

Productivity Concentration of Three Native Fruit Species of Brazilian Savanna

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Abstract

The vegetal exploitation in Brazil has a strong contribution to the country's economy, but it is still an underdeveloped activity for the small producers, resulting in the low capacity to distribute the total production. The aim of paper was to analyze the market structure to the production of three native fruit species from the Cerrado biome through market concentration and market inequality. The vegetable species analyzed were *Caryocar brasiliense* (pequi), *Spondias tuberosa* (umbu) and *Hancornia speciosa* (mangaba). The data for the analysis were obtained on Production of Vegetal Exploitation and of Forestry (or PEVS) through the database Brazilian Institute of Geography and Statistics (the IBGE) for the period from 2016 to 2018. The methodology used consisted of the application of its own indexes for analyze concentration and inequality in a population. The indices were the Herfindahl-Hirschman Index, the Joly index, Theil index, concentration ratio and the Gini coefficient. The results of the Herfindahl-Hirschman and Joly indices indicated that market for the species studied as highly concentrated, what means a low distribution across the region of Cerrado. The concentration ratio index showed the state of Minas Gerais as the largest state with a concentration in the production of pequi, mangaba and umbu, respectively. The results also showed that the Brazilian market for these three species was characterized as highly uneven and uncertain. Among the three species, pequi production showed a decrease in production concentration at the end of period. The paper conclusion consisted in the identification of the market structure for each product and in the understanding that the territory of the Cerrado biome in each Brazilian state that comprises it, interferes in the productivity and distribution form of these species.

Keywords: *Caryocar brasiliense*, market concentration, market structure and vegetal exploitation

INTRODUCTION

With the importance of vegetable exploitation in Brazil for the contribution of the economy, food security and income generation for low-income families, a study about the Brazilian vegetable exploitation potential is characterized as an interesting strategy tool to know the market structure and to think in public policies that favor the competitive environment of this sector.

The Brazilian territory is composed of six terrestrial biomes and the second largest of which is Cerrado. The Cerrado biome is considered as the Brazilian savanna and has approximately 240 million hectares, equivalent to 22% of the national territory, covering more than six thousand species native to this region, such as *Caryocar brasiliense* Camb., *Spondias tuberosa* L. and *Hancornia speciosa* (Reis and Schmiele, 2019).

Being considered one of the richest savannas in the world, the Cerrado is no longer seen as an unproductive or underdeveloped region when it comes to agricultural and forestry production. However, even if it has this recognition, studies with information about fruits of this biome are considered limited (Morzelle et al., 2015). Despite public policies to help with development for this sector, there is a little knowledge about the impacts of vegetal exploitation in the region, whose small producers without conditions of competitiveness feel the market concentration in their production.

In economics, market concentration refers to the holding market power by a company, state or a country in production and competitiveness terms. According to Rebouças et al. (2017), market concentration occurs mainly due to factors: the absence potential competition and due to market entry barriers. For the authors, studying concentration indexes is looking for solutions that go against the abuse of power by those who harm new competitors, small producers and the consumer.

It is important to identify real situations regarding the economic activities of a country, mainly the activities of the forestry sector, which have contributed with approximately 6.2% of Brazil's industrial GDP. The vegetal exploitation have gained strength within this sector in the last years and to think about the families of small producers or extractive cooperatives that seek subsidies with the production of native species in the regions where they live, the market concentration and inequality in production tends to be a problem for these producers, being necessary the elaboration of strategies that help in the distribution channels.

Thus, the aim of paper was to analyze the market structure for the production of three native fruit species from Cerrado biome, through the market concentration and market inequality.

MATERIAL AND METHODS

The data about production needed to measure market concentration and market inequality indices were obtained from database of IBGE (Brazilian Institute of Geography and Statistics) for the period 2016 to 2018. The native species of Cerrado biome analyzed were "pequi", "umbu" and "mangaba". The Brazilian federative units that comprise the Cerrado biome are shown in Figure 1.

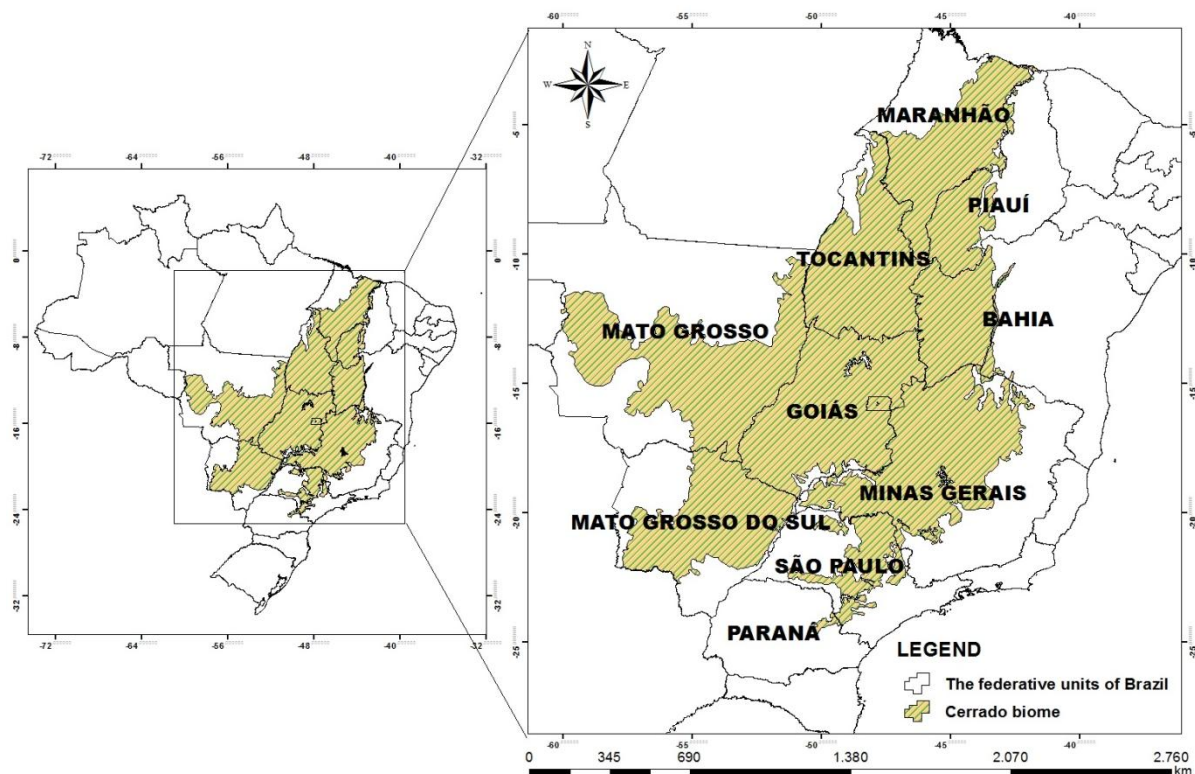


Fig. 1: Brazilian federative units that comprise the Cerrado biome.

After obtaining the data, they were worked in Excel software to apply the market concentration and market inequality indices. These indices used in the analysis were:

Concentration indices

a) **Herfindahl-Hirschman Index (HHI)**: this index considers the share of all producing states of the studied species, whose value increases as the market concentration intensifies. The index is defined by:

$$HHI = \sum_{i=1}^n P_i^2 \quad (1)$$

Where:

HHI = the Herfindahl-Hirschman Index value;

P_i = the share of State in the total production.

According to the results, a market in a monopoly situation will present a maximum value of 1, that is, in this case, a single State holds the entire market power, while for an equal participation the value is indicated by $1/n$, where n represents the number of participating States in the market, according to the classification in Table 1.

Table 1: Market classification according to Herfindahl-Hirschman index.

Herfindahl-Hirschman Index value	Herfindahl-Hirschman Index classifications
HHI tends to be 0	Market tends to be a perfect competition
$HHI = 1$	Monopoly
$HHI < 0,1$	Highly competitive market
$HHI > 0,18$	Highly concentrated market

Source: Heimann et al. (2015).

b) **Joly index:** this index considers the absolute size of each state included in that market. It is defined by:

$$J = \frac{\sum_{i=1}^n (X_i)^2}{(\sum_{i=1}^n X_i^2)} \quad (2)$$

Where:

J = Joly index;

X_i = total production value of a State.

c) **Concentration ratio:** index that considers the producers participation in the market. To measure this index, are used data from the four and eight participants with the highest production values, represented by CR4 and CR8, respectively. However, in this paper, the three largest participants in the Cerrado biome were considered due to the small number of States that producer pequi, umbu and mangaba. The below equation expresses how to apply this index:

$$CR_k = \sum_{i=1}^k y_i \quad (3)$$

Where:

CR_k = concentration ratio value;

y_i = market share of the State in total production value (%).

The market classification according concentration ratio values can be seen in Table 2.

Table 2: Market classification according concentration ratio value.

Market levels classifications	CR4 (Considering the 4 largest producers)
Highly concentrated	$i > 75\%$
High concentration	$65\% < i < 75\%$
Moderate concentration	$50\% < i < 65\%$
Low concentration	$35\% < i < 50\%$
Concentration absence	$i < 35\%$
Clearly atomistic	$i = 2\%$

Source: Heimann et al. (2015).

Inequality indices

a) **Theil index:** it's an index that determines the degree of uncertainty in the market. This index is an inverse measure of concentration, since the value varies from $E = 0$ (considered a monopoly) to $E = \log n$ (market with n participants whom the same value or volume produced) (Hersen et al., 2019). The equation that defines Theil index is:

$$E = \sum_{i=1}^n P_i \times \ln\left(\frac{1}{P_i}\right) \quad (4)$$

Where:

E = Theil index;

P_i = share of the State in total produced;

\ln = Neperian logarithm used in equation.

b) **Gini index:** in economics, the Gini coefficient or Gini index (Table 3) is one of the best known measures of inequality and can be used to measure the distribution of income, consumption, wealth, among other different approaches. The Gini index assumes values between “zero” and “one”, being defined by the following equation:

$$G = 1 - \frac{\sum_{i=1}^n (C_{ij} + C_i)}{n} \quad (5)$$

Where:

G = Gini index;

n = participants number;

C_{ij} = cumulative share in production (ascending order);

C_i = State participation.

Table 3: Gini index classification.

Gini index value	Market inequality
0.101 – 0.250	Null to weak
0.251 – 0.500	Weak to average
0.501 – 0.700	Average to strong
0.701 – 0.900	Strong to very strong
0.901 – 1.000	Very strong to absolute

Source: Heimann et al. (2015).

RESULTS AND DISCUSSION

In the Table 4, the Herfindahl-Hirschman and Joly indices indicate a high market concentration for the three native fruit species investigated in this biome. The difference between the values is relatively small, but individually, can be noticed that umbu has a higher concentration index than the others. The Theil index shows a greater uncertainty in all years in the umbu market, while for pequi the market was more uncertain in 2016 and the mangaba in 2018. Regarding the evolution of concentration indexes between 2016 and 2018, there's a reduction of uncertainty and the market concentration for the pequi and umbu, different from the mangaba production, registering an increase in uncertainty in 2018, as well as an increase in concentration.

Table 4: Concentration measures for the production of the three native species.

Index name	Year / Species								
	2016			2017			2018		
	Pequi	Umbu	Mangaba	Pequi	Umbu	Mangaba	Pequi	Umbu	Mangaba
Herfindahl-Hirschman	0.658	0.746	0.562	0.407	0.712	0.638	0.391	0.703	0.664
Joly	0.658	0.746	0.562	0.407	0.712	0.638	0.391	0.703	0.664
Theil	0.291	0.178	0.295	0.429	0.192	0.282	0.435	0.194	0.225

Analyzing the data was possible to identify the largest producers States from each native species. The Tables 5, 6 and 7 show the States of Minas Gerais, Bahia and Goiás as the three largest participants in the market, corroborating with the Herfindahl-Hirschman index of each one, because theirs highly concentrated market.

Table 5: Largest producing states in 2016.

Specie	State name	%	Specie	State name	%	Specie	State name	%
Pequi	Minas Gerais	79.72	Umbu	Bahia	85.25	Mangaba	Bahia	69.62
	Goiás	14.45		Minas Gerais	13.69		Minas Gerais	27.75
	Tocantins	3.53		Piauí	1.01		Goiás	1.81
	Bahia	2.18		Goiás	0.05		Maranhão	0.82
	Mato Grosso do Sul	0.13						
	100.0			100.0			100.0	

Table 6: Largest producing states in 2017.

Specie	State name	%	Specie	State name	%	Specie	State name	%
Pequi	Minas Gerais	57.06	Umbu	Bahia	82.99	Mangaba	Bahia	78.74
	Goiás	26.56		Minas Gerais	15.22		Minas Gerais	11.85
	Tocantins	9.02		Piauí	1.79		Tocantins	5.42
	Mato Grosso	4.63					Maranhão	2.85
	Bahia	2.54					Goiás	1.14
	Maranhão	0.13						
	Mato Grosso do Sul	0.06						
	100.0			100.0			100.0	

Table 7: Largest producing states in 2018.

Specie	State name	%	Specie	State name	%	Specie	State name	%
Pequi	Minas Gerais	57.49	Umbu	Bahia	82.00	Mangaba	Bahia	79.23
	Goiás	20.51		Minas Gerais	15.00		Minas Gerais	18.98
	Tocantins	11.57		Piauí	3.00		Maranhão	1.51
	Mato Grosso	6.90					Mato Grosso do Sul	0.14
	Bahia	2.39					Goiás	0.14
	Piauí	0.52						
	Mato Grosso do Sul	0.36						
	Maranhão	0.26						
		100.0			100.0			100.0

Note: The States of São Paulo and Paraná weren't considered per presenting production values and the produced quantity equal to zero, making them irrelevant for the research.

As what has been observed, the state of Minas Gerais, which corresponds to the CR1 of the four largest producers in the concentration ratio, went from 79.72% at the beginning of the analyzed period, to 57.49% in terms of produced quantity of pequi. When these values are compared with the umbu and mangaba values, can be noticed the state of Bahia with 85.25% of CR1 in the initial year for umbu specie, reducing its concentration ratio to 82.41% in 2018 whereas to mangaba increased from 69.65% to 79.23% in the same year. The concentration ratios observed in the market of each product within these three years are shown in Table 8, were considered market are highly concentrated, being $i > 75\%$ in all cases.

Table 8: Concentration ratio result to four largest states.

Index	Year / Species								
	2016			2017			2018		
	Pequi	Umbu	Mangaba	Pequi	Umbu	Mangaba	Pequi	Umbu	Mangaba
CR4 (%)	99.8	100.0	100.0	95.2	100.0	96.1	96.5	99.9	99.8

The market inequality measured using the Gini index showed values between 0.600 and 0.800 and can be seen in Table 9.

Table 9: Gini index results.

Index	Year / Species								
	2016			2017			2018		
	Pequi	Umbu	Mangaba	Pequi	Umbu	Mangaba	Pequi	Umbu	Mangaba
Gini	0.766	0.789	0.757	0.692	0.784	0.753	0.672	0.782	0.776

For 2016, the market for each species was considered a very strong unequal market. In the following year, 2017, the pequi market shows average inequality, while umbu and mangaba continue with a strongly unequal market. In 2018, this feat was repeated, showing that pequi production in a historical analysis decreased its market inequality, also corroborating with the other indices that indicated the decrease in market concentration. In contrast, umbu and mangaba species remained in an unequal market or had an increase of inequality.

The indices when analyzed in general indicate a situation of oligopoly market structure, where few states have control of the largest market share. The state of Minas Gerais is the holder of the highest production values and strong market concentration, despite a decrease when considers the pequi in respective period.

According Afonso, Angelo and Almeida (2015), the state was characterized as the second largest pequi producer in the country, reinforcing the public incentive policies that started in the region in the 1980s. The Cerrado in Minas Gerais has a strong development, since cooperatives and associations in the north of the state are the main responsible for the processing of native species. According to Ferreira et al. (2015), the highest values of pequi production fluctuate between the states of Minas Gerais and Goiás.

Other studies such as Oliveira et al. (2017) about the identification of critical points in the mangaba exploitation system point out the gap in the real data about the number of extractive communities despite the strong production of the fruit in the region being of regional knowledge.

The other states which have less expressiveness in the production of the observed species may indicate their participation in the market through the production of other native species of the region that were not considered here, considering the exploitation must not have only a source income for the producers, so that they, for example, don't become dependent of just one specific market segment.

Regarding the indicators used in paper, two of them corroborated to understand the decrease in market concentration and inequality market, being them Herfindahl-Hirschman index and the Gini index. Considering that if there is a decrease in the market concentration of some product, consequently there will be a decrease in your inequality, as possible distributions were made within this market.

CONCLUSION

The market concentration and inequality were well evidenced in the analyzed results. It was concluded that productivity of pequi, umbu and mangaba was classified as highly concentrated by the Herfindahl-Hirschman, Joly indices and by the concentration ratio, basing in the four largest producing states. For Theil index and Gini index, the market was characterized as extremely uncertain and very unequal, respectively.

It was also noted that the inequality and market concentration for species in the region with Cerrado biome is due to the size of this biome in each state. The proportion of biome in each States is different, thus influencing high productivity in the states with the largest Cerrado area or low productivity in the states with the smallest areas with the biome. It's worth mentioning that it's up to the State to adopt public politics that encourage the production of other products that are native to this biome and that can contribute as an extra income.

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