
FOOD MILES' CONTRIBUTION TO PAPAYA TRANSPORT LOGISTICS: FROM THE FIELD TO THE WAREHOUSE

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ABSTRACT

Highlights: Papaya is among the most consumed fruits by the Brazilian population. As it is a very perishable fruit, its logistics depend on successful management. In this sense, the food miles concept seeks to ensure the quality of food and the reduction of losses and waste, through the adoption of a more efficient distribution and marketing logistics chain, with shorter distances between production and consumption.

Objective: Assess whether the distance traveled during the transportation of papaya for sale interferes with losses and waste.

Designs/Methodology/Assessment: Application of the food miles concept in a quantitative way through the Weighted Average Source Distance (WASD) method to promote more efficient logistical strategies for perishable products.

Results: Most of the papaya routes fall into the long and medium-long routes category. The main result found was an average distance of food miles of 1,359 km from different producing municipalities and different levels of production volume. This value is classified as a medium-long distance route.

Research limitations: Detailed assessment of operational practices during transport.

Practical Implications: The long distances traveled between the origin and destination added to the impacts caused during transport can contribute to an increase in the rates of losses and waste. This is because during transport the papaya is packed in inappropriate packaging and in non-refrigerated trucks, not guaranteeing the preservation of the fruit. In addition, long distances imply not only an increase in transport costs, but also a higher CO₂ emission.

Originality/value: The use of the concept of food miles in an applied and quantitative way allows decision makers to think about a more adjusted logistics, in order to seek more sustainable and efficient routes, not only in terms of cost but also in routes that have less impact on the environment.

Keywords: Losses; Waste; CEASA.

1. INTRODUCTION

In recent years, the concern with eating habits has been gaining more and more followers in search of healthy eating through the consumption of fruits, vegetables and greens (FVG) *in natura*. More recently, this population has also demanded food produced near the place of consumption. For this model of sustainable “production-consumption”, the international scientific community has named food miles. The concept was created by Professor Tim Lang in the mid-1990s in the UK during the Sustainable Agriculture Food and Environment (SAFE) event and first described in a report entitled “The Food Miles Report: The dangers of long-distance food transport” (Kemp *et al.*, 2010). The term food miles has been researched continuously, not only because it deals with production close to the place of consumption, but also because it is concerned with the quality of the food that will be consumed, as well as considering important implications for economic, environmental and socio-cultural sustainability. Food miles is the distance between the place where the food is produced and the place where it is finally purchased or consumed (Watkiss *et al.*, 2005; Sirieix *et al.*, 2008; Caputo *et al.*, 2013; Van Passel, 2013). Sustainable agriculture is an important political issue, which is why researchers and decision-makers are addressing the problem off-farm, with special attention to the food miles issue (Sirieix *et al.*, 2008).

Nevertheless, before the breadth of the food miles concept, concern for local food was already the goal of many other surveys (Feenstra, 1997; Feagan, 2007; Sims, 2009; Caspi *et al.*, 2012).

The big issue is that food miles has a repertoire that goes far beyond local food, as it considers issues of environmental, economic and social sustainability. Sirieix *et al.* (2008) explains that food miles have implications in terms of energy use and pollutants. Pirog and Benjamin (2003) consider food miles so important that they are an indicator of sustainable development. This is why extensive research discusses the importance of the food miles concept when it comes to CO₂ emissions (Weber; Matthews, 2008; Coley *et al.*, 2009; Coley *et al.*, 2011; Kissinger, 2012; Pratt, 2013; Mosammam *et al.*, 2018; Tobarra *et al.*, 2018, Malak-Rawlikowska *et al.*, 2019).

Another issue also much discussed in research that addresses the food miles concept is consumers’ perception of food miles. Schnell (2013) explains that consumers are still very confused about what the consumption of locally produced food is, because they do not understand the subject as a spatial issue (distance), they only understand the concept as a way of valuing food produced nearby. Along these lines, Bazzani and Canavari (2017) describe that the meaning of “place” should be explained more in terms of connection to a geographical area than in terms of food miles. The concept of location goes beyond the simple distance. For people,

food is an expression of the identity of a region or country. For Caputo *et al.* (2013), if the label on the packaging contains information about the time and number of miles that the food travels, the positive effects on consumer welfare will be greater than just knowing the amount of CO₂ emissions.

With growing consumer concern about the environment and climate change, the market for sustainable products is expected to expand significantly in the future (Akaichi *et al.*, 2017). This demands better efficiency of transport systems through the applicability of food miles wherever possible. The way the food system is organized contributes substantially to global warming and climate change (Sirieix *et al.*, 2008). In addition, the energies used by food chains are often punished by inefficient logistics (Schlich *et al.*, 2006; Coley *et al.*, 2009). Thus, an increase in food miles leads to increases in the environmental, social and economic burdens associated with transportation (Watkiss *et al.*, 2005).

In Brazil, the concept is still little known, but it has gained followers because it is a very promising topic, of important impact and contribution to Food and Nutritional Security (FNS). In the face of a population whose percentage of obesity is growing significantly and as a consequence of the increase in Chronic Non Communicable Diseases (NCD) (diabetes mellitus, hypertension and others), the increase in the supply of FLV is a way for the government to promote public FNS policies with access to healthy food. According to González-Muniesa *et al.* (2017), more than 2 billion of the world’s population is obese or overweight. Obesity and overweight, in addition to impacting on people’s quality of life, are associated with different multifactorial components: diet, physical activity, family history, cultural preferences, eating practices, and behaviors associated with food consumption (González-Muniesa *et al.*, 2017).

In the environmental sphere, the concern is directed at climate change and the impact of these changes on the conditions and quality of life of populations, since they directly affect consumers’ decisions to purchase products that are sustainable and environmentally responsible (Weber; Matthews, 2008). According to Watkiss *et al.* (2005), the greater the distances travelled by food, the greater the environmental, social and economic burdens associated with transportation. These include carbon dioxide emissions, air pollution, congestion, accidents, noise, and fuel consumption. In industrialized countries such as Great Britain and the USA, food travels greater distances to reach the consumer. Between 1978 and 1999, the distances with food transport in Great Britain increased by 50% (Pirog; Benjamin, 2003). In the United Kingdom, since 1978, the annual volume of food transported by heavy vehicle has increased by 23% and the average distance for each journey has increased by more than 50% (Watkiss *et al.*, 2005).

Longer distances are also associated with greater losses. The longer the FVG remains in route, the greater the possibility of loss of the product, which begins to deteriorate from the moment it is harvested. Thus, the approach of local production makes the food miles concept theory feasible, through the practice of short transport routes. Therefore, proposals to reduce the levels of losses and waste along the FVG chain should be considered as an important factor contributing to the supply and availability of food, and also contributing to the lower environmental impact, either by reducing greenhouse gas emissions or by the conscious use of natural resources.

According to FAO calculations, food losses worldwide are around 30%, which represents approximately 1.3 billion tons per year (Gustavsson *et al.*, 2011). According to the authors, it is estimated that approximately one third of fresh fruit and vegetables are thrown away because their quality has fallen below the acceptance limit. The loss of food also contributes to important environmental impacts such as: the non-rational use of water resources, energy, the use of land on which food that did not reach its final destination was produced, as well as unnecessary emissions of greenhouse gases into the atmosphere (FAO, 2013). Reducing food injuries would, at the very least, contribute to the reduction of waste, but its immediate effect is to reduce commercial losses. An increase in food supply combined with a reduction in costs caused by reduced commercial losses would possibly lead to a reduction in the price to the final consumer.

Eliminating or minimizing these losses has the following advantages: (1) the food supply can be significantly increased, without increasing the cultivation area and without using large amounts of energy, water and capital; (2) elimination of energy spent to produce and market the food lost; (3) reduction in pollution due to the reduction of organic matter decomposition; (4) better satisfaction of consumer needs and better nutrition, with the same amount of energy, land, water and work (Hirschbruch, 1998).

Aspects related to the physical environment, facilities and the relationship with hygienic conditions, including handlers, should be planned in order to minimize losses and waste. Specific actions such as the standardization of processes and services, with the creation of technical operational routines and procedures, training of the team, and control of activities through analysis should be implemented to reduce losses (Hirschbruch, 1998).

Thus, throughout the supply chain, food can suffer losses that are associated with its production, harvest and post-harvesting, processing, distribution, and marketing (Parfitt *et al.*, 2010). Therefore, food production where the region of supply is close to the region of demand can contribute to reduced levels of losses and waste, because it improves

the proper use of natural resources, increasing the supply and availability of these foods, as well as facilitating access to them in quality and at adequate prices. According to Weber; Matthews (2008), the increasing demand for organic and locally grown food, both in the U.S. and Europe, shows that consumers are concerned about the form of production employed and the place of origin. Therefore, "food miles" become the subject of debate on food sustainability (Van Passel, 2013). In this sense, when evaluating the supply chain by identifying at what stages or under what conditions the highest levels of losses and wastage are associated, strategies and actions could be proposed in order to make this chain more efficient and with food produced closer to the demanding regions.

All these considerations call for research and studies to try to measure and reduce food miles, avoiding losses and waste. In the case of FVG, in Brazil, the market is quite pulverized, so that these products are marketed by large wholesalers, as is the case with the Supply Centers (CEASA). Cunha and Campos (2008) describe that CEASA moves approximately 14 million tons of horticultural products, which represents US\$ 10 billion annually. And when we consider the other products and services it sells, this figure is higher than the sales of the two main Brazilian retail chains combined.

Still according to Cunha and Campos (2008), CEASA forms a decentralized network, with around 40 administrative units, 53 main commercial units and other smaller units, becoming the main responsible for the food supply of the Brazilian urban population. Another differential factor is that CEASAs are important operational agents in the agricultural systems of local governments, centralizing, even if in a non-systematic manner, initiatives relevant to state agricultural policies as well as food security policies. An advantage not exploited in this sense is the fact that the main central offices systematically collect statistical data on the quantity marketed and origin of products. This makes it possible to identify the municipalities and micro-regions that offer products, categorizing their relevance in terms of quantity of supply, the diversification or specialization of their trade agenda, and the seasonality of this supply (Cunha, 2015).

As for the marketing of FVG, traditionally composed of producers, wholesalers and retailers, these have been undergoing changes, either by the direct connection of large retailers with producers, or by the revaluation of the wholesaler. Most of the horticultural wholesalers operate in the CEASAs. These warehouses have the capacity to concentrate a large part of the market, eliminate competitors, and provide specialized services (Oliveira; Rocha, 2005).

Considering the trend of consumers towards fresher and better quality food, it may be important to know where the FVGs marketed by CEASAs come from and where they go,

what distances they travel and to understand their logistics and marketing practices. Van Passel (2013) explains that one of the variables when studying “food miles” is to understand the externalities of transport, taking into account its different modes and its efficiency.

This article aims to assess whether the distance covered during the transport of papaya for marketing interferes with losses and waste. To this end, the routes practiced by the papaya marketed at CEASA Campinas were identified and the Weighted Average Source Distance (WASD) method was applied to calculate the food miles route and thus identify the transport and marketing management practices capable of mitigating the rates of losses and waste.

2. METHOD

Research location

CEASA Campinas was selected for the development of the research. The works started in 1972, but only in 1989 the warehouse was municipalized, and the stock control belonged to the City Hall of Campinas. At that time, the purpose was to approximate the agricultural production of national and imported products to the consumers, stimulating the commercialization and the consumption of fruit and vegetables. The warehouse is located on the margins of D. Pedro I Highway, with easy access to Rodovia dos Bandeirantes and Anhanguera. It has a physical area of 300 thousand m² and has undergone constant improvement. There are more than 580 wholesalers (called permissionaires) in approximately 940 stores (called boxes and stones). The market sells nearly 50,000 tons of fruit, greens and vegetables per month, at around R\$ 140 million a month (CEASA Campinas, 2020).

Selected product

Papaya was selected for being one of the most marketed fruits at CEASA Campinas by volume in tons, and also for its perishability and variety of production sites.

Data collection

The data collected for the study, such as papaya transport routes (field - warehouse), volume and financial values, were obtained through the website of the Brazilian Program for the Modernization of the Horticultural Market (Prohort). The data refer to the year 2018. The distances were collected using Google Maps. Visits to the warehouse were also made to learn about transportation and marketing practices

adopted by wholesalers through interviews, as well as conversations with managers of the FVG market. The interviews were carried out in the box or in the commercialization module (stone). Six wholesalers, responsible for the aggregate purchase volume of 2.3 thousand tons/month, were interviewed. They represent 54.97% of the total papaya sold at CEASA Campinas. The aim was to learn about the characteristics of buying and selling, and the perception of wholesalers about the logistics of the papaya chain.

Data analysis

For the weighted calculation of distances, the Weighted Average Source Distance (WASD) method, employed by Pirog and Benjamin (2003) in a similar work, was used. Its weighted average distance is calculated from the product's origins to assume a single distance, which combines information of distances between the production site and the point of sale and the volume of food transported. The WASD equation is given by:

$$WASD = \frac{\sum(m(k)xd(k))}{\sum m(k)} \quad (1)$$

where:

k = Different production location points

m = Volume of each point of production

d = Distance from each production point to each point of sale

When searching for a single product, with several routes of origin but with a single destination, the calculation of the weighted average distance is more efficient; thus, it is relatively easy to calculate food miles for a single unprocessed product (Pirog; Benjamin, 2005). Pirog et al. (2001) also used the WASD method to calculate food miles for table grapes consumed in the state of Iowa in the US, for a period of three different years.

The WASD method is an indicator created by Carlsson-Kanyama (1997) to calculate a single distance where information on distances between producers, consumers and volume is combined. For her, the result obtained through the method also helps in calculations for estimates of possible environmental risks, such as emissions of pollutants.

In recent decades, different methods have been created to calculate food miles and have been replaced by more advanced techniques (Mosammam et al., 2018). The WASD equation has already been used by several researchers studying the American food system to calculate food miles (Pirog; Benjamin, 2003).

Rajkumar and Jacob (2010) used the WASD method to calculate the food miles increase in vegetable markets for an organized retailer in Chennai, India. Nicholson et al. (2011) applied the WASD method to compare different scenarios of possible source locations for the supply chain of a dairy industry, where the objective was to reduce supply chain costs through a transshipment model. Atallah et al. (2014) also used WASD to calculate a non-local distance of origin for certain consumption patterns. Schmitt et al. (2017) used WASD to compare degrees of locality between two different sources of cheese origin. Mosammam et al. (2018) applied WASD to calculate food miles for a group of 14 agricultural products imported into Iran.

In order to better position the papaya food miles and support the decision making of the agents in this chain, the index was classified into four categories according to the distance of the routes between the origin and the destination, as shown in Table 1.

Table 1. Classification of the categories of the papaya food miles route

Food Miles route classification	Distance
Short	< 400
Short-average	401 – 1.000
Medium-long	1.001 – 1.600
Long	> 1.601

Source: Prepared by the authors.

3. RESULTS AND DISCUSSION

Profile of CEASA Campinas

In the 2018 fiscal year, the Brazilian CEASAs offered 13 million tons of fruit and vegetable products. The states that contributed the most to the supply of products were: São Paulo (27.5%), Minas Gerais (19.5%), Rio de Janeiro (18.2%), Paraná (8.8%), and Goiás (7%) (Prohort, 2018).

The ranking of horticultural marketing of wholesale warehouses in relation to volume is: (1) CEAGESP São Paulo, (2) CEASA Rio de Janeiro, (3) CEASA Grande BH, (4) Mercado do Produtor de Juazeiro, (5) CEASA Goiânia, (6) CEASA Curitiba, (7) CEASA Recife, (8) CEASA Porto Alegre, (9) CEASA Campinas and (10) CEASA Salvador (CONAB, 2019).

In the same period of 2018, CEASA Campinas offered a physical volume of approximately 604 thousand tons in the market of horticultural products, of which 327 thousand tons are fruit and 274 thousand are vegetables. These results, when compared to 2017, were 4.5% lower. Part of this reduction is due to the truckers' strike in May 2018. The ten

most traded FVGs in volume were listed in the following order: potato, watermelon, orange, banana, onion, papaya, tomato, apple, pineapple and mango (CEASA Campinas, 2019). This amount demonstrates the potential of this market, showing its importance in the supply of fruits and vegetables, in Campinas and region.

In relation to the financial volume, the movement is also significant for the region, since the sector moved in 2018 approximately 1.5 billion Reais (CEASA Campinas, 2019).

Relevance of papaya marketing at CEASA Campinas

In 2018, Brazil produced 1,060.4 thousand tons of papaya, distributed over 27.2 thousand hectares, with most of the production in the southeast and northeast regions (FAO, 2018). Around 0.3% of Brazilian production is sold by CEASA Campinas.

Papaya is of great socioeconomic importance for national fruit farming (Lucena, 2016). According to the Brazilian Agricultural Research Corporation (Embrapa), of the Ministry of Agriculture, Livestock and Supply, Brazil is the second largest papaya producer in the world, behind India, and is one of the world's leading exporters, with a destination especially for the European market. The main Brazilian cultivars are Sunrise Solo – better known as papaya Hawaii, Papaya or Amazon; Improved Sunrise Solo – papaya Hawaii; and Tainung No. 1 and Tainung No. 2 – popularly known as Formosa (Embrapa, 2020). Brazil is also the second largest exporter in the world; however, almost 98% of papaya production is absorbed by the domestic market (Lucena, 2016).

In Brazil, papaya originated in the Amazon Basin, with a tropical climate, but currently, production is concentrated in the regions of southern Bahia; northern Espírito Santo; western Bahia; Chapada do Apodi, in Rio Grande do Norte; northern Minas Gerais; and Baixo Jaguaribe/Vale do Acaraú, in Ceará (Lucena, 2016).

In the 1970s, the state of São Paulo was the largest papaya producer in Brazil, representing almost 50% of all production, but due to the emergence of the mosaic virus the culture migrated to other regions of the country, such as northeast Pará, extreme south of Bahia and northern Espírito Santo. In the 1980s, the migration took place for commercial reasons and much less for phytosanitary reasons (Ruggiero *et al.*, 2011, apud Lucena, 2016).

Currently, the main papaya producing poles in Brazil are those that supply the fruit to CEASA Campinas (Figure 1).

The main producing states are Espírito Santo and Bahia, which together hold 65% of the national production,

or about 691 thousand tons (Figure 1) (IBGE, 2018). The main papaya producing municipality in Brazil is Pinheiros, in the state of Espírito Santo, covering 1,200 km to Campinas, which is considered a medium-long distance. In Parauapebas, Pará, the papaya must go a distance of 2,200 km to CEASA Campinas, considered a long distance.

In the state of Bahia, the municipality of Prado stands out. The papaya of this region needs to travel around 1,600 km to be sold at CEASA Campinas. In the same way as the production of Apodi, in Rio Grande do Norte, this municipality, which also borders Ceará, covers a distance of approximately 2,800 km to CEASA Campinas (Figure 1).

In 2018, 36 thousand tons of papaya were commercialized, 6% of the horticultural volume commercialized by CEASA Campinas. This volume guaranteed papaya the status of the 6th most marketed fruit and vegetable product in the warehouse. (Prohort, 2018).

When comparing volume within the fruit ranking, papaya won 4th place, with 11% of the total volume of fruit, behind only watermelon, orange and banana. There are nine states that supplied papaya to the warehouse (Table 2) (BRASIL, 2018).

Table 2. States supplying papaya to CEASA Campinas by volume

State	Volume (tons)
Bahia	19,813
Espírito Santo	11,565
Minas Gerais	3,386
Rio Grande do Norte	1,022
São Paulo	401
Santa Catarina	29
Sergipe	20
Rio Grande do sul	11
Paraíba	5
Papaya Subtotal	36,252
Total Fruits Marketed at CEASA Campinas	327,648

Source: Prepared by the authors from BRASIL (2018).

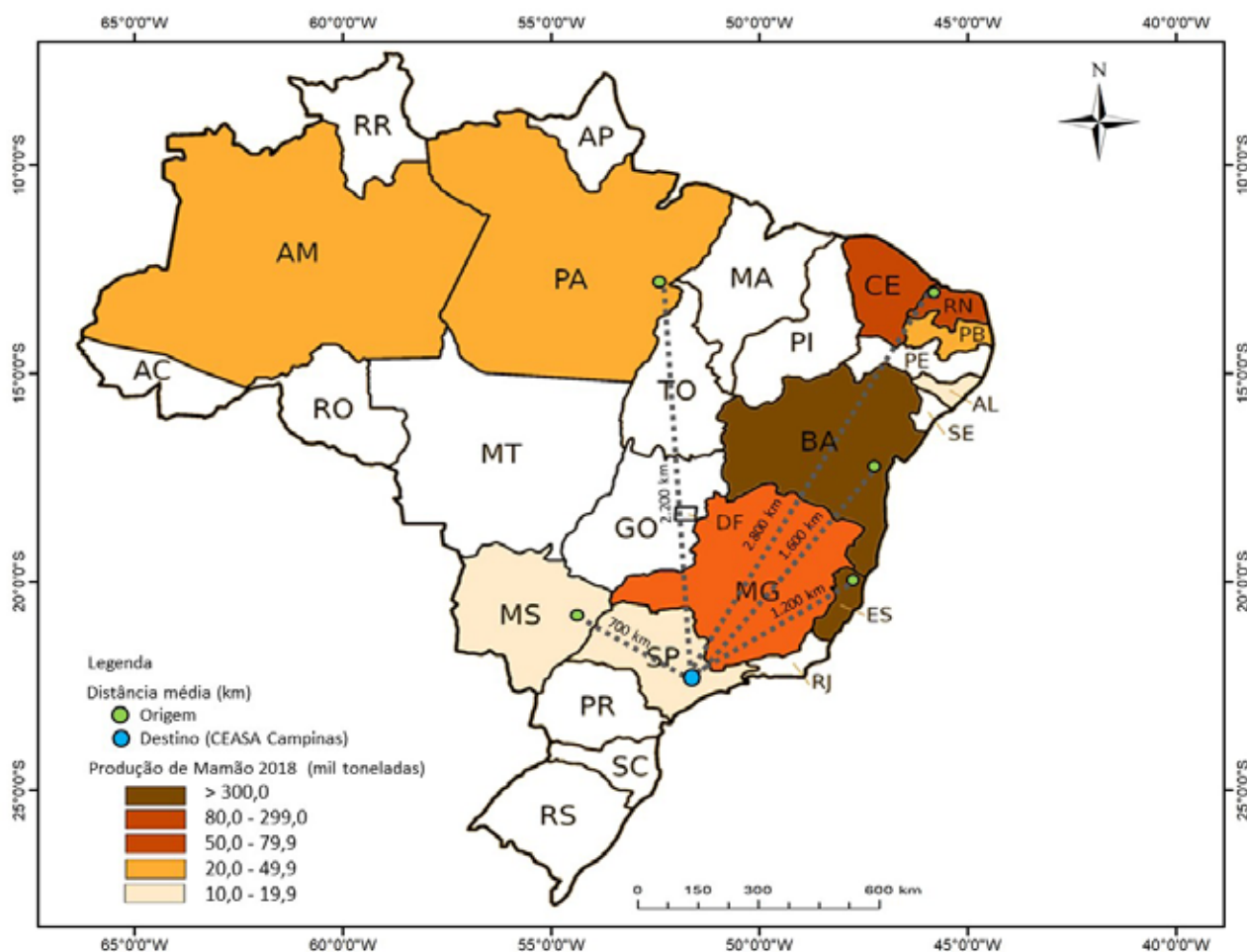


Figure 1. Main papaya producing states bound for CEASA Campinas

Source: Prepared by the authors from IBGE (2018).

The states of Bahia and Espírito Santo, together, represent 87% of the total volume of papaya sold in CEASA Campinas in 2018 (Table 2). Bahia is the state that offered the most papaya to the warehouse, 55% of the total volume, a value higher than the sum of the other eight states that sell the fruit, a total of 45%.

When considering the total financial volume, the states of Bahia and Espírito Santo represent 88% of total financial resources for the same period. The state of Sergipe is noteworthy, although it represents only 0.05% of the volume in tons sold, its price R\$/Kg is R\$ 5.98, the highest of the nine states analyzed.

In general, 68 Brazilian municipalities supplied papaya to the warehouse in 2018, of which 21 are in Bahia and 14 in Minas Gerais (Table 3).

Table 3. Total number of papaya producing municipalities for CEASA Campinas

State	Municipalities (total)
Bahia	21
Minas Gerais	14
Espírito Santo	12
São Paulo	11
Rio Grande do Norte	3
Santa Catarina	3
Rio Grande do sul	2
Paraíba	1
Sergipe	1
Total	68

Source: Prepared by the authors from BRASIL (2018).

The cities of Itabela, Eunápolis, Porto Seguro, São Felix do Coribe and São Jesus da Lapa form the top five in Bahia in terms of volume of papaya sold at CEASA Campinas. These five municipalities are so expressive that together they represent 78% of the total volume supplied by Bahia and 43% of the total volume from all states.

When analyzed the top 5 for Espírito Santo, the cities of Linhares, Pinheiros, Boa Esperança, Montanha and São Mateus are responsible for 91% of the state's papaya volume sold in the Campinas warehouse and represents 29% of the total volume of the states.

Main marketing routes of papaya with CEASA Campinas

Although papaya is a perishable fruit and needs an efficient transport model, the main producing municipalities are located at a distance of more than 1,500 km and are classified in the most superior categories of food miles, medium-long and long (Table 1). It is worth noting that the ten

most distant producing cities from the warehouse represent 15% of the total papaya volume (Table 4).

Table 4. Ranking of the ten cities with the greatest distance to CEASA Campinas

Municipalities/FU	Distance (km)	Volume traded (t)
Lajes/RN	2,881	4
Baraúna/RN	2,825	873
Mossoró/RN	2,780	145
Baraúna/PB	2,659	5
Neópolis/SE	2,268	20
São Félix/BA	1,853	11
Una/BA	1,625	702
Belmonte/BA	1,594	347
Porto Seguro/BA	1,585	3,173
Santa Cruz Cabralia/BA	1,582	293

Source: Prepared by the authors from BRASIL (2018).

The city of Lajes, in the state of Rio Grande do Norte, for example, is 2,881 km away from Campinas/SP, being a long route. In contrast, the production site closest to CEASA is located in the city of Campinas, 11 km away, being a short route.

Table 5. Ranking of the ten cities with the highest volume up to CEASA Campinas

Municipalities/FU	Volume traded (t)	Participation (%)	Distance (km)
Itabela/BA	5,886	16.2	1,419
Eunápolis/BA	3,391	9.4	1,522
Porto Seguro/BA	3,173	8.8	1,585
Linhares/ES	3,072	8.5	1,140
Pinheiros/ES	2,841	7.8	1,165
Boa Esperança/ES	2,266	6.3	1,149
São Félix do Coribe/BA	1,611	4.4	1,471
Bom Jesus da Lapa/BA	1,401	3.9	1,560
Montanha/ES	1,337	3.7	1,224
Lassange/MG	1,291	3.6	826
Subtotal	26,270	72.5	1,340
Total traded at CEASA Campinas	36,252		
Weighted Average Distance (Food Miles)			1,359

Source: Prepared by the authors from BRASIL (2018).

Considering the distances of all the papaya transport routes to CEASA Campinas, weighted by the volume of each origin, the result that shows the average distance traveled was obtained from the calculation of the WASD method. Therefore, the weighted average origin-destination distance for papaya transport obtained is 1,359 km (Table

5), in the medium-long extract of the food miles classification scale defined in Table 1. If we point to the weighted average distance of the larger producers, the average route signals for 1,340 km (Table 5). The most distant municipality that occupies the third position in volume traded is Porto Seguro, located on the Bahian coast, east of the State (Figure 2).

When considering the longest route, 2,881 km, compared to the food miles result, it is equivalent to rotating 2.1 times the WASD distance (Figure 2).

The ten routes that supply the most papaya to CEASA Campinas amount to 72.5% of the total volume. Of these, nine routes exceed 1,100 km to the warehouse, considered routes that cover medium-long distances.

According to Marques and Caixeta-Filho (2000), distances of more than 1,000 km where the fruit is transported in bulk, together with poor packaging, lead to damage to the product, so that the cargo can reach the warehouse in poor condition and presentation to the consumer, causing losses. Schnell (2013) states that throughout his research, a figure often cited among researchers is that food travels an average of 2,414 km; however, the practice of the "100-mile diet," in which people should consume as much food as possible within 100 miles (equivalent to 160 km) away from their homes, would be feasible.

Thus, it is concluded that the weighted average was high, i.e. papaya travels long distances to reach the warehouse in Campinas.

In an attempt to meet the food miles concept, in which the consumer gives preference to products produced close to the place of consumption, it is inferred that papaya should have its greatest share of supply in municipalities located in the state of São Paulo, because the distances are shorter and consequently the harvest could be made closer to the optimal point of ripening of the fruit, which in this case would also add greater organoleptic and sensory properties.

However, Brazil has a large territorial extension; therefore, climate and soil conditions, in addition to the value of renting the land are conditions that need to be better assessed. In any case, transportation and marketing practices are also important factors to consider. In the case of papaya, it is worth checking whether the current production models would be able to avoid the mammalian virus.

Main transportation and marketing practices for papaya

Papaya is among the fruits that travel the longest distances to reach CEASA Campinas. Because it is a fruit of fast perishability, during transport there may be losses of sensory characteristics, which consequently disintegrate the value of the product. Therefore, one of the big bottlenecks to be overcome is the type of transportation used.

Most wholesalers operate with bulk transport, in which papayas are packed in wooden boxes, usually in open body trucks, covered with tarpaulin, and sometimes in trunk trucks. This traditional model of transport causes mechanical damage and early ripening. Wholesalers also said they use the transport services of third-party companies or even self-employed drivers. Therefore, refrigerated transport is not common practice in this segment.

Although wholesalers have access to or have cold chambers for the packaging of papaya, which guarantees a longer life for the product, the vast majority do not use it. These wholesalers evaluate the quality of the papaya in the warehouse itself when the trucks arrive for unloading, or in some cases through periodic visits to the production site. Those who reported not assessing the quality of papaya said they work with known suppliers, which for them is a reliable guarantee of quality.

As for classification and reclassification procedures, wholesalers said that it is a routine practice during marketing and that in this specific case, these operations, unlike other fruits, are manual. Most of them perform transshipment operations. These activities (classification, reclassification and transshipment operations) may be associated with lower efficiency of the logistic chain and may contribute to higher costs due to higher labor requirements and consequently higher levels of fruit losses.

The data indicate that the commercial relationship is of purchase and sale without direct relation with the means of production, and that most of the permission holders interviewed act only as commercial agents and that there is almost no production relationship. This may be associated with less control at the stages of the chain involving area planted and harvested, as well as greater control of health standards and the quality of papaya to be marketed.

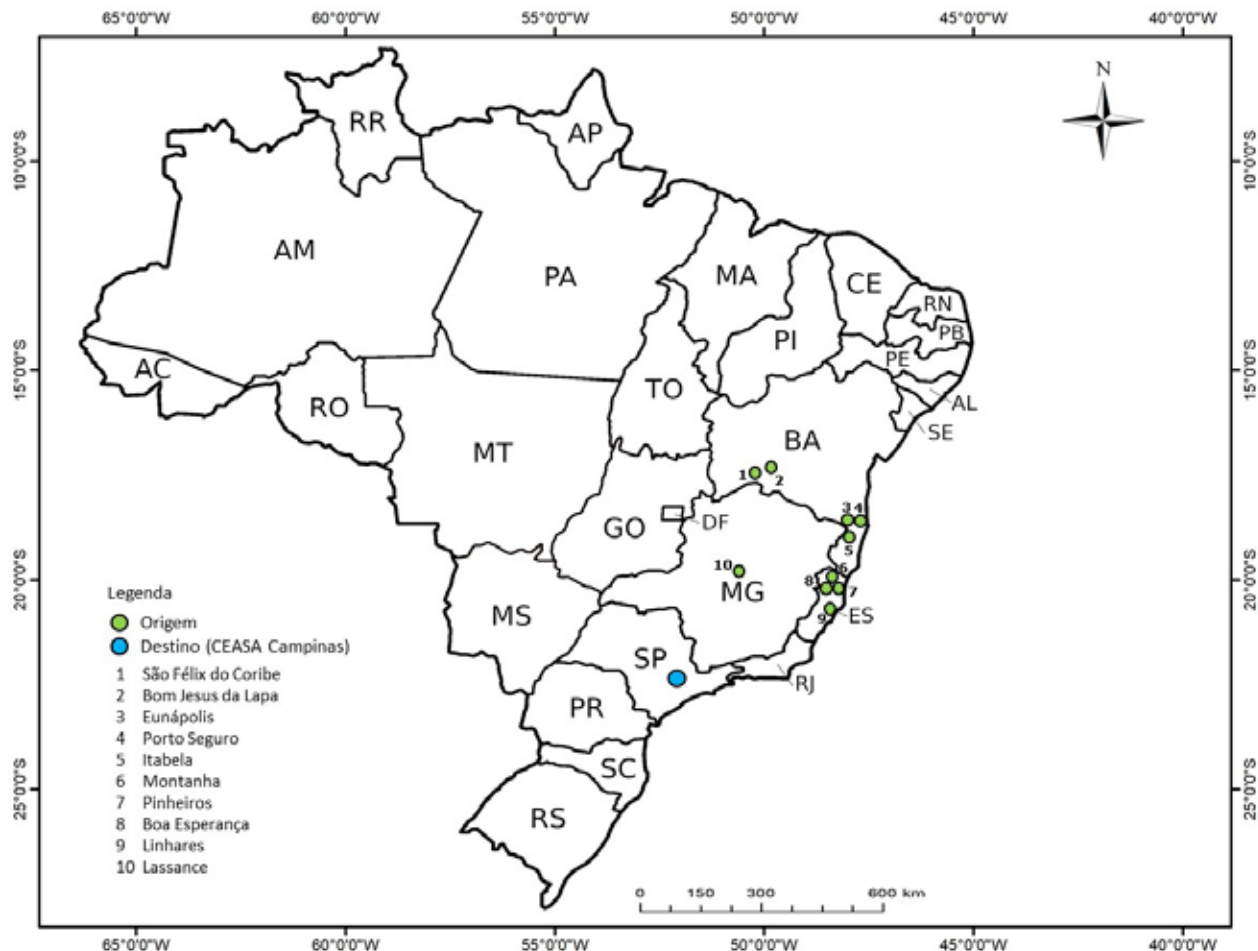


Figure 2. The ten main routes with the highest volume heading to Ceasa Campinas

Source: Prepared by the authors from IBGE (2018).

For most wholesalers, the packaging used is still the wooden box, but some also use other packaging such as cardboard boxes, plastic boxes, and niches surrounding the fruit may be of various materials. Still according to the experts interviewed, the stages that are most associated with the loss of quality of papaya are in transport (greater distances, type of transport, and type of packaging), transshipment operations and the inadequate sizing of the purchase.

As a rule, considering the perishability of papaya, the ideal would be the fruit to be packed in cardboard boxes and transported by refrigerated truck. However, refrigerated transport is little used because it makes transport more expensive (Caldarelli et al., 2009). In other words, the cost of transport per km driven in this case is higher when compared to the traditional mode of transport. Studies show that the increase in the conservation period of papaya at 10°C can prevent injuries, allowing it to mature. According to Caldarelli et al. (2009), transport in refrigerated trucks at a temperature ranging from 10 to

12°C with relative humidity between 90 to 95%, allows the fruit to be transported for a period of 7 to 10 days.

Therefore, as a result of all the considerations raised in this research, it was inferred that the logistic chain of papaya presents characteristics that contribute to a reduction in the supply of fruit, as a consequence of the high levels of losses and waste existing during its transport and marketing. Characteristics were identified along the papaya logistics chain, such as the use of wooden crates and transport in open trucks that are protected by tarpaulin, long distances, bulk marketing, especially for beautiful papaya and the natural fragility of the fruit which, because of its climate, continues its ripening process until its deterioration.

4. CONCLUSION

It is concluded that the adoption of short routes combined with refrigerated transport for papaya would be

the most appropriate scenario for maintaining quality and consequently increasing shelf time for marketing. In addition, producers and wholesalers could benefit from the sale of a product from production close to the place of consumption, in order to captivate a loyal public of consumers who are concerned about social and environmental issues, in addition to the added value that this would generate when marketed. It is worth noting that in this context the cost of transport would also be reduced. Greater dynamism, presented by an adjusted and efficient logistics chain can contribute to lower levels of losses and waste of papaya, greater supply of the product, signaling the most appropriate points of origin and with better indicators of efficiency from their place of destination.

The result found for papaya food miles was 1,359 km, considered a medium-long distance route. The long distances traveled between the origin and destination added to the impacts caused during transport can contribute to an increase in the rates of losses and waste. This is because during transport the papaya is packed in inappropriate packaging and in non-refrigerated trucks, not guaranteeing the preservation of the fruit. In addition, long distances imply not only an increase in transport costs, but also a higher CO₂ emission. For future studies, it is worth checking the levels of pollutants emitted over different production distances. Understanding and knowing the importance of food miles allows users and especially decision makers to think of a more adjusted concept of production and logistics in order to seek more sustainable and efficient routes, not only in terms of cost, but in routes that bring rational use and with less impact on the environment.

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