noticias/geral/2019/06/549553-semma-renovara-com-aterro-e-emdurb.html> Acesso em: 18 out. 2019.

POLETTO, J. A**. "Viabilidade energética e econômica da incineração de resíduo sólido urbano considerando a segregação para reciclagem".** 2008. 119p. Dissertação (Mestrado em Engenharia Mecânica) – Faculdade de Engenharia do Campus de Bauru, Universidade Estadual Paulista. Bauru, 2008. Disponível em: <https://repositorio.unesp.br/bitstream/handle/11449/91712/polettofilho_ja_me_bauru.pdf;jsessionid=C51882DD87B99093B5B852407A2B8FE6?sequence=1> Acesso em: 07 nov. 2019.

REMEDIO, M. V. P.; MANCINI, S. D.; ZANIN, M. Potencial de reciclagem de resíduos em um sistema de coleta de lixo comum. **Engenharia Sanitária e Ambiental,** v. 7, n. 1, p. 58-69, 2002. Disponível em: <http://www.abes-dn.org.br/publicacoes/engenharia/resaonline/v7n12/v7n12a04.pdf> Acesso em: 09 dez. 2019.

SAIKIA, D.; NATH, M. J. Integrated solid waste management model for developing country with special reference to Tezpur municipal area, India. **International Journal of Innovative Research & Development***,* v. 4, n. 2, p. 241-249, 2015. Disponível em: <http://admin.indiaenvironmentportal.org.in/files/file/solid%20waste%20management%20Tezpur.pdf> Acesso em: 09 dez. 2019.

SILVEIRA, A. M. M. **Estudo do peso específico de resíduos sólidos urbanos**. Rio de Janeiro, 2004. 106p. Tese (Mestrado em Ciências em Engenharia Civil) – Programa de Pós-Graduação em Engenharia, Universidade Federal do Rio de Janeiro. Disponível em: <http://www.getres.ufrj.br/pdf/SILVEIRA_AMM_04_t_M_int.pdf> Acesso em: 09 nov. 2019.

SOARES, E. L. S. F. **Estudo da caracterização gravimétrica e poder calorífico dos resíduos sólidos urbanos**.

Rio de Janeiro, 2011. 133p. Dissertação de mestrado – Programa de Pós-Graduação em Engenharia Civil, COPPE, de Universidade Federal do Rio de Janeiro. Disponível em: <http://objdig.ufrj.br/60/teses/coppe_m/ErikaLeiteDeSouzaFerreiraSoares.pdf> Acesso em: 05 abr. 2020.

SOUZA, M. T. S. de; PAULA, M. B. de; SOUZA-PINTO, H. de. O papel das cooperativas de reciclagem nos canais reversos pós-consumo. **Revista de Administração de Empresas**, v. 52, n. 2, p. 246-262, 2012. Disponível em: <https://www.redalyc.org/pdf/1551/155123666009.pdf> Acesso em: 09 dez. 2019.

VILHENA, A. (coord.). **Lixo municipal: manual de gerenciamento integrado**. 4. Ed. São Paulo (SP): CEMPRE, 2018. 316 p. : il. ; 11.264 kbytes. Disponível em: <http://cempre.org.br/upload/Lixo_Municipal_2018.pdf> Acesso em: 29 out. 2019.

**APPENDIX A:** Photos of the COOPECO cooperative collecting household waste at the Mary Dota housing unit in Bauru-SP (July 2019).

Source: Guilherme Colletti Coral (2019).