CARBON FOOTPRINT OF BROILER MEAT AND BEEF BRAZILIAN CONSUMERS

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RESUMO: The present study aimed to compare the carbon footprint of consumers with a similar lifestyle who frequently eat beef and those who eat broiler meat. An online questionnaire was distributed using several networks. The questions were about the customer age, level of education, gender, marital status, family size, type of house, salary, car type, and appropriate actions toward sustainability. A total of 222 answers were analyzed using the Cluster Analysis with a unweight pair-group average and employing Euclidean distance. Mean values were compared using Student T-test adopting the significance level of 95% (p value ≤ 0.05). After identifying the Clusters, five individuals from each Cluster were randomly selected, and the carbon footprint was calculated. Results indicated that individuals with the same lifestyle that eat beef have a higher carbon footprint (3 t/year) than those who eat broiler meat. .

KEYWORDS: Environmental impact, meat consumers, ecological impact, beef production, broiler production

RESUMO. O presente estudo visou comparar a pegada de carbono de consumidores com estilo de vida semelhante, que consumiam carne bovina e carne de frango com frequência. Um questionário *online* foi distribuído usando as redes disponíveis. As questões perguntadas versaram a respeito do perfil do consumidor, constando idade, nível de educação, gênero, estado civil, tamanho da família, tipo de residência, tipo de carro, e ações adotadas visando sustentabilidade. Um total de 222 respostas foi analisado com da aplicação da análise de *Cluster* adotando peso equitativo de médias e a distância Euclidiana. Os valores médios foram comparados usando o teste T-Student e adotando a significância no nível de 95% (p valor ≤ 0.05). Após a identificação dos agrupamentos das respostas, cinco indivíduos de cada Cluster foram selecionados ao acaso e as pegadas de carbono destes indivíduos foram calculadas. Os resultados indicaram que aqueles indivíduos com o mesmo estilo de vida que consumiram carne bovina apresentaram uma pegada de carbono maior (3 t/ano) do que aqueles que consumiram carne de frango, em todos os grupos estudados.

PALAVRAS-CHAVE: Impacto no meio ambiente, consumidores de carne, impacto ecológico, produção de carne bovina, produção de frangos de corte.

1 INTRODUCTION

The term "carbon footprint "refers to the mass of greenhouse gases (GHG) emitted due to the production, use, and disposal of a product. Studies on product carbon footprint emissions account for a set of processes related to the lifecycle of a product (PANDEY et al. 2011). Consumers are increasingly concerned with climate change issues, and government legislation is envisioning carbon labeling for appearing on some products. More clearly understand consumer behavior and what influences their choices is important to achieve a way to motivate sustainable consumption (PHILLIPS, 2009). Companies should prepare for how carbon emissions labels might affect future consumer choice (GROENING, 2015). Regarding food systems, studies show that reducing over-consumption and food wastes PAILLARD et al. (2011) or, reduction of meat

consumption STEHFEST et al. (2009) has consequences for the environmental sustainability.

Previous studies indicated that the provision of information is not enough to encourage more sustainable purchasing decisions. Even tough information is available, seldom consumer demand read or digest all the information provided (ALVES, 2012). Consumer goods contribute to anthropogenic climate change across their product life cycles through carbon emissions arising from raw materials extraction, processing, logistics, retail, and storage, through to consumer use and disposal (BOKKEN, 2012; SOUSSANA, 2014; SECO; et al. 2009).

The current large variety of products to meet the heterogeneity of tastes of individual customers increasingly difficult decision making, which leads the consumer to use mental shortcuts, such as the labels and tags (ALVES, 2012). Studies of food products carbon footprint have been made by numerous international supply companies such as Tesco (TESCO, 2013), Casino (CASINO, 2013), and Dole (DOLE, 2011), with the result certified by third parties and expressed at the quality label on the product packaging. These studies are

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due to the growing awareness of the global challenge to reduce emissions that cause climate change. The awareness of the possible consequences of changes in ecosystem dynamics increased consumer demand for products with environmental certification of origin. This kind of study in animal production is an innovation.

The Brazilian government is encouraging the adoption of measures to reduce GHG emissions in all productive sectors, especially in agriculture. In late 2009, it was established the National Policy on Climate Change (BRASIL, 2001), which instigates various sectors of the economy to research, develop and adopt low-carbon technologies (BRASIL, 2009). According to the Inter-Ministerial Committee on Climate Change, the low-carbon agriculture is related to the adoption of processes englobing recovery of pastures, crop-livestock integration, conservation tillage, biological nitrogen fixation and planted forests. This same committee set emissions reduction targets between 5% and 6% for the agricultural sector, considering emissions forecast for 2020.

Most major economies demonstrate increased dependence on traded carbon, either as export or as an import. Because energy is increasingly embodied in internationally traded products, both as fossil fuels and as products, energy and climate policies in other countries may weaken domestic climate policy via carbon leakage and mask energy security issues (ANDREW, 2013). An individual carbon footprint is the sum of all emissions of greenhouse gasses (carbon dioxide), which was induced by a person activity in a given time frame. Evaluating footprints has been referred to as consumption-based accounting.

This study compared the environmental impact of broiler meat and beef consumers in Brazil, using the carbon footprint assessment.

2 MATERIALS AND METHODS

An online questionnaire containing several questions related to the consumer habits including the daily consumption of either broiler meat or beef was randomly sent to several persons and their network of friends, family, and acquaintances. The customer profile was obtained with questions related to age, level of education, gender, marital status, the number of children (family size), type of house, salary, car type, and appropriate actions toward sustainability such as recycling.

The sample was chosen based on the size of the Brazilian population IBGE, (2014). The sampling error adopted was 10%, and the total estimated sample size was 100 participants; however, the total number of answers were n=222 that were used in the study. A Cluster Analysis (CA) was carried out using a unweight pair-group average employing Euclidean distance. Mean values were compared using Student T-test adopting the significance level of 95% (p value ≤ 0.05).

From the total of 222 answers from consumers of all Brazilian regions, a database was prepared. The data mining technique was used to discover the variables that would determine the patterns of consumption as recommended by CHAPMAN; et al. (2000). The software WEKA, (2017) (version 3.6.13) was used to process the database that resulted into three clusters (CL0, CL1, and CL2).

Afterward, five individual from each group were randomly selected (15 beef consumer and 15 broiler meat consumer), and the reference data was used as input into the WWF online footprint calculator (WWF, 2017). Some adaptation was made to adjust the carbon footprint calculator to the Brazilian conditions.

3 RESULTS

The respondents had the following profile (CL0) marital status: 35% were single, 14% were divorced, and 51% were married. (CL1) Age: 26% were older than 45 years, from 36 to 45 years old a total of 40% responded the questions, between 16 and 25 years old the percentage of answers was 3%, and between 26 to 35 years old a total of 31% responded to the questionnaire. (CL2) Gender: 31% of the responders were male, and 69% were female. The Travel options were several: car, airplane or public transportation. The answers regarding household items were quite similar, and the use of specific elements such as light bulbs in LED, for instance, was indicated. The note was also made for those recycling wastes. The educational level of the respondents was slightly higher, and they seemed to earn a little more than the population in general. Overall, the comparability of the survey sample with the population was at a reasonable level. The results from the Cluster Analysis (Table 1) indicate that the mean value of carbon footprint of beef eaters was higher (3 t/year) than the broiler consumers in all studied clusters.

Table 1 - Carbon footprint of broiler and beef consumers (t/year CO_2e)

Carbon footprint of broiler consumer (t/year CO_2e)			Carbon footprint of beef consumer (t/year CO_2e)		
CL0	CL1	CL2	CL0	CL1	CL2
15	16	21	19	22	21
17	15	21	20	26	19
19	20	20	21	21	15
23	18	16	23	20	20
19	17	14	19	26	21
Mean ± SD					
19±3	17±2	18±3	20±2	23±3	19±2

The average values found s distributed by each cluster are shown in Figure 1.
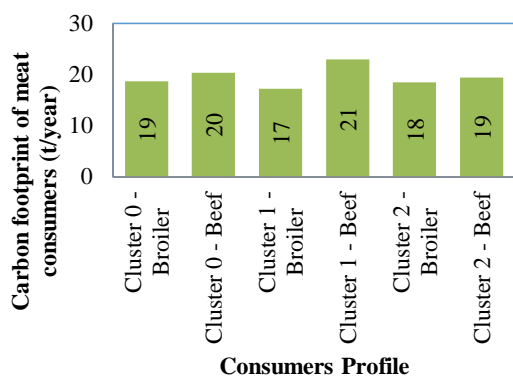
Figure 1- *Mean values of carbon footprint of broiler and beef consumers grouped (t/year CO_2e).*

The carbon footprint of beef eaters (Mean = 21 t/year; Standard error mean = 1) was 13% higher (P-value = 0.008) than the broiler meat eaters (Mean = 18 tons/year; Standard error mean = 1). Similar studies on this topic indicate that beef consumers in all meals presented a carbon footprint 14% higher than those eating broiler meat.

4 DISCUSSION

The concept of the carbon footprint is rather new, both in research and business, and some food companies have only recently started to make carbon footprint information available to their consumers. Consumer preferences for carbon footprint information have, however, been partially addressed by studying the impact of food choice about other goods KOISTINEN; et al. (2013). The carbon footprint is a useful indicator for evaluating the environmental impact a consumer' lifestyle might infer on climate change. It provides regulation to identify systems, technologies, or processes to mitigate this impact PICASSO et al. (2014). Furthermore, carbon footprint has brought to the same round of discussion farmers, industry, consumers, policy makers, and researchers, to work together to address one of the most challenging problems humanity is facing.

Consumers are increasingly concerned with climate change issues, government legislation is being put in place, and already carbon labeling is appearing on some products PAILLARD et al. (2013). There are substantial trade-offs between global and local environmental impacts. While climate change is a global problem, biodiversity loss is a local matter and must be addressed by local decision makers.

The results found in the present study indicate that beef consumers might assume a higher impact on the environment than those eating broiler. However, it was not questioned if the beef was produced in grazing land that according to PICASSO et al. (2014) might reduce the production impact to the environment.

The results also provided expressive perceptions related to the meat consumption and the sustainable vision and way of life in older and married people. This scenario can also be attributed to the education level which was higher in these groups. The estimation of carbon footprint helps understanding consumers behavior while prioritizing habits and energy use aiming to reduce CO_2 emission (KIM and NEFF, 2009).

Industry (in meeting the consumers' needs) has spared no effort to label their products and advertise about it. In contrast, governments and regulation sectors are not implementing effective measures in Brazil to meet such requirements. In Europe, Canada and the USA some tradeoffs are often transformed into non-tax barriers in international and/or regional trade (SOUSSANA, 2014).

5 CONCLUSION

Considering similar lifestyle and taking into account just the consumer preference for eating broiler meat every day lead theses customers to present less impact on the environment than those eating beef, as the carbon footprint of consumers eating beef is higher than those eating broiler meat.

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