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Talisia esculenta (A. ST.-HIL.) Radlk: características físico-químicas, atividade antioxidante e atividade biológica

Talisia esculenta (A. ST.-HIL.) Radlk: physico-chemical characteristics, antioxidant activity and biological activity

Talisia esculenta (A. ST.-HIL.) Radlk: características fisicoquímicas, actividad antioxidante y actividad biológica

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Resumo

Talisia esculenta Radlk (A. ST.-HIL.) é uma fruta nativa brasileira, conhecida como pitomba, pertencente à família Sapindaceae. O objetivo do presente trabalho foi realizar uma revisão da literatura com o objetivo de identificar estudos sobre sua caracterização físico-química, atividade antioxidante e atividade biológica. A busca dos artigos foi realizada no PubMed, SciELO, Science Direct e LILACS. Foram identificadas 90 publicações, 8 na SciELO, 3 na LILACS, 67 na Science Direct e 12 na PubMed. Posteriormente, verificou-se duplicação dos artigos entre as bases de dados, e a triagem foi realizada através da leitura dos títulos, resumos e leituras na íntegra, para analisar quais artigos se enquadravam no objetivo do estudo, e apenas 5 estudos foram incluídos. A revisão expõe *Talisia esculenta* Radlk (A. ST.-HIL.) como uma fruta que possui potencial bioativo, mas são escassos os estudos que abordem sua composição química e sua atividade biológica.

Palavras-chave: pitomba; atividade antioxidante; atividade biológica; compostos bioativos.

Abstract

Talisia esculenta (A. ST.-HIL.) Radlk is a Brazilian wild fruit, known as a pitomba, belonging to the Sapindaceae family. The objective of the present work was to perform a review of the literature in order to identify studies on its physico-chemical characterization, antioxidant activity and biological activity. The articles search was done in PubMed, SciELO, Science Direct and LILACS. We identified 90 publications, 8 in SciELO, 3 in LILACS, 67 in Science Direct and 12 in PubMed. Subsequently, duplication of the articles between the databases was verified, and the triage was done by reading the titles, abstracts and reading in full, to analyze which articles fit the study objective, and only 5 studies were included. The review exposes *Talisia esculenta* Radlk (A. ST.-HIL.) as a fruit that has a bioactive potential, but there is a shortage of studies that deal with its chemical composition and its biological activity.

Keywords: pitomba; antioxidant activity; biological activity; bioactive compounds.

Resumen

Talisia esculenta (A. ST.-HIL.) Radlk es una fruta brasileña nativa, conocida como pitomba, que pertenece a la familia Sapindaceae. El objetivo de este trabajo fue revisar la literatura para identificar estudios sobre su caracterización fisicoquímica, actividad antioxidante y actividad biológica. Se buscaron los artículos en PubMed, SciELO, Science Direct y LILACS. Identificamos 90 publicaciones, 8 en SciELO, 3 en LILACS, 67 en Science Direct y 12 en PubMed. Posteriormente, los artículos se duplicaron entre las bases de datos, y el examen se realizó leyendo los títulos, resúmenes y lecturas completos para analizar qué artículos se ajustaban al objetivo del estudio, y solo se incluyeron 5 estudios. La revisión expone *Talisia esculenta* Radlk (A. ST.-HIL.) Como una fruta que tiene potencial bioactivo, pero los estudios que abordan su composición química y actividad biológica son escasos.

Palabras clave: pitomba; actividad antioxidante; actividad biológica; compuestos bioactivos.

1. Introduction

Brazil is the most biodiverse country in the world and the third largest producer of fresh fruits globally. This fact notoriously contributes to the economy of the country. Some of its richest biomes by the number of plant species are the Amazon, Atlantic rainforest, Cerrado, and Caatinga (Lacerda *et al.*, 2004; Coradin *et al.*, 2011; Giulietti *et al.*, 2004). Despite the great diversity of native plant species, many of them still remain unresearched or even unknown. Furthermore, an increased interest in natural or minimally processed products

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has been observed, particularly due to the benefits associated with regular consumption of such foods. The importance of this food habit is currently recognized because it can reduce the risk of chronic non-communicable diseases (CNCD) (Opas, 2016; Nascimento *et al.*, 2014; Guarim-Neto *et al.*, 2003).

Talisia esculenta A.St.-Hil Radlk of the Sapindaceae family is among the lesser known Brazilian fruits. It is commonly known as "pitomba". Its tree reaches height of 6 to 12 m and the diameter of the trunk varies between 30 and 40 cm (Vieira e Gusmão, 2008). The fruit has a thick peel and elongated seeds with reddish spots (Santos *et al.*, 2012).

Pitomba is characterized as a fruit of Brazilian wilderness, encountered most often in Brazilian biomes of Caatinga, Cerrado, and Atlantic rainforest as well as in the neighboring countries: Bolivia and Paraguay (Santos *et al.*, 2012, Giulietti *et al.*, 2004; Santos *et al.*, 2008). Its fruition is annual and produces moderate quantity of seeds; flowering occurs from August to October and ripening of fruits is from January to March depending on the locality (Guarim-Neto *et al.*, 2003).

The fruit of pitomba represents a known economic potential. It is sold *in natura* in open markets of the Northern and Northeastern regions of Brazil and it is well accepted by the population of the Northeastern region. Its pulp is used in production of jams, jellies, and sweets with a flavor similar to an apricot (*Prunus armeniaca* L., Rosaceae) (Santos *et al.*, 2012; Santos *et al.*, 2008). The seeds have been extensively studied as a source of compounds with insecticidal activity (Freire *et al.*, 2009; Freire *et al.*, 2012).

Nevertheless, studies that treat the fruit as food, characterize it, and determine its antioxidant and biological activities are scarce. Some recent articles point to pitomba as being a likely source of bioactive compounds (Neri-Numa *et al.*, 2014; Souza *et al.*, 2016).

In view of the above, the objective of this research was to perform a review of literature about the fruit of the species of *Talisia esculenta* Radlk to identify studies that address its physico-chemical characteristics, antioxidant and biological activities.

2. Compilation of Studies

This survey was conducted from September to October 2016 and included articles published in the last 15 years (from 2001 to 2016) that were obtained from the following databases: PubMed, SciELO, Science Direct, and LILACS. "*Talisia esculenta*" and "pitomba" were used as search terms and combined using the "and" operator with: "centesimal composition", "antioxidant activity", "phenolic compounds", and "cell culture". Original studies of the basic experimental and/or applied type that analyzed the composition of pitomba (*Talisia esculenta* Radlk) and its *in vitro* and *in vivo* effects were included in this review. Excluded were articles about biological control of pests, botany, and biometrics of pitomba. The following steps were performed for selecting the articles after defining the inclusion and exclusion criteria: verifying duplication of the articles between databases and sorting by reading of the titles, reading of the abstracts, and reading in full. The inclusion criteria allowed publications in English, Spanish, and Portuguese.

90 articles were identified in the databases participating in this research. Out of these, 7 were duplicated between the databases, bringing the number of articles qualifying for further investigation in the selection to a total of 83. Among the articles that were not adhering to the inclusion criteria, 75 were excluded after the examination of their titles, 2 after the analysis of the abstracts, and 1 was excluded after the in-depth reading. Ultimately, the search resulted in 5 studies suitable for analysis in this review.

Out of the 5 selected articles, 2 works examined the physical-chemical composition (Silva *et al.*, 2008; Marin *et al.*, 2009); 2 works analyzed the antioxidant activity and *in vivo* and *in vitro* effects (Neri-Numa *et al.*, 2014; Souza *et al.*, 2016); and 1 work evaluated the inflammatory potential *in vivo* (Freire *et al.*, 2003). Table 1 presents a summary of the characteristics of the selected articles. It is evidenced that all the studies were carried out in Brazil, being collected mainly in the Amazon region and in the cerrado.

Table 1. Summary of the studies included in the review.

Authors/ Year of publication /Country	Variables studied	Part of the fruit analyzed	Model	Methods used
Freire *et al.*, 2003, Brazil.	Lectin, leukocyte migration, inflammatory response.	Seed	*In vivo*	Isolation of lectin; air bag model produced on the dorsal skin of rats; induction of edema in the subplantar region of the right hind paw by injection of TEL.
Silva *et al.*, 2008, Brazil.	Moisture, protein, total lipids, total dietary fiber, ash, calcium, iron, zinc.	Pulp	*In vitro*	Moisture at 105°C. Protein by total nitrogen method (Kjeldahl flask). Lipids - technique described by Bligh and Dyer (1959) and the total food fiber content by enzymatic-gravimetric method of Prosky (1988).

				Calcium, iron, and zinc: method described by AOAC.
Marin *et al.*, 2009, Brazil.	Calcium, iron, zinc, magnesium, phosphorus, phytic acid, tannin.	Pulp	*In vitro*	Inductively coupled plasma atomic emission spectroscopy; Colorimetric method and titration; Molar ratio of phytic/mineral acid.
Neri-Numa *et al.*, 2014, Brazil.	Total content of polyphenols, flavonoids; antiproliferative, antioxidant, and antimutagenic activities.	Whole fruit	*In vitro* and *in vivo*	DPPH; ABTS; ORAC; HPLC; Folin and Ciocalteu.
Souza *et al.*, 2016, Brazil.	Antioxidant activity, phenolic compounds, aroma.	Pulp	*In vitro*	DPPH, ABTS, ORAC; LC-MS/MS; GC-MS were used together with headspace solid-phase microextraction.

TEL: lectin from the seed of *Talisia esculenta*; AOAC: Official Methods of Analysis; DPPH: 2,2-diphenyl-1-picrylhydrazyl; ABTS: 2,2'-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid); ORAC: Oxygen Radical Absorbance Capacity; HPLC: High Performance Liquid Chromatography; UACC-62: tumor cell (melanoma); NCI-ADR/RES: tumor cell (breast expressing multiple drug resistance phenotype); OVCAR-3: tumor cell (ovary); LC-MS/MS: liquid chromatography coupled to mass spectrometry; GC-MS: gas chromatography coupled to mass spectrometry

3. Physico-Chemical Characteristics

Talisia esculenta (A. ST.-HIL.) Radlk is shown in figure 1. Silva *et al.*, (2008) and Marin *et al.*, (2009) evaluated the physico-chemical composition of the pulp of pitomba in their studies.

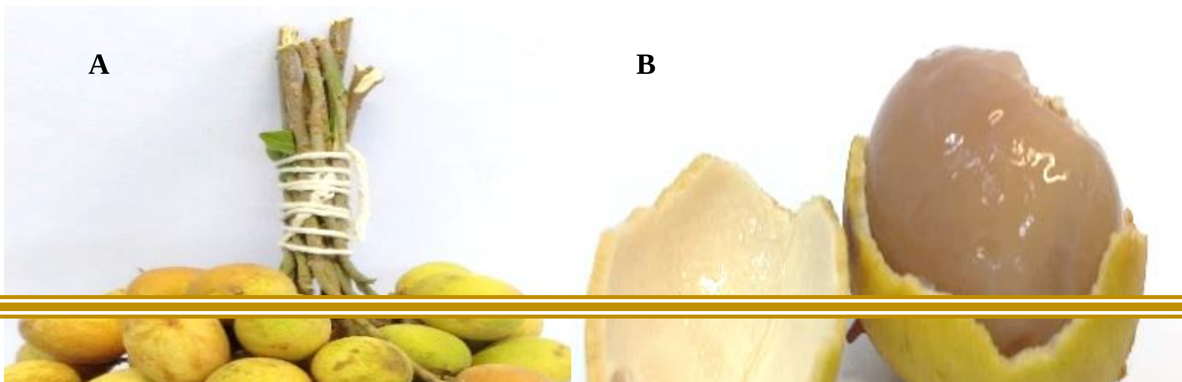

Figure 1. A- Bunch of pitomba, B- Apparent pulp.
Source: Author (2017).

The variables examined in both works Silva *et al.,* (2008) and Marin *et al.,* (2009) were: total caloric value TCV (56.35 - 79.1kcal/100 g of pulp), calcium (10.6 - 26.7 mg/100 g of pulp), iron (0.6 - 2,4 mg/100 g of pulp) and zinc (0.5 - 0.84 mg/100 g of pulp).

Both research used fruits from the same Brazilian biome of Cerrado. However, the substantial differences that were observed between the obtained values can be explained by the different conditions of the analyses as well as different harvest times, types of soil, annual precipitation, incidence of UV rays, among other conditions that influence the composition of fruits (Gobbo e Lopes, 2007).

Wall (2006) evaluated mineral composition of lychee (*Litchia chinensis)*, longan (*Dimocarpus longan*), and rambutan (*Nephelium lappaceum*), fruits belonging to the same family as pitomba, and discovered the following values: 6.9 mg/100 g, 4.7 mg/100 g, 7.6 mg/100g for calcium; 0.67 mg/100 g, 0.43 mg/100 g, 0.50 mg/100 g for iron; and 0.23 mg/100 g, 0.16 mg/100 g, 0.26 mg/100 g for zinc, respectively. The values were lower than in the study by Marin *et al.*, (2009).

Queiroz *et al.*, (2012) examined chemical constituents of lychee fractions in its pulp in g/100 g of dry matter and found contents of 3.80±0.72 for lipid, 6.68±0.59 for protein, 1.82±0.09 for ash, and 85.38±0.89 for carbohydrates. These values were higher than those determined for pitomba by Silva *et al.*, (2008) and Marin *et al.*, (2009).

Brazilian Food Composition Table (2011) provides the following values for umbu (*Spondias tuberosa*) and ambarella (*Spondias dulcis* Parkinson), fruits native to the Brazilian Caatinga biome, respectively: 37 and 46 kcal/100 g for TCV; 0.8 and 1.3 g/100 g for protein; 9.4 and 11.4 g/100 g for carbohydrates; 2 and 2.5 g/100 g for dietary fiber; 11 and 11mg/100 g for magnesium. Among the native Brazilian fruits, these presented the closest values to those of pitomba analyzed by Silva *et al.*, (2008).

The difference in composition between the studies is probably due to edaphoclimatic conditions such as seasonality, circadian rhythm, temperature, rainfall index, ultraviolet radiation, altitude, and type of soil as well as time of year when the fruits were harvested. These factors interfere with primary plant metabolism that is responsible for production of compounds responsible for nutritional food value and classified as carbohydrates, proteins, and lipids, among others (Asai *et al.*, 2017; Gouvea *et al.*, 2012; Gobbo e Lopes, 2007).

4. Bioactive Compounds and Antioxidant Activity

The bioactive compounds with antioxidant properties present in the foods have been widely studied (Alu'Datt *et al.*, 2017; Ho *et al.*, 2017; González-Aguilar *et al.*, 2017; Pellegrini *et al.*, 2017; Atef e Ojagh, 2017). These substances are part of the composition of fruits and vegetables and maintain a redox state of a cell, reducing oxidative damage to key structures in the organism, such as lipids, proteins, and DNA, as well as preventing the occurrence of CNCD (Martins *et al.*, 2016; Zimmermann e Kirsten, 2008).

Investigating the antioxidant potential of *T. esculenta*, Neri-Numa *et al.*, (2014) and Souza *et al.*, (2016) used the same 3 methods of analysis: sequestration of 2,2-diphenyl-1-picrylhydrazyl free radical (DPPH), a method based on 2,2'-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) radical (ABTS), and the oxygen radical absorption capacity (ORAC).

The DPPH and ABTS methods are among the most used techniques for this purpose, the application of more than one method in the same study is crucial to affirm an antioxidant potential of a given product, whether natural and / or obtained from synthetic sources (Alves *et al.*, 2010) In spite of the ORAC method that was carried out by the two studies, it is no longer suitable for evaluation of the antioxidant activity due to its association with in vivo oxidative stress mechanisms and results obtained with this in vitro method can not be extrapolated for *in vivo* effects (Usda, 2018).

According to Neri-Numa *et al.*, (2014), the antioxidant activity of the hydroalcoholic extract of the *T. esculenta* fruit was significantly higher than kaempferol, gallic acid, myricetin, and quercetin when analyzed by DPPH and ORAC (hydrophilic) methods. It is worth mentioning that according to the ORAC method, the results were about 10 times higher for the *T. esculenta* extract in relation to the standards. The comparisons with the standards were not determined for the ABTS method that returned a result of 115.69 TE μg/g for the pitomba extract. In relation to the total phenolic compounds and the content of flanonols, pitomba demonstrated 105.84 mg GAE/g and 88.05 mg CE/g, respectively. According to the findings of this study, *T. esculenta* is classified as a fruit with an average content of total phenolic compounds, according to a classification proposed by Vasco *et al.,* (2008). The authors also investigated presence of bioactive compounds in the fruit and, with the aid of high efficiency liquid chromatography (HPLC), identified 89.90 mg/100 g and 30.20 mg/100 g of the flavonoid aglycones – quercetin and myricetin, respectively.

Also investigating the antioxidant activity of the *T. esculenta*, Souza *et al.,* (2016) analyzed the methanolic pulp extract of the fruit. The ORAC method revealed 78.19 μmol TE/g for the extract (10.95 μmol TE/g for fresh pulp). The DPPH was 7.22 mg GAE/g for the extract (1.0 mg GAE/g for fresh pulp) and the ABTS revealed 12.93 mg GAE/g for the extract (1.8 mg GAE/g for fresh pulp). The authors suggested that pitomba had an antioxidant potential that is superior or similar to various fruits (apple, apricot, banana, kiwi, mango, nectarine, orange, peach, pear, pineapple, and melon) with an exception of blueberry and cranberry (Wu *et al.,* 2004). The higher antioxidant potential of red fruits is probably justified by the high content of anthocyanins, a phenolic compound with a pronounced antioxidant action (Tsao, 2010), which are practically absent in fruits with similar coloring to pitomba.

Still, in the study of Souza *et al.,* (2016), with the aid of chromatography coupled to quadrupole time-of-flight, the authors identified 13 phenolic compounds in the methanolic extract of the pulp of *T. esculenta* that are, in ascending order of retention time: quinic acid, gallic acid, chlorogenic acid, catechin, epicatechin, caffeic acid, syringic acid, p-coumaric acid, rutin, ferulic acid, quercetin, eriodictyol, acacetina. All of these compounds act as efficient antioxidant agents in different systems (Grzesik *et al.,* 2018; Saidani *et al.,* 2017; Alves *et al.,* 2016; Liang *et al.,* 2016), corroborating the results found in the *in vitro* antioxidant activity tests for pitomba. Regarding the quantification of phenolic compounds in the methanolic extract, Souza *et al.,* (2016) quantified predominantly the quinic acid (507.8 μg/g for dry pulp) followed by coumaric, ferulic, gallic, caffeic, and chlorogenic acids that ranged between 0.6 and 3.4 μg/g for dry pulp. Epicatechin, catechin, and quercetin were also measured with values of 2.9, 1.4, and 0.6 μg/g for dry pulp, respectively. These compounds are found in a wide variety of fruits with recognized antioxidant potential (Rothwell *et al.,* 2012; Rothwell *et al.,* 2013; Neveu *et al.,* 2010).

Souza *et al.,* (2016) have also characterized a total of 27 volatile compounds in the pulp of pitomba. The composition of the volatile fraction in fruits is essential for characterization and identification, because they indicate their *flavor* profile, being generally represented by esters, aldehydes, alcohols, terpenes, and their derivatives (Bicas *et al.,* 2011). Of the total volatile compounds identified in pitomba, the esters: phenethyl acetate (18%), isopentyl acetate (15.11%), and 2-phenylethanol (13%) were predominant, followed by the alcohols, with the 2-phenylethanol as a major compound (13.43%). Moreover, β-ionone (0.72%), linalool (0.84%), and β-bisabolene (0.24%) were also observed, in smaller quantities.

For fruits belonging to the same botanical family as the *Talisia esculenta*, Queiroz *et al.,* (2015) evaluated the antioxidant potential of pulp extracts from *Litchi chinensis*. The aqueous extract and the acetone extract showed a percentage of the DPPH radical capture of 41.95% and 27.25 %, respectively.

The different results for the same parameters examined by the 2 studies that evaluated pitomba should probably be attributed to the differences in the implementation of methodologies, such as different harvest times and conditions and different types of the extracts. Furthermore, the secondary metabolites produced by plants may undergo modifications in quantity and quality according to the edaphoclimatic characteristics to which they are exposed, such as rainfall index, solar radiation, temperature, relative air humidity, type of soil, wind, and harvest period (Gobbo e Lopes, 2007). Moreover, the genetic factor should also be considered since the production of secondary metabolites is strictly genetically regulated (Verma *et al.,* 2015).

5. Biological Activity: *In vitro* and *in vivo* studies

Preliminary studies on *in vitro* and *in vivo* biological systems are essential for the assessment of the bioactive potential of fruits. Such models assist in elucidation of metabolic pathways that explain the varied biological effects attributed to dietary intake of fruits recognized as potential functional foods. Works in various experimental models demonstrated the activity of fruits as antiproliferative agents in tumor cell lines, antioxidant agents in different biological models, and mitigating agents in inflammatory processes. It is therefore noted that fruits constitute as potential modular components of various processes involved in the genesis of CNCD (Mariani *et al.,* 2013; Gouveia *et al.,* 2017).

Neri-Numa *et al.*, (2014) evaluated the antiproliferative activity of the pitomba extract in the lineages of tumor cells U251 (glioma), UACC-62 (melanoma), MCF-7 (breast adenocarcinoma), NCI-ADR/RES (breast expressing phenotype multiple drug resistance), 786-0 (kidney), NCI-H460 (lung), PC-3 (prostate), OVCAR-3 (ovary), HT-29 (human colon adenocarcinoma) and VERO (kidney, normal cells of African green monkey). In all of the models the tested concentrations ranged between 0.25, 2.5, 25, and 250 μg/ml. There was an observed increase in the antiproliferative activity directly proportional to the increase of the concentration of the extract in all of the cellular lines, thus, demonstrating a dose-response effect. The myricetin and quercetin flavonoids, identified in the extract in question, have antiproliferative activity documented in other studies (Klimaszewska-Wísniewska *et al.*, 2017; Sánchez-González *et al.*, 2017; Yang *et al.*, 2017; Pan *et al.*, 2016), a fact that may help explain the observed results. Moreover, studies conducted on lychee (*Litchi chinensis*), a fruit belonging to the same family as pitomba, also demonstrated an antiproliferative potential. Wen *et al.*, (2015) isolated and tested 3 phenolic compounds of lychee leaf (secoisolariciresinol 9'-O-β-D-xyloside; 4,7,7',8',9,9'-hexahydroxy-3,3'-dimethoxy-8,4'-oxy-neolignan; and cinnamtannin B1), and identified cinnamtannin B1 as a potent intracellular antioxidant and antiproliferative agent in HepG2 and Siha cells. Wang *et al.*, (2011) evaluated the anticancer effect of the ethanolic extract from the pericarp of lychee in *in vitro* and *in vivo* models for hepatocellular carcinoma and breast cancer. They have verified potential anticancer activity in all of the conducted tests because the extracts led to an inhibition of cellular proliferation, induction of cancer cells apoptosis, and up-regulation and down-regulation of genes involved in regulating cellular cycle, signal translation, transcriptional regulation, mobility, and invasiveness of cancerous cells. Furthermore, the authors indicated ADP-ribosyltransferase (NAD+; poly (ADP-ribose) polymerase)-like 1 (ADPRTL1), Cytochrome P450, subfamily I (CYP1A1), and Hyaluronan-mediated motility receptor (HMMR) as key molecular targets for the action of the extract tested. The composition of the pericarp of lychee demonstrates a wide variety of phenolic compounds with recognized antioxidant action (Wang *et al.*, 2011).

In addition to the *in vitro* proliferative activity, Neri-Numa *et al.*, (2014) also evaluated an anticlastogenic activity in animal model, investigating the protective effect of the pitomba extract against clastogenicity induced by cyclophosphoamide in rats. The experiment demonstrated that the administration of the *T. esculenta* extract drastically reduced the number of micronucleated polychromatic erythrocytes (MPE), highlighting that all the concentrations tested (30, 100, and 300 mg/kg per body weight) differed significantly from the control positive (cyclophosphoamide), being the highest concentration that presented a more significant protection with a 95.03% reduction of MPE. Studies that evaluate anticlastogenic activity of other fruits of the Sapindaceae family were not found in the literature so far.

In relation to the inflammatory aspect, Freire *et al.,* (2003) evaluated the inflammatory potential of the first isolated lectin of the family Sapindaceae, extracted from the seed of pitomba (pitomba seed lectin - PSL) (Freire *et al.*, 2001; Freire *et al.*, 2002). Plant lectins can mimic the activity of lectins of mammals. For this reason, they have been used in studies that simulate various pathophysiological processes, including proinflammatory mechanisms (Freire *et al.,* 2003). Thus, Freire *et al.*, (2003) evaluated the effect of PSL on neutrophil migration in mice using the dorsal air pouch, peritoneal cavity, and paw edema models. The concentrations that were used varied between 50 and 2000 µg/ml of PSL in the different experimental models. The authors concluded that the PSL induced neutrophil migration in the different models of cavity and paw edema in mice. However, the authors emphasize that the mechanisms responsible for the observed effects still remain unknown.

The studies selected according to the inclusion criteria for this revision evaluated the pulp and the seed of pitomba separately and the homogenized fruit as a whole, but none evaluated peel of this fruit in isolation. It is important to emphasize that the peel and the seed of pitomba, although not used as food, represent the majority weight percentage of the fruit (≥ 80% p/p). Yet there is still a lack of information about them, especially about the peel. Studies that assess the use potential of fruit residues are important in promotion of a sustainable production system. Furthermore, the literature has already demonstrated potential usefulness of plant residues (Hsu *et al.*, 2012), including that of other fruits in the Sapindaceae family.

In recent review, Emanuele *et al.*, (2017) pointed to lychee being a functional food by gathering studies that demonstrated that the peel of the fruit is the source of flavonoids and anthocyanins (proanthocyanidin B2, proanthocyanidin B4, and epicatechin, while cyanindin-3-rutinside, cyanidin-3-glucoside, quercetin-3-rutinoside, and quercetin-3-glucoside). Meanwhile, the seed demonstrated a varied content of phenolic compounds with antitumor and cardioprotective action, although it was related to toxicity in the presence of methylene Cyclopropyl-Alanine (MCPA) and methylene cyclopropyl-glycine (MCPG) that are hypoglycemic substances (Das *et al.*, 2015; Shrivastava *et al.*, 2017).

3. Conclusion

The fruit of the *Talisia esculenta* species has demonstrated, in its different structures, antioxidant, antiproliferative, antimutagenic, and inflammatory activities so this may possibly be useful in preventing diseases caused by excess free radicals, such as some CNCD. In light of these findings, further studies on its chemical composition and biological effects in vitro and in vivo, since the preliminary results were promising. Moreover, the shortage of research on the composition and biological potential of pitomba has been confirmed, despite it being known and consumed in several regions of Brazil.

Although few studies have been carried out to date, the available information confirms the importance of follow-up research with pitomba. In addition to the potential biological benefits, toxicological tests are essential to indicate whether its consumption is safe. Dissemination of information on little-known fruits, such as the pitomba, can contribute to the local economy in the fruit producing regions, considering the increase in the search for natural foods and their benefits through their regular consumption.

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