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Carbon Footprint of Food Consumption by Cats and Dogs in Brazil

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Abstract

Greenhouse gas emissions increase every year and their effects on a global scale are increasingly greater and more noticeable. Consequently, there is also a growing concern related to environmental issues. Among the many factors involved in raising dogs and cats, their diet is one of the most important. It requires a large amount of food inputs, which despite increasing every year and being responsible for a portion of current greenhouse gas emissions, still receive little attention from the scientific community and the media. To verify the potential impacts of raising companion animals in Brazil, this work estimated the carbon footprint generated by feeding dogs and cats in the country through a mathematical model. In this model, an average Brazilian dogs and cats is considered, as well as a standard dog and cat food, and the annual consumption of each ingredient present in the food. The results showed an estimated carbon footprint per capita of 334.06 kg CO_2-eq/year for dogs and 147.73 kg CO_2-eq/year for cats, totaling an estimate of 18.67 x 10^9 kg CO_2-eq/year for the Brazilian population of dogs and 3.78 x 10^9 kg CO_2-eq/year for the Brazilian population of cats.

Keywords: Companion animals, greenhouse gasses pet, food

1. Introduction

The greenhouse effect consists of a natural process of increasing atmospheric temperature exerted by a group of specific gases through the partial retention of solar radiation that reaches the Earth's surface (YORO et al., 2020). Notably, global warming constitutes the acceleration and intensification of this effect by anthropogenic actions due to rapid changes in natural ecosystems (AHMED et al., 2018). Global warming has become responsible for serious environmental imbalances on a global scale, such as fires, storms and droughts (IPCC, 2022), in addition to the impacts on the water cycle by reducing its availability, and consequently, impacting agricultural yields and food security (RUST, 2018; IPCC, 2022).

Paradoxically, food systems and agriculture account for approximately 34% of all greenhouse gases (GHG) emissions, with livestock amounting to approximately 71% of agriculture's GHG emissions (FEIGIN et al., 2023). These gases are generated directly through the enteric fermentation of animals and indirectly through food production, pesticides, fertilizers, and the use of fossil fuels, among other factors (GROSSI et al., 2019). It is estimated that in 2020, the emissions of GHG on agricultural land amounted to around 10.5 billion tonnes of carbon dioxide equivalent (CO_2-eq), a level that increases every year (FAO, 2022). Note that kg CO_2-eq serve as a standard metric for comparing emissions across different greenhouse gases. This measure converts the emissions of various gases into the equivalent amount of carbon dioxide, reflecting their respective global warming potentials.

One area of the economy that is often overlooked and understudied regarding its contribution to GHG emissions in Brazil is the estimated pet population, which consists of a total of 144.3 million animals, including 55.9 million dogs and 25.6 million cats (ABINPET, 2021), and represents the 2nd and 3rd largest national dog and cat population globally (ABINPET 2021; FEDIAF 2023; HealthforAnimals 2022). Similar to livestock production, raising pets incurs environmental impacts, including the production of waste that pollutes the environment and emits greenhouse gases. Moreover, the dietary requirements of pets demand agricultural and livestock products (OKIN, 2017; MARTENS et al., 2019), especially those of animal origin, which constitute an essential component of the diets of dogs and cats (BENNET, 2021; ROSI et al., 2017; CHAI et al., 2019).

In the United States (USA), a pioneering study estimated that the pet population is responsible for producing 58 ± 14 billion kg year-1 of CO_2-eq of GHGs (methane and nitrous oxide), while the human population produces 235 billion kg year-1 (OKIN, 2017). Similar studies have been conducted in other countries. Su et al. (2018a) found that cats and dogs in Japan account for 2.50-10.70 billion kg of CO_2-eq annually, considering diet-associated emissions. Similarly, in China, these pets are responsible for 2.40-7.50 billion kg of CO_2-eq annually (SU et al. 2018b), while Martens at al. (2019) found that that cats and dogs in the Netherlands are responsible for 0.43-1.65 million kg of CO_2-eq annually when considering diet-associated emissions.

In Brazil, Pedrinelli et al. (2021) studied the diets of 618 dogs and 320 cats, and found that an average canine diet was responsible for 828.37 kg of CO_2-eq annually for dry diets or 6,541 kg of CO_2-eq for wet diets, amounting to 0.04–0.34 Gt CO_2-eq annually for dog food-associated emissions for the entire Brazilian canine population. However, research on the contribution of the dog and cat population to carbon equivalent emissions in Brazil still remains scarce despite the observed increase in companion animals, which is concomitant with the growth of the human population. This increase is also evidenced by the growth in revenue in the pet market worldwide by around 5.4%, on average, from 2020 to 2021 (ABINPET, 2021). Given these factors, research in this area is crucial to elucidate and promote practices that minimize the impacts generated by maintenance of dogs and cats. For that, this study had the following specific objectives: (i) to determine the type and composition of food consumed by dogs and cats, (ii) to estimate a model of the average

Brazilian dog and cat, (iii) to estimate the mass (kg) of food consumed by dogs and cats, and (iv) to estimate the carbon footprint (kg CO_2-eq) resulting from the diet of dogs and cats and compare it with the carbon footprint of the diet of the Brazilian human population.

2. Materials and Methods

An overview of the Materials and methods can be found in Figure 1.

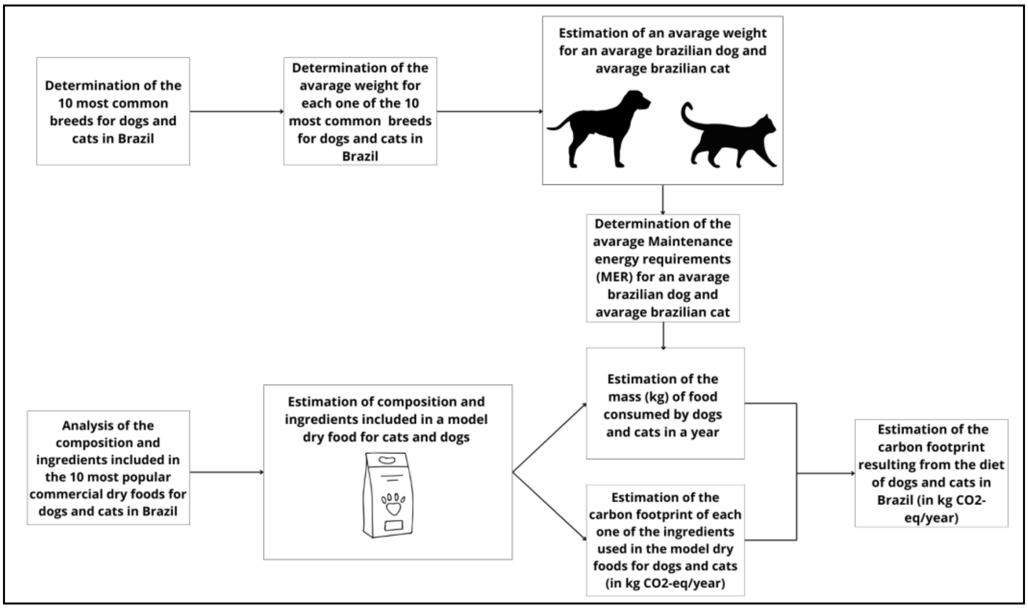

Figure 1. An overview of the Materials and methods

To estimate the type, composition, and energy of the model food for dogs and cats, as well as the average model for Brazilian dogs and cats, their body masses and energy expenditures, and the total mass of the model of their regularly consumed foods were estimated using the methodology established by Zanini (2022).

2.1 Estimation of the Type, Composition and Energy of Model Food for Dogs and Cats

The main source of food for the studied animals is commercial food, which varies between wet, dry, and snacks. The composition of food varies and is important for determining its impacts, which varies according to the products used as ingredients. In 2020, the sale of dry extruded commercial food in Brazil represented 89.3% (US$3.7 billion) of total revenue from the Pet Food sector (CANADA, 2022). Therefore, this category of commercial food is currently used to conduct the calculations involved in this work, as it represents the majority of pet food sales.

To determine the chemical composition of dry food, the nutritional composition of a model food for adult dogs and cats (Table 1) was estimated using the arithmetic mean of the nutritional composition of the ten most popular foods for dogs and cats on the Petlove website (one of the largest online pet products store in the country according to CNN Brasil (2023) (https://www.petlove.com.br/). It is worth noting that all of the most popular foods for both species belong to the Premium category, which differs from the Popular category. Premium brands are formulated to provide superior nutrition to dogs and cats during different life stages while using a fixed formulation, meaning the product maintains a constant ingredient list regardless of market price or availability (Companions Animals, 2019).

Table 1. Estimated average chemical composition of the most popular* foods for dogs and cats in Brazil

* Most popular being the 10 most purchased brands according to the Petlove website.

Nutrients	Composition for dogs (%)	Composition for cats (%)
Humidity (max.)	10.20 ± 0.63	10.00 ± 0
Crude protein (min.)	22.50 ± 1.64	33.20 ± 2.84
Ethereal extract (min.)	10.90 ± 2.07	11.55 ± 1.18
Minerals (max.)	8.45 ± 1.42	7.80 ± 0.25
Fiber (min.)	3.25 ± 0.42	3.90 ± 0.51
Phosphorous (min.)	0.72 ± 0.07	0.71 ± 0.13

Source: Adapted from ZANINI (2022).

Next, the gross energy, energy digestibility coefficient, and metabolizable energy of each food were estimated (Table 2) using the predictive equations for each group (cats and dogs) from the Nutrient Requirements of Dogs and Cats (NRC, 2006) and the average chemical composition of food for dogs and cats. Average values in Tables 1 and 2 were used for purposes of calculations, given that commercial food packaging labels in Brazil do not provide the exact content for each nutrient but rather a maximum and/or minimum estimate at which they may be present.

Table 2. Estimated gross energy (GE), energy digestibility coefficient (EDC), digestible energy (DE) and metabolizable energy (ME) of the most popular foods for dogs and cats in Brazil

Parameters	Mean values of the most popular foods for dogs	Mean values of the most popular foods for cats	Estimated values for the model food for dogs	Estimated values for the model food for cats
GE	4,273.05 Kcal/kg	4,513.55 Kcal/kg	4,499.67 Kcal/kg	4,657.32 Kcal/kg
EDC	86.02%	84.09%	85.57%	84.04%
DE	3,675.87 Kcal/kg	3,795.29 Kcal/kg	3,850.40 Kcal/kg	3,913.79 Kcal/kg
ME	3,441.87 Kcal/kg	3,539.65 Kcal/kg	3,577.60 Kcal/kg	3,657.45 Kcal/kg
Conversion factor between GE and ME	1.25	1.27		

Source: Adapted from NRC (2006) and ZANINI (2022).

Okin (2017) assumed that the first five ingredients of the model food represented its total mass, each carrying equal weights and therefore representing 20% of its total weight. However, it is important to note that commercial pet food typically contains more than five ingredients, each with a specific chemical composition and varying proportions within the food. Therefore, this approach does not accurately represent real pet food formulations.

After referring to the latest Sector Information Bulletin published by the National Union of the Animal Food Industry (SINDRAÇÕES, 2022), which includes a forecast of the total consumption of each ingredient used by the Pet Food sector in 2022, an ordered list was compiled, focusing on components most feasible for the Brazilian context. Thus, the selected ingredients to constitute the model and represent its total mass include corn, flours and fats of animal origin, poultry by-product meal, poultry fat, soybean meal (46% CP), corn gluten meal (21%), vegetable fat (corn oil), wheat and co-product (wheat bran) and 60% corn gluten bran. These ingredients collectively represent 97.67% of the mass of ingredients consumed by the pet food sector.

The gross energy and chemical composition of each selected ingredient were obtained from the Brazilian Tables for Poultry and Swine by Rostagno et al. (2017). These values served as the basis for determining the chemical composition of the foods described in table 1. The respective gross energy values are presented in Table 2, and the model foods formulated for dogs and cats are shown in Tables 3 and 4. After the calculations were done, the data was then selected and revised by specialists from the Pet Food industry and validated by the authors.

Table 3. Estimation of the energy proportion of inclusion of ingredients in model foods for dogs and cats

Ingredients	**% energy in model food for dogs**	**Gross energy (Kcal) in model food for dogs**	**% energy in model food for cats**	**Gross energy (Kcal) in model food for cats**
Corn (grain 6.92% CP)	24.39	1042.39	6.62	298.71
Poultry offal flour	29.49	1260.20	33.28	1502.20
Poultry fat	10.00	427.31	10.65	480.73
Soybean meal (46% CP)	5.54	236.78	15.02	678.04
Corn gluten meal 21%	5.78	247.04	7.32	330.49
Wheat and e co-produto (wheat bran)	13.38	571.73	14.01	632.32
Corn gluten meal 60%	9.27	396.29	10.29	464.63

Table 4. Estimation of the chemical composition of model foods for dogs and cats

Nutrients	**Target composition of the model formulation of dog food (%)**	**Composition of the model formulation of dog food (%)**	**Target composition of the model formulation of cat food (%)**	**Composition of the model formulation of cat food (%)**
Humidity (max.)	10.20	9.82	10.00	8.92
Crude protein (min.)	22.50	26.23	32.20	33.29
Ethereal Extract (mín.)	10.90	12.17	11.55	13.40
Mineral matter (max.)	8.45	6.40	7.80	7.80
Fibrous matter (min.)	3.25	355	3.90	4.00
Non-nitrogenous extract	44.70	41.83	34.55	32.59
P total (min.)	0.72	1.12	0.71	1.27

Finally, the metabolizable energy of the food model formulated using the NRC equations (2006) and its chemical composition (Table 2) were estimated.

2.2 Estimation of Body Mass and Energy Expenditure for Dogs and Cats

Body mass data are fundamental for estimating dietary energy expenditure and the amount of food consumed by animals. To determine the average body mass of a Brazilian model for dogs and cats, the arithmetic mean of the average body mass of the ten most common dog breeds in Brazil was calculated. Data about the most common dog breeds were obtained from the Pet Census 2020 (DOGHERO, 2021b) and the average body mass for each breed was acquired from the official American Kennel Club (AKC, 2017) and Federation Cynologique Internationale (FCI, 2022) websites. For mixed-breed dogs, prevalent in Brazil, their average body mass was calculated by averaging the other nine most common breeds, resulting in an average weight of 8.16 kg.

Similarly, for cats, the average body mass of a Brazilian model cat was estimated by calculating the arithmetic mean of the ten most common breeds in Brazilian households, sourced from the 2020 Feline Census (DOGHERO, 2021a). Each breed was categorized by body size using information from the World Cat Federation (WCF, 2022), and average body masses for different sizes (very small, small, medium, large and giant) were obtained from Kienzle & Moik (2011). In cases where the breed encompassed more than one body size category, the simple arithmetic average was calculated between the respective values. Mixed-breed cats, also predominant in Brazil, had their average body mass determined by averaging the other nine most common breeds, resulting in an average weight of 3.53 kg.

To estimate the individual energy expenditure of dogs and cats, the Maintenance Energy Requirement (MER) equations (FEDIAF 2021) were used, which are tailored for adult animals with varying levels of physical activity, considering factors such as breed, physiological status, and activity level. This approach allowed us to estimate the minimum and maximum variation of energy expenditure for adult dogs and cats.

2.3 Estimation of the Total Mass of Model Foods Consumed Annually

The calculation of annual food mass consumption was done using the equation:

$$M_{total} = M_{individudal} \times N^{\circ}$$

In this equation, M_{total} corresponds to the annual mass of food consumed by the population in question (in kg/year), $M_{individual}$ represents the annual mass of food consumed by the individual (in kg/year/individual) and N° is the total number of individuals in the population (data obtained from ABINPET, 2021). The M total calculated for the entire dog and cat population separately will be summed to obtain the M total value for the entire pet population in Brazil.

The calculation of $M_{individual}$ was done using the equation:

$$M_{individual} = \frac{MER}{ME} \times 365$$

Where MER refers to the Maintenance Energy Requirement (made for low and very active animals of both species; in kg/day) and ME corresponds to the metabolizable energy of the model food (in kcal/kg).

2.4 Estimation of the Carbon Footprint (kg CO_2-eq) of Feeding Dogs and Cats

The calculation of the annual mass of CO_2-eq was done using the equation:

$$CO_2eq_{total} = CO_2eq_{product} \times M_{product}$$

Where CO_2eq_{total} refers to the total mass of annual CO_2-eq produced by the population (in kg/year), CO_2-eq product corresponds to the annual carbon footprint produced per kg of agricultural product (in kg CO_2-eq/kg product /year) and $M_{product}$ represents the mass of the model food ingredient consumed in a year (in kg/year).

The $M_{product}$ calculation was obtained for each ingredient of the model food determined for dogs and cats. Then the values obtained for each ingredient were summed to obtain the value of CO_2-eq total per model food type. The CO_2-eq total of dogs and cats were summed to obtain the value of CO_2-eq total of the entire pet population.

The results of Garzillo et al. (2019) were used to obtain the CO_2-eq product of each ingredient (Figure 2). However, due to the lack of specific data for certain ingredients, the following adaptations were made: “Corn (grain 6.92% CP)” was considered as “corn (grain)”; “corn gluten meal (21%)” and “corn gluten meal (60%)” were considered as “ground corn and corn hominy”; “poultry offal flour” was considered as “chicken or chicken giblets, chicken or chicken gizzards, chicken hearts, chicken or chicken livers”; “soybean meal” was considered as “soybean fiber”; “wheat and wheat co-product (wheat bran)” were considered as “wheat flour and wheat fiber”; “vegetable fat (corn oil)” was considered as “unspecified oil”; and lastly, the ingredient “poultry fat” was considered as “unspecified part of chicken or chicken”.

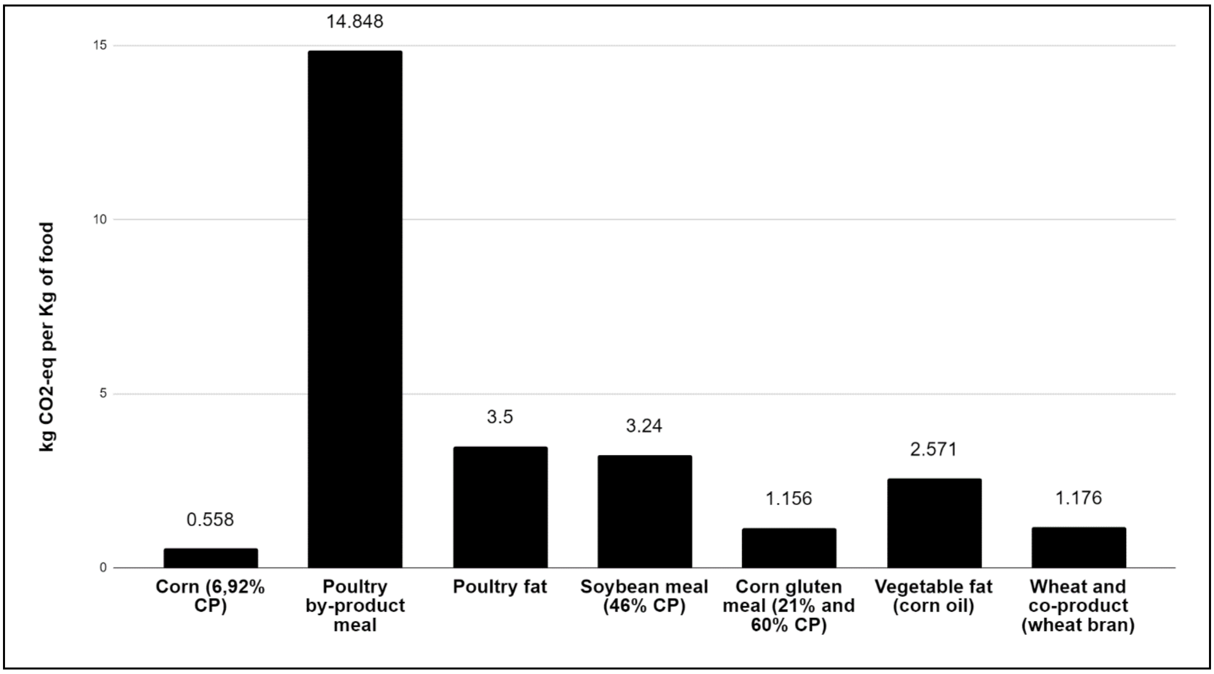

Figure 2. Carbon footprint in kg CO_2-eq per kg of food (production + processing + transport) of each ingredient that makes up the model food for dogs and cats in Brazil

Source: Adapted from Garzillo et al. (2019).

Furthermore, to allow comparison with human diets, data obtained by Garzillo et al. (2021)

were used. They estimated that the average carbon footprint of the Brazilian diet per person is 4.489 kg CO_2-eq day -1.

3. Results

3.1 Daily Energy Needs by Cats and Dogs

Initially, it was essential to determine the energy requirement for the maintenance of dogs and cats, which was based on the average models for each animal using MER equations. By determining the maximum and minimum MER values for animals with high and low physical activity levels, an approximate average MER for each animal group was obtained. This process yielded results of 651.78 kcal/day for the average Brazilian dog model and 196.15 kcal/day for the average Brazilian cat model.

3.2 Potential Consumption of ME, kg of Food, and BE of Each Animal Category

Based on the average values obtained and the ME (metabolizable energy) of the stipulated standard food, the average annual consumption of ME and food per animal in each category were estimated. Notably, to calculate the quantity of each ingredient used in the stipulated food, it was necessary to obtain the GE (gross energy) values corresponding to each ingredient, so the conversion factor from ME to GE was used. We found that the annual GE consumption was 297 374.63 kcal for the average Brazilian dog and 90 925.33 kcal for the average Brazilian cat.

3.3 Potential Consumption (in kcal and kg) and Carbon Footprint of Each Ingredient by Animal Category

Using the energy percentage of each ingredient in the standard food for each category and the annual GE consumption, an approximate estimate of the annual GE consumption was made for each stipulated food ingredient per animal in each category. Based on the obtained values and the GE of each ingredient (kcal/kg), the annual consumption in kg per animal of each category was then estimated for each ingredient of the stipulated standard food. Subsequently, the approximate annual carbon footprint produced for each ingredient per animal in each category was estimated based on the amount of CO_2-eq produced per kg of ingredients (Table 5).

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Table 5. Annual consumption in kcal and kg for each ingredient by animal category

*The amount consumed annually in kg of both ingredients was added to allow for the necessary equivalences.

Category	Corn (Grain 6,92% CP)	Poultry by-product meal	Poultry fat	Soybean meal (46% CP)	Corn gluten meal 21%	Corn gluten meal 60%	Corn oil	Wheat and co-products (grain bran wheat)
Annual consumption in kcal by the average Brazilian dog	75 529.67	87 695.78	29 737.46	16 474.55	17 188.25	27 566.63	6363.82	39 788.72
Annual consumption in kg by the average Brazilian dog	19.54	18.46	3.20	3.94	4.33	5.54	0.68	10.15
Annual footprint (kg CO_2-eq/year) equivalent to the average Brazilian dog	10.9	274.09	11.2	12.77	11.41*		1.75	10.15
Annual consumption in kcal by the average Brazilian cat	6019.26	30 259.95	9683.55	13 656.98	6655.73	9356.22	2545.91	12 738.64
Annual consumption in kg by the average Brazilian cat	1.56	7.83	2.51	3.53	1.72	2.42	0.66	3.30
Annual footprint (kg CO_2-eq/year) equivalent to the average Brazilian cat	0.87	116.26	8.79	11.44	4.79*		1.70	3.88

3.4 Carbon Footprint of Feeding Each Animal Category (Brazilian Dogs and Brazilian Cats)

Finally, the carbon footprint of food for an individual and the entire population within each animal category were estimated, with the estimated average carbon footprint of Brazilian dogs being 18.67 x 10 9 kg CO_2-eq/year (34.06 kg CO_2-eq/year per individual) and for cats being 3.78 x 10 9 kg CO_2-eq/year (147.73 kg CO_2-eq/year per individual), as shown in Figures 3 and 4.

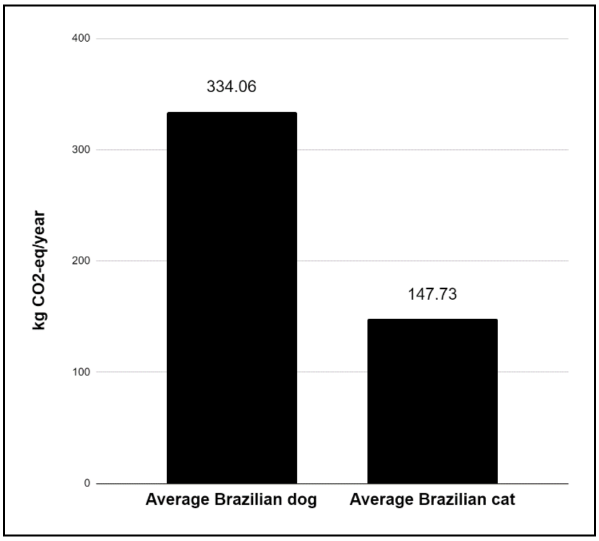

Figure 3. Annual carbon footprint resulting from the diet of an average Brazilian dog and cat (kg CO_2-eq/year)

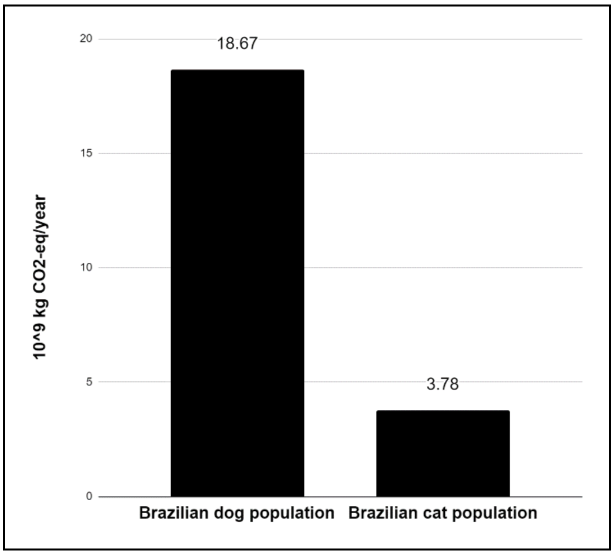

Figure 4. Annual carbon footprint resulting from the diets of the Brazilian dog and cat populations (10^9 kg CO_2-eq/year)

4. Discussion

Initially, it is necessary to acknowledge the scarcity of data for the preparation of this work and the need for adaptations and approximations made to estimate the carbon footprint resulting from feeding dogs and cats in Brazil. Notably, there is a significant lack of data, mainly regarding the characteristics of the category of Brazilian dogs without defined breed (mixed-breed), which constitute the largest pet population in the country (DOGHERO, 2021b). Another considerable factor is the insufficient data pertaining to the overall carbon footprint of agricultural and animal by-products, such as wheat co-product and poultry offal flour, which are important components for the production of pet food (SINDIRAÇÕES, 2022). The production of animal by-products is less efficient since it requires a larger number of livestock animals on average compared to animal-sourced ingredients intended for human consumption, such as meat. Nevertheless, these by-products remain in use due to their significantly lower cost (KNIGHT, 2023). Considering the lack of data concerning these products, their environmental impacts are potentially underestimated in this study.

It should also be noted that in this work, it was assumed that the entire Brazilian population of dogs and cats consumes exclusively dry extruded commercial food, disregarding potential impacts from alternative food sources, such as wet food, which have greater environmental impact (PEDRINELLI et al., 2021). This exclusion represents another factor leading to a considerable underestimation of the true environmental impacts of Brazilian pet food. Furthermore, the average MER considered in this study, especially for dogs, differs significantly from other studies, such as the data provided by Knight (2023). This discrepancy may be attributed to the use of different dog and cat models between studies and the more conservative approach adopted here, which does not account for animals with higher activity levels (and subsequently higher MER), nor animals fed with excessive energy sources, which would require a lot more food and create much larger environment footprint. Given these factors, it is important to highlight that this work provides an initial approximation of the carbon footprint resulting from feeding dogs and cats in Brazil. Therefore, it is imperative to consider this fact, along with the methodology developed and used, when comparing results across studies.

The estimated average carbon footprint of the Brazilian diet per person is 4.489 kg CO_2-eq/day (GARZILLO et al., 2021), resulting in an annual production of approximately 1,638.48 kg CO_2-eq per individual. In contrast, the annual carbon footprint per individual of the canine population is 334.06 kg CO_2-eq, while that of the feline population is 147.73 kg CO_2-eq. Therefore, the human impact is, respectively, about 5 and 11-fold higher than that produced by the pet population. Additionally, considering that the Brazilian population consists of approximately 99.3 million adult men and 103.8 million adult women (IBGE, 2022a; IBGE, 2022b), with estimated total body masses of 725.88 x 10 7 kg and 647.81 x 10 7 kg respectively (IBGE, 2008), the annual production of kg CO_2-eq per kg is 22.41 kg per kg CO_2-eq for Brazilian men, and 26.25 kg CO_2-eq per kg for Brazilian women. Conversely, the annual production of kg CO_2-eq per kg of dogs and cats represents, respectively, about 40.94 and 41.85 kg CO_2-eq. Such discrepancy highlights a significant difference in the carbon footprint resulting from food consumption between humans and companion animals when considering the individual weight of each category.

Compared to other countries such as Japan (SU et al, 2018a) and the Netherlands (MARTENS et al., 2019), the estimated average annual carbon footprint per capita for dogs and cats regarding commercial dry food production is significantly lower in Brazil. The average values for the Netherlands are 2.6 and 1.15 times higher than Brazil's for dogs and cats respectively, while Japan's average values are 1.5 and 1.13 times bigger than Brazil's for dogs and cats respectively. In comparison to China (SU et al., 2018b), Brazil's results are triple for dogs and more than quadruple for cats. However, the different methodologies used by each study must be considered, as well as the interference generated in the results by variations in the average dog and cat models in each country. Additionally, factors such as the size of companion animal populations and the composition of their diets in each region also play a significant role.

Ultimately, the main challenge lies in addressing the impacts generated by the agricultural industry, which provides components used in pet food production. The unsustainable agro-export model currently prevalent in Brazil remains a major contributing factor to the high carbon footprint estimated in this work, as this sector is responsible for most GHG emissions in Brazil (CERRI et al., 2009; PINTO et al., 2022). Therefore, there is a pressing need for alternatives to the current agricultural production model as a whole. A potential solution could involve incorporating alternative protein sources (such as those derived from plants, insects or yeast), while still maintaining a commercial food formulation suitable for dogs and cats to prevent potential nutritional deficiencies.

5. Conclusion

In conclusion, based on the food and animal models proposed in this study, it is evident that food production for the companion animal population in Brazil results in significant carbon equivalent emissions, although such emissions can still be considered small when compared to the country's agricultural industry, such as demonstrated by the studies of Cerri et al. (2009) and Pinto at al. (2022). Furthermore, this study underscores the pressing need for further research to obtain comprehensive data on the subject, which would enable more accurate estimates and values closer to reality. Such studies will be crucial for understanding and mitigating the environmental impact of pet food production in Brazil.

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Authors contributions

Dr. Augusto Gameiro was responsible for study design and revising. Miss Júlia Boaventura was responsible for data collection and calculation. Both authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Macrothink Institute.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

Open access

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