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Epidemiology of oral transmission of Chagas disease and socioeconomic conditions in Pará, Brazil

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ABSTRACT

OBJECTIVE

Verify relationships between the prevalence of CD, Human Development Index (HDI), the production and consumption of açaí in Pará.

METHODS

Cross-sectional study with secondary data on CD prevalence collected on the platform of the Department of Informatics of the Unified Health System (DATASUS), notified in the period from 2007 to 2018. Data on HDI, local production and consumption of açaí, were obtained from the website and the Agricultural Census of the Brazilian Institute of Geography and Statistics (IBGE), respectively. Comparisons of the number of cases, HDI and local açaí consumption were performed using Spearman's correlation, while the evolution of annual production was verified by analysis of variance. Correlations with a p-value <0.05 were considered significant.

RESULTS

There was no significant correlation between the number of cases of Chagas disease among the municipalities according to the HDI (p = 0.2000). However, there was an increase in the annual production of açaí (X2 = 40.25; p = 0.0001) and a significant correlation between local consumption of açaí and the prevalence of chagas disease (p = 0.003), although without statistical significance in the correlation between açaí production and oral transmission (p = 0.087).

CONCLUSIONS

The prevalence of CD was associated with local consumption of açaí, but not by oral transmission or influenced by the HDI, in a non-causal way. The increase in annual production concerns about the increase in the prevalence of CD in the state of Pará.

DESCRIPTORS

Chagas disease, Epidemiology, Cross-sectional studies, Disease transmission infectious, Euterpe.

RESUMO

OBJETIVO

Verificar relações entre a prevalência da DC, Índice de Desenvolvimento Humano (IDH), a produção e consumo de açaí no Pará.

MÉTODOS

Estudo transversal com dados secundários de prevalências de DC obtidos na plataforma do Departamento de informática do Sistema Único de Saúde (DATASUS), notificados no período de 2007 a 2018. Os dados sobre IDH, produção e consumo local de açaí, foram obtidos no website e no Censo Agrícola do Instituto Brasileiro de Geografia e Estatística (IBGE), respectivamente. As comparações do número de casos, IDH e consumo local de açaí foram realizadas pela correlação de Spearman, enquanto a evolução da produção anual foi verificada pela análise de variância. As correlações com valor de p<0,05 foram consideradas significativas.

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RESULTADOS

Não houve correlação significativa entre o número de casos de doença de chagas entre os municípios de acordo com o IDH (p=0,2000). Porém, houve aumento da produção anual de açaí (X2= 40,25; p=0,0001) e correlação significativa entre o consumo local de açaí e a prevalência da doença de chagas (p=0,003), embora sem significância estatística na correlação entre a produção de açaí e transmissão oral (p=0,087).

CONCLUSÃO

A prevalência de DC associou-se ao consumo local de açaí, mas não pela transmissão oral ou influenciada pelo IDH, de forma não causal. O aumento da produção anual preocupa sobre o aumento da prevalência de DC no estado do Pará.

DESCRITORES

Doença de Chagas, Epidemiologia, Estudos transversais, Transmissão de doença infecciosa e Euterpe.

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INTRODUCTION

Chagas' disease (CD) is a parasitosis caused by the infection of the protozoan *Trypanosoma cruzi*[1]. According to the World Health Organization (WHO), there are 6 to 7 million people infected with this disease worldwide[2]. Since Brazil is the second country with the highest number of infected people, it is estimated that the country, up to 2010, had around 1,156,821, second only to Argentina, which was estimated to presence of 1,505,235 cases up to the same period[3].

CD or trypanosomiasis was discovered by physician Carlos Ribeiro Justiniano Chagas in 1909, through the verification of a new type of protozoan, named by him as *Trypanossoma cruzi*, in the blood of inhabitants of the city of Lassance, in the state of Minas Gerais[4].

Vectorial transmission of CD occurs through triatomines, popularly known as barbers or hickeys[5]. These insects are hematophagous and belong to the subfamily Triatominae composed of 137 different species of triatomines, 7 of which have a vector potential for transmission[6]. The barber's sting does not substantially transmit CD, since it is its feces deposited under the injured skin after or during the sting are the sources of *Trypanossoma cruzi*.

Trypanossoma cruzi has three forms in its life cycle: amastigote, epimastigote and trypomastigote. The metacyclic trypomastigote forms found in the barber's feces penetrate the skin through the injured mucosa or the conjunctiva mucosa. In the region where entry was made, trypomastigotes suffer phagocytosis by macrophages. However, through toxic substances they manage to break the vacuole. In this way, trypomastigotes spread to neighboring cells and, through blood and lymph vessels, infect other tissues and organs. Within cells, *Trypanossoma cruzi* differs in amastigote form, making successive simple binary divisions until cell lysis. After the death of the cell, the amastigote forms again differentiate into trypomastigote, thus continuing the infection. The presence of parasites in the blood is more frequent in the acute phase of the disease, characterized by being olingosymptomatic, in most cases or by feverish conditions, edema, polyadenia, hepatomegaly and splenomegaly[4,7].

The symptomatic chronic phase, which manifests years after the acute phase, is characterized by chagasic heart disease, in 27% of cases, and digestive dilations, in 6% of cases[7]. In the heart, *Trypanossoma cruzi* infects cardiac muscle fibers through the multiplication mechanism of amastigote forms leading to chronic fibrosing myocarditis and changes in cardiac contractility[4,9,10], digestive manifestations, such as dilations of the colon[11] and esophagus[12], are due to the presence of protozoa in the various constituents of the digestive system.

The other forms of transmission of CD in humans, which can occur through oral transmission, through the ingestion of food contaminated with triatomines, blood transfusion, congenital transmission, laboratory accidents and tissue and organ transplantation[4] should be highlighted.

In the past, Chagas' disease was classified by the WHO as a tropical disease, later the UN changed this nomenclature to a neglected disease[13], due to the fact that the disease in question, as well as others belonging to the same classification, mainly affects poorer populations living in developing countries - Latin America being its endemic region -, these individuals, due to their socioeconomic conditions, have restricted access to health services, this panorama corroborates with the difficulties faced by Latin countries in controlling and preventing the disease.

Most cases of the disease until 2006 were due to vector contamination[14], this number has been reduced gradually since the creation of SUS, due this system be integrative and deals not only with treatment issues, but also with education around health and other preventive measures that promote the disease control. Diverse public health policies were created to avoid the numerous problems brought by the barber to people who were infected by it[15]. In this way, the vectorial form of contagion of the disease was drastically reduced.

Currently, Chagas disease in Brazil mainly affects the North region - according to the regional division of the Brazilian Institute of Geography and Statistics (IBGE)[16] -, in which the increase in the incidence of new cases is observable, most of which is due to oral infection. Among the 5 municipalities that had the highest average annual incidence of the disease in Brazil, 4 of them were from the state of Pará[17].

In addition to the high incidence rates, Pará has the highest number of cases of Acute Chagas Disease among all the Brazil Federative Units, presenting 2,170 new cases of the disease between the years 2007 and 2018, which represents about 80.13% of the cases reported in Brazil in the same period[18].

In 2018, 75.94% of the cases in Pará were transmitted oral-

ly[18]. In the state, this panorama has been associated with the consumption of açai, which is a fruit native to the Brazilian Amazon and consumed by the population of the northern region daily[1]. Its production in Brazil was 221,646 tons in 2018, where the largest production is in the state of Pará of 147,730 tons, in the respective year[19].

The oral contamination of the Chagas disease comes mainly from the açaí pulp that is contaminated with Triatoma remnants, this kind of transmission was demonstrated by Barbosa-Labello, from the incubation of parasites in the açaí pulp and in the administration of this to mice from this process the maintenance of the virulence of *T. cruzi* in the food has been proven[20]. In view of the large number of cases of oral transmission in Pará and with the consumption of açaí associated with it, state technical programs and resolutions were developed for the manipulation of açaí by producers, traders, and beaters. In 2010, through Decree No. 2,475 of 10/09/2010, the State Quality Program of Açaí was implemented, which essentially seeks to train açaí beaters, traders, and producers, as well as their registration with the municipal health departments and the Defense Agency Agriculture of the State of Pará. This measure, among other objectives, sought to intensify health surveillance and monitor possible contaminants in the fruit[21].

Another decree that deserves to be highlighted under the context of contamination of açaí by *Trypanossoma cruzi*, is Decree nº 250 of 10/13/2011, which stipulates the collection of samples of açaí to monitor and prevent its contamination. In 2012, hygienic-sanitary rules were established, through Decree No. 326 for the manipulation of açaí: a physical structure of establishments that sell fruit pulp is prescribed, as well as conduits to be followed for cleaning and disinfecting açaí. What needs to be questioned is the resoluteness of state programs in the sense of reducing the number of cases by oral transmission, as the existing health standards and surveillance have not effectively reduced this number[22,23].

The consumption of infected foods that promote the transmission of Chagas disease shows an important aspect to be analyzed in the epidemiology of neglected disease: the living conditions of the population that consumes it, a factor that may be related to the inadequate treatment of açaí, which consequently results in their contamination. The relationship between neglected diseases and the Human Development Index (HDI) is statistically very clear, an example of which is the North region, which has the lowest HDI and has the highest number of Neglected Tropical Diseases when compared to other Brazilian regions[24,25]. Therefore, the study aims to verify the relationship between the number of cases and the average of Chagas disease, the Human Development Index, production, and consumption of açaí in the municipalities of Pará.

METHODS

Cross-sectional study with secondary data obtained on the platform of the Department of Informatics of the Unified Health System, of the number of cases of Acute Chagas Disease reported in the period from 2007 to 2018[26]. The HDI data of the municipalities of Pará were obtained from the Brazilian Institute of Geography and Statistics[27], local production and consumption of açaí were obtained from the IBGE agricultural census[28,29]. Comparisons of the number of cases, HDI and local açaí consumption were performed using Spearman's correlation, while the evolution of annual production was verified by the X^2 test. Correlations with $p < 0.05$ were considered significant.

RESULTS

Table 1 shows the number of confirmed and notified Chagas' disease cases in the Notifiable Diseases Information System by municipality in the state of Pará compared to the likely mode of infection. In which one, oral infection represents the largest number of cases.

Table 1. Confirmed cases of Chagas disease by notification municipality in the state of Pará and probable mode of infection from 2007 to 2018.

Municipality of notification	Ignored/ Withe	Vector	Vertical	Accidental	Oral	Other	Total
Abaetetuba	43	22	1	-	242	-	308
Acará	-	-	-	-	1	-	1
Afuá	1	3	-	-	6	-	10
Água Azul do Norte	-	1	-	-	-	-	1
Alenquer	1	-	-	-	1	1	3
Altamira	1	1	-	-	3	-	5
Anajás	6	1	-	-	26	-	33
Ananindeua	43	7	-	-	348	-	398
Anapu	1	-	-	-	-	-	1
Augusto Corrêa	-	1	-	-	2	-	3
Aurora do Pará	-	2	-	-	1	-	3
Bagre	1	1	-	-	42	-	44
Baião	1	1	-	-	-	-	2
Barcarena	17	17	-	-	87	-	121
Belém	134	11	1	-	249	-	395
Benevides	1	-	-	-	6	-	7
Bragança	1	2	-	-	20	-	23
Breves	8	6	-	-	256	-	270
Bujaru	-	-	-	-	2	-	2
Cachoeira do Arari	-	1	-	-	-	-	1
Cachoeira do Piriá	-	-	-	-	1	-	1
Cametá	12	3	-	1	73	-	89
Capanema	1	-	-	-	5	-	6
Capitão Poço	3	-	-	-	1	-	4
Castanhal	16	3	-	-	7	-	26
Conceição do Araguaia	-	-	-	-	5	-	5
Concórdia do Pará	1	1	-	-	-	-	2
Curralinho	19	-	-	-	38	-	57
Curuá	-	-	-	-	2	-	2
Curuçá	-	1	-	-	-	-	1
Garrafão do Norte	-	2	-	-	1	-	3
Igarapé-Miri	8	6	-	-	60	-	74
Irituia	2	5	-	-	3	-	10
Jacareacanga	-	-	-	-	1	-	1
Juruti	2	1	-	-	-	-	3
Limoeiro do Ajuru	8	8	-	-	13	-	29
Magalhães Barata	-	-	-	-	1	-	1
Marituba	1	-	-	-	2	-	3
Melgaço	2	-	-	-	7	-	9
Mocajuba	-	-	-	-	3	-	3
Moju	17	1	-	-	11	-	29
Muaná	4	17	-	-	20	-	41
Nova Ipixuna	-	1	-	-	-	-	1
Oeiras do Pará	-	1	-	-	11	1	13
Oriximiná	1	-	-	-	-	-	1
Paragominas	1	-	-	-	4	-	5
Ponta de Pedras	5	1	-	-	1	-	7
Portel	1	-	-	1	8	-	10
Porto de Moz	1	-	-	-	1	-	2
Prainha	-	-	-	-	1	-	1
Redenção	3	-	-	-	-	-	3
Salinópolis	1	-	-	-	-	-	1
Salvaterra	-	1	-	-	-	-	1
Santa Izabel do Pará	1	-	-	-	5	-	6
Santarém	1	1	1	-	21	-	24
São Domingos do Capim	2	2	-	-	10	-	14
São João de Pirabas	-	-	-	-	3	-	3
São Miguel do Guamá	1	3	-	-	4	-	8
São Sebastião da Boa Vista	1	-	-	-	27	-	28
Tailândia	2	-	-	-	-	-	2
Tomé-Açu	-	1	-	-	-	-	1
Tracuateua	-	1	-	-	-	-	1
Tucumã	1	-	-	-	-	-	1
Tucuruí	1	-	-	-	6	-	7
Total	378	137	3	2	1648	2	2170

Data from the Ministry of Health / SVS - Information System for Notifiable Diseases - Sinan Net[14].

Table 2 shows in its second column the consumption of açaí in the establishment in tons per municipality in Pará. The term consumption in the establishment refers to the quantity of fruit, in tons, that were produced and consumed in the cor-

responding municipality. The third column shows the average number of confirmed cases from 2007 to 2018.

Table 2. Consumption in the establishment of açaí in tons in 2006 and the average number of cases of chagas disease in the period from 2007 to 2018 by municipality in the state of Pará.

Municipality	Consumption in the establishment*	Media Confirmed Cases**
Curuá (PA)	1	0,166666667
Porto de Moz (PA)	1	0,083333333
Benevides (PA)	2	0,5
Castanhal (PA)	3	0,583333333
Marituba (PA)	6	0,166666667
Alenquer (PA)	9	0,083333333
Santa Izabel do Pará (PA)	30	0,416666667
Paragominas (PA)	46	0,333333333
Prainha (PA)	57	0,083333333
Garrafão do Norte (PA)	69	0,083333333
Augusto Corrêa (PA)	89	0,166666667
Aurora do Pará (PA)	147	0,083333333
São João de Pirabas (PA)	151	0,25
Cachoeira do Piriá (PA)	169	0,083333333
Bragança (PA)	189	1,666666667
São Miguel do Guamá (PA)	223	0,333333333
Mocajuba (PA)	228	0,25
Capitão Poço (PA)	235	0,083333333
Altamira (PA)	242	0,25
Santarém (PA)	374	1,75
Irituia (PA)	471	0,25
Melgaço (PA)	564	0,583333333
São Domingos do Capim (PA)	1328	0,833333333
Bagre (PA)	1726	3,5
Limoeiro do Ajuru (PA)	2018	1,083333333
Barcarena (PA)	2362	7,25
Belém (PA)	2630	20,75
Portel (PA)	2694	0,666666667
Afuá (PA)	3464	0,5
Oeiras do Pará (PA)	3781	0,916666667
Breves (PA)	4287	21,33333333
Anajás (PA)	4589	2,166666667
Cametá (PA)***	5968	6
Bujaru (PA)	6140	0,166666667
Abaetetuba (PA)	6862	20,16666667
Acará (PA)	8262	0,083333333
Muaná (PA)	9359	1,666666667
Ponta de Pedras (PA)	10212	0,083333333
São Sebastião da Boa Vista (PA)	10945	2,25
Igarapé-Miri (PA)	11898	5
Curralinho (PA)	13265	3,166666667

Data mentioned in the agricultural census conducted by the Brazilian Institute of Geography and Statistics in 2006[29].** Data from the Ministry of Health / SVS - Information System for Notifiable Diseases - Sinan Net from 2007 to 2018[14]. In the municipality of Cametá, a case of Acute Chagas Disease was excluded because the year of notification appears as "White "[14].**

The dispersion graph shown in figure 1 shows the association between the average of cases (vertical axis) and consumption in the establishment of açaí in tons (horizontal axis). The linear line indicates a positive association between the variables.

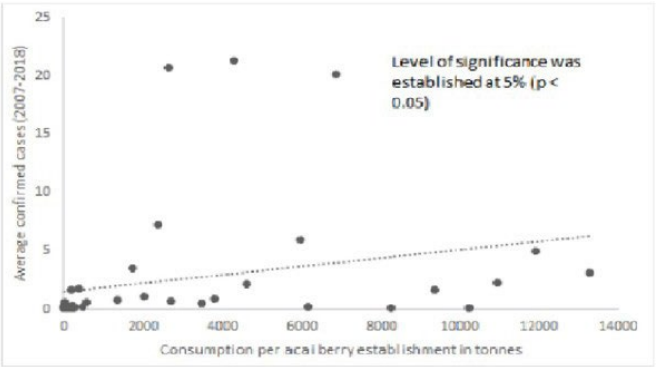

Figure 1. Relationship between the average number of cases of Chagas disease in the period from 2007 to 2018 and the consumption of açai per ton in 2006 in the municipalities of the state of Pará. Black Circle: Municipalities; Black dashed line: Linear trendline. Data adapted from Data from the Ministry of Health / SVS - Information System for Notifiable Diseases - Sinan Net[14] e agricultural census conducted[29].

DISCUSSION

A higher number of new cases of CD was observed in the state of Pará, since between 2007-2018 the state presented 2170 new cases, while the total in the country was 2708 in the same period. In addition, the main means of contagion occurred orally, this is observable in 2018, since about 75% of Chagas' notifications in Pará occurred through the ingestion of contaminated food, the main one being açaí[26].

It was found that there is a significant relationship between cases of Chagas disease by oral, mainly due to the intake and production of açaí, with an annual increase in fruit production in tons year by year related to the number of cases by oral transmission in each municipality of Pará per year, both in the period from 2007 to 2018 (X^2= 40,25; p=0,0001).

In addition, a significant correlation was found between local consumption of açaí and the average of Chagas disease (rs= 0,54 p=0,003). However, when the correlation between the number of total cases by oral transmission and the production of total açaí in tons between the years 2007 to 2018 was made, no statistical significance was found (p=0,087).

There was no significant correlation between the number of cases of Chagas disease in the years 2007 to 2018 in the municipalities of Pará according to the Human Development Index acquired in the last census conducted by the IBGE in 2010 (p=0,2).

CONCLUSION

There are significant relationships between cases of Chagas' disease orally, mainly due to the intake of açaí, and their production and consumption in the municipalities of Pará. Along with the increase in cases of the disease, an increase in the production of açaí was also observed in the studied period, although not correlated with the Human Development Index (HDI). It is noteworthy that a causal relationship between the consumption of açaí and the average number of cases cannot be established, that is, the present study states that the two variables are related, but not directly of cause and effect. For that, more data would be needed regarding the consumption of açaí in the state of Pará, however Census Agricola has not reported such data since 2006.

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REFERENCES

1. Ferreira RTB, Branquinho MR, Leite PC. Transmissão oral da doença de Chagas pelo consumo de açaí: um desafio para a Vigilância Sanitária. Vig. Sanit. Debate. 2014;2(04):4-11.
2. Pan American Health Organization. [internet]. [acesso em 2020 jul 17]. Disponível em: https://www.paho.org/en/topics/chagas-disease.
3. World Health Organization. Chagas disease in Latin America: an epidemiological update based on 2010 estimates. Wkly Epidemiol Rec. 2015 fev;90(6):33-44.
4. Neves DV, Melo AL, Linardi PM, Vitor RWA. Parasitologia humana. 9ª ed. São Paulo: Atheneu; 1995.
5. Westphalen EVN, Bisugo MC, Araújo MFL. Aspectos epidemiológicos e históricos do controle da doença de Chagas no Continente Americano. BEPA, Bol. epidemiol. paul. [internet]. São Paulo; 2012 [acesso em 2020 jul 17] ; 9(105): 18-35. Disponível

em:http://periodicos.ses.sp.bvs.br/scielo.php?script=sci_arttext&pid=S1806-42722012000900002&lng=es.
6. Argolo AM, Felix M, Pacheco R, Costa J. Doença de Chagas e seus principais vetores. (única). Rio de Janeiro: Imperial Novo Milênio; 2008.
7. Rey, L. Bases da Parasitologia Médica. 3 ed. Rio de Janeiro: Guanarabara Koogan; 2009.
8. Rassi A Jr, Rassi A, Marin-Neto JÁ. Chagas disease. Lancet. 2010 abr; 375 (9723): 1388-1402.
9. Rassi A Jr, Rassi A, Marin-Neto JA. Chagas heart disease: pathophysiologic mechanisms, prognostic factors and risk stratification. Mem. Inst. Oswaldo Cruz. 2009 jul; 104(1): 152-158.
10. Rassi A Jr, Rassi A, Marin-Neto JA. Chagas disease. Lancet. 2010 abr; 375 (9723): 1388-1402.
11. Enez DV, Henriquez CI. Chagasic megacolon in Venezuela – case report. Rev. Colo-proctol. 2020 jun; 40 (2): 172-174.
12. Abud TG, Abud LG, Vilar VS, Szejnfeld D, Reibscheid S. Achados radiológicos no megaesôfago secundário à doença de Chagas: radiografia de tórax e esofagograma .Radiol Bras. 2016 dez. 49(6): 358-362.
13. Cruz AE. Doenças Negligenciadas no Brasil: responsabilidades pela persistência da negligência. [Tese de Mestrado]. São Paulo: Pontifícia Universidade Católica, 2010.
14. Brasil, Ministério da Saúde. Banco de dados do Sistema Único de Saúde -DATASUS [internet]. [acesso em 13 jul 2020]. Disponível em: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinanwin/cnv/chagasbr.def
15. Barreto ML, Teixeira MG, Bastos FI, Ximenes RAA, Barata RB, Rodrigues LC. Successes and failures in the control of infectious diseases in Brazil: social and environmental context, policies, interventions, and research needs. Lancet. 2011 mai; 377:1877-89.
16. IBGE – Instituto Brasileiro de Geografia e Estatística. Evolução da divisão territorial do Brasil: 1872-2010. Rio de Janeiro: IBGE, Diretoria de Geociências; 2011. 261p.
17. Ministério da Saúde, Secretaria da Vigilância em Saúde. Doença de Chagas: 14 de abril – Dia Mundial. Bol Epidemiol [internet]. 2020 abr [acesso em 14 Jul 2020]; 51(n.esp.):1-43. Disponível em: http://www.saude.gov.br/boletins-epidemiologicos
18. Brasil, Ministério da Saúde. Banco de dados do Sistema Único de Saúde -DATASUS [internet]. [acesso em 13 Jul 2020]. Disponível em: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinannet/cnv/chagasbr.def
19. IBGE – Instituto Brasileiro de Geografia e Estatística. Produção da Extração Vegetal e da Silvicultura [internet]. [acesso em 2020 jul 15]. Disponível em: https://sidra.ibge.gov.br/tabela/289
20. Barbosa RL. Transmissão oral do Trypanosoma cruzi pela polpa de açaí em camundongos. [Dissertação]. Campinas: Universidade Estadual de Campinas; 2010.
21. Pará. Decreto nº 2.475 de 10/09/2010. Dispõe sobre a implementação do Programa Estadual de Qualidade do Açaí, e dá outras providências. Diário Oficial do Estado do Pará. 2010 set 13.
22. Pará. Decreto nº 250, de 13 outubro de 2011. Altera dispositivos do Decreto nº 2.475, de 10 de setembro de 2010, que dispõe sobre a implementação do Programa Estadual de Qualidade do Açaí, e dá outras providências. Diário Oficial do Estado do Pará. 2011 out. 14; p.
23. Pará. Decreto nº 326, de 20 janeiro de 2012. Estabelece requisitos higiênico-sanitários para a manipulação de Açaí e Bacaba por batedores artesanais, de forma a prevenir surtos com Doenças Transmitidas por Alimentos (DTA) e minimizando o risco sanitário, garantindo a segurança dos alimentos. Diário Oficial do Estado do Pará. 2012 jan. 24.
24. Lindoso JA, Lindoso AABP. Neglected tropical diseases in Brazil. Rev. Inst. Med. Trop.. 2009 set-out; 51(5): 247-253.
25. SEBRAE - Serviço Brasileiro de Apoio às Micro e Pequenas Empresas. Boletim: Produção Nacional de Açaí. [internet]. 2015 [acesso em 05 ago 2020]. Disponível em: http://www.bibliotecas.sebrae.com.br/chronus/ARQUIVOS_CHRONUS/bds/bds.nsf/64153228c3c444bcdb587b6b501fa076/$File/5827.pdf
26. Brasil, Ministério da Saúde. Banco de dados do Sistema Único de Saúde - DATASUS [internet]. [acesso em 13 jul 2020]. Disponível em: http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinanwin/cnv/chagasbr.def
27. IBGE – Instituto Brasileiro de Geografia e Estatística. Cidades [internet]. [acesso em 2020 jul 15]. Disponível em: https://cidades.ibge.gov.br/
28. IBGE – Instituto Brasileiro de Geografia e Estatística. Produção da Extração Vegetal e da Silvicultura [internet]. [acesso em 2020 jul 15]. Disponível em: https://sidra.ibge.gov.br/tabela/289
29. IBGE - Instituto Brasileiro de Geografia e Estatística. Produção, Venda e Valores da produção e da venda na extração vegetal nos estabelecimentos agropecuários, com agricultura familiar e não familiar, por produtos da extração vegetal, condição do produtor em relação às terras, destino da produção e grupos de atividade econômica. [internet]. [acesso em 2020 jul 15]. Disponível em: https://sidra.ibge.gov.br/tabela/2233