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RESEARCH ARTICLE

Bromatology, food chemistry and antioxidant activity of *Xanthosoma sagittifolium* (L.) Schott

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ABSTRACT

Taioba or Cocoyam - *Xanthosoma sagittifolium* (L.) Schott - leaves and petioles consumption is almost restricted to Brazilian traditional communities because the lack of knowledge about their chemical and nutritional features. This study was carried out to determine the Taioba leaves and petioles chemical properties (moisture, fixed mineral residue, Calcium, Magnesium, proteins, lipids, dietary fiber and carbohydrates) were quantified; Calcium oxalate was evaluated as an anti-nutritional factor. Bioactive compounds (vitamin C, chlorophyll, carotenoids, lycopene and phenolic compounds) were also determined. Antioxidant capacity was evaluated by DPPH and ABTS methods. Taioba leaves and petioles present greater quantity of proteins, fibers, Calcium, Magnesium and vitamin C than some conventional plants used as salad. The amount of Calcium oxalate was not considered harmful to human consume. Antioxidant activity related to Taioba bioactive compounds has functional and nutraceutical abilities, which opens promising prospects for its use.

Keywords: Unconventional food plants; Taioba; Bioactive compounds; Bromatological analysis

INTRODUCTION

There are over 3,000 potential food plant species still underexplored in Brazil, many of them being native species. Because they are naturally adapted to their natural environment they need few financial supports, are resistant to pests and diseases and grow in different types of soil and climate. Such features are important to incentive their farming and to spread their nutritional potential to people, contributing to minimize malnutrition in poorer regions (Kinupp and Lorenzi, 2014).

Unconventional Food Plants (UFP) have nutritional potential but are not include in human daily diet due to the lack of information about its use a food (Kinupp and Barros, 2008; Kinupp and Lorenzi, 2014). Many UFP contain more minerals and proteins than conventional food plants, such as leaves of *Boehmeria caudata* and *Phenax uliginosus*, with 24,15% of proteins, *Muehlenbeckia sagittifolia* with 27,02% and *Solanum americanum* with 29,9% (Kinupp and Barros, 2008). Yet, there are few researches reporting their nutritional contents and antinutritional facts for safe human consumption (Kinupp and Lorenzi, 2014).

Xanthosoma sagittifolium (L.) Schott (Araceae) is a UFP known in Brazil as Taioba (Kinupp and Lorenzi, 2014; Caxito et al., 2015) which, along with *Xanthosoma mafaffa*, constitute the species of the genus with greater economic importance (Heredia Zárate et al., 2005). Taioba is grown and consumed in some regions of Africa, Asia and (Kobori and Rodriguez-amaya, 2008; Jackix et al., 2013; Caxito et al., 2015); in South America its leaves are eaten steamed (Jackix et al., 2013) and braised (MAPA, 2010), and in Brazil there are reports of its consumption in the States of Bahia, Minas Gerais, Rio de Janeiro and Espírito Santo (Seganfredo et al., 2001). In Amazon region Taioba corms are used in traditional diet, but the leaves are often discarded (Pérez et al., 2007; Jackix et al., 2013).

Taioba farming is simple and has low cost with high productivity; its leaves can be cut from 60 to 75 days after planting and it yields nearly 6,000kg/ha (MAPA, 2010). Almost all the plant body is used for human consumption – corms, leaves, petioles and inflorescences (Falade and Okafor, 2015). The species can be grown in regions with more than 20 ºC (MAPA, 2010), which makes it an important alternative for family farming (Souza, 2008).

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Taioba leaves are excellent sources of calcium, phosphorus, iron (Caxito et al., 2015) and vitamin C (Pinto et al., 2001b), but the fibers are their main constituents (Jackix et al., 2013). Reducing intake of Calcium and Magnesium in the diet exposes individuals to the risk of chronic diseases (Jahnen-Dechent and Ketteler, 2012). Calcium is stored mainly in the bones and plays an important structural role, and, outside the skeleton, control various cellular processes such as muscle contraction, neuronal transmission, hormone secretion, organelle communication, cell motility, fertilization and cell growth (Arruda and Hotamisligil, 2015). Magnesium is important for the proper functioning of the Central Nervous System, playing an important role in the control of Alzheimer's disease since it prevents memory decline; also works in the control of diabetes, hypertension, migraine, hyperactivity and attention deficit, as well as preventing stroke (Wang et al., 2018).

Although Taioba has nutritional value and food potential, the plant may contain anti-nutritional factors that reduce its consumption (Pinto et al., 2001a). Knowing the nutricional and anti-nutritional components and the bioactive compounds from leaves and petioles of this plant, that are the least used parts as food, is important to include them in human diet in a safety and effective way thus being considered as an alternative or complementary food. The goal of the study was to determine the nutritional and functional properties of leaves and petioles of Taioba, beyond evaluate calcium oxalate contents to detect anti-nutritional factors.

METHODS

Botanical material

Taioba fresh leaves and petioles (*Xanthosoma sagittifolium* (L.) Schott) were randomly collected in the morning, between 60-75 days after planting in 2017, from the individual cultivated at Horta Didática Agroecológica of Grande Dourados Federal University (UFGD) in Dourados, Mato Grosso do Sul State, Brazil (Latitude 22º 13' 18" S e Longitude de 54º 48' 23" W). The voucher was deposited in the herbarium of Grande Dourados Federal University (DDMS) under the number 6009.

The leaves were separated from the petioles and both were manually chopped, sanitized by immersion for 10 minutes in a 0,66% dehydrated sodium dichloroisocyanurate solution, washed in potable water and slightly dried with paper to then be crushed into the processor, put in flexible polypropylene packaging and stored at -10 ° C until the time of use.

Chemical analysis

Humidity contents were determined in air circulation oven at 105 ºC (AOAC, 2003), mineral contents in mufla oven at 550 ºC (AOAC, 2003), protein and lipids contents according to AOAC (2003) and food fiber according to AOAC (2005). Total carbohydrates were calculated by difference (100 g – grams of humidity, protein, lipids and minerals).

Calcium and magnesium were determined by Nitric-perchloric digestion and the mineral elements were quantified by spectrophotometry of atomic absorption (Malavolta et al., 1997). The analyzes were performed in triplicate and the results expressed in g/100 g of sample on dry basis and standard deviation.

Calcium oxalate contents in leaves and petioles were determined according to Iwoha and Kalu (1995) following the three steps: digestion, calcium oxalate precipitation and potassium permanganate titration. Initially 25 g of sample was mixed with 190 mL of distilled water and 10 mL of HCl (6 M), heated (100 ºC/1h) and then cooled in ice bath. The volume was completed com distilled water up to 250 mL and filtered by vacuum.

To 125 ml aliquots of the filtrate were added 4 drops of Methyl Red solution (0,1%), then NH4OH P.A was added by dripping till the color changed from salmon-rose (pH 4-4.5) to light-yellow. The aliquots were heated to 90 ºC, chilled, filtered, heated again to 90 ºC and added to 10 mL of $CaCl_2$ solution (5%) with stirring till complete dissolution, and then chilled to 5 ºC for 12h. Each solution was transferred to Falcon® tubes and centrifuged at 2500 rpm for 5 minutes. The supernatant was discarded, the precipitate containing the oxalate was dissolved in 10 mL of H_2SO_4 20% (v/v) and then added 300 mL of distilled water. A 125 mL aliquot of each solution was heated to 90 ºC and titrated with KM_nO_4 solution (0.05 M) until the color light pink persists for 30 seconds. The analysis was performed in triplicate. Calcium oxalate percentage was calculated by Equation 1 and the result was presented in mg of calcium oxalate/100g of sample.

$$\text{Ca oxalate}(\text{mg}/100\text{g}) = \frac{V \times (Vme)}{(DF) \times 10^5} \times \frac{(DF) \times 10^5}{(ME) \times mf} \quad (1)$$

V = spent volume of $KMnO_4$ (mL); V_{me} = mass-equivalent volume (1 mL) of $KMnO_4$ 0,05 M, solution = equivalent to 0,00225 g of anhydrous oxalic acid; DF = dilution factor (2,4) obtained from dividing the total filtrate volume (300 mL) by the used aliquot (125 mL); ME = molar equivalent of $KMnO_4$ in oxalate; m_f = sample mass.

The content of vitamin C was determined by Tillmans method (AOAC, 1990) using the solution of 2,6-dichlorophen-indophenol-sodium (DCFI) and 2%

oxalic acid. The percentage of chlorophyll was determined by Lichtenthaler method (1987); an aliquot (1 g) of leaves or petioles was macerated in mortar with 10 mL acetone solution (80%) (v/v) until all the pigmentation is extracted, then it was centrifuged at 4000 rpm for 10 min. The supernatant was transferred to a 25 mL volumetric flask. The volume was completed with acetone solution (80%) (v/v). Absorbance readings were performed in a UV-VIS spectrophotometer (Biochrom, Libra S60PC model) with 647 nm and 663 nm wave-length. P.A. acetone was used as negative control. Each sample was analyzed in triplicate. The results were expressed in mg of chlorophyll by 100 g of sample. The percentage of total chlorophyll was calculated by Equations 2, 3 and 4 (Lichtenthaler,1987).

$$Chlorophyll\ a = 12,25\left(A_{663}\right) - 2,79\ \left(A_{647}\right) \quad (2)$$

$$Chlorophyll\ b = 21,50\left(A_{647}\right) - 5,10\ \left(A_{663}\right) \quad (3)$$

$$Total\ chlorophyll = 7,15\ \left(A_{663}\right) + 18,71\left(A_{647}\right) \quad (4)$$

A_{663} and A_{647} = absorbances at their respective wavelengths.

To analyze carotenoids, 2.5 g aliquots of leaves or petioles were macerated in mortar with celite (0.5 g) and cold P.A. acetone (10 ºC). Carotenoid saturated acetone was being replaced by acetone P.A. until complete extraction, which was verified by depigmentation of the sample. Then the sample was vacuum filtered and transferred to a separation funnel containing previously 40 mL of petroleum ether P.A., obtaining a mixture of acetone + carotenoids + petroleum ether. The acetone was removed from the mixture by drag with distilled water by successive washings. The solution composed of Carotenoids and petroleum ether was transferred to a 50 mL volumetric flask and the volume was completed with petroleum ether (Rodriguez-Amaya, 1999). The absorbance of the extract was obtained using a UV-VIS spectrophotometer (Biochrom, Libra S60PC model) at 450 nm for total carotenoids and 470 nm for lycopenes, and petroleum ether used as negative control. The amounts of carotenoids and lycopenes were obtained by Equation 5. The analysis was made in triplicate and the results expressed in μg/g of sample.

$$Carotenoids\ contents\ (\mu g/g) = \frac{A \times V \times 10^4}{A^{1\%}_{1cm} \times M} \quad (5)$$

A = absorbance of the solution at the wavelength of 450 nm (total carotenoids) or 470 nm (lycopene); V = final volume final of the solution (50 mL); $A^{1\%}_{1cm}$ = absorptivity factor in petroleum ether (2592 for beta-carotene or 3450 for lycopene); M = sample mass (g).

For the evaluation of phenolic compounds, the extract was obtained from the mixture of the sample (5 g) and the solvent in the ratio of 1:5 (m/v); the solvent was a 70:29.5:0.5 (v/v/v) mixture of acetone/water/acetic acid. The mixture was homogenized at 250 rpm for 3 h in the absence of light at 25 ºC and centrifuged for 10 min at 1500 rpm. The supernatant was the extract whose absorbance was obtained at 765 nm in a UV-VIS spectrophotometer (Biochrom, Libra S60PC model), and distilled water was the negative control (Singleton and Lamuela Raventos, 1999). The amount of phenolic compounds in different concentrations of gallic acid (100 a 1000 μg/mL) was calculated from the interpolation between absorbance values of a standard curve. The results were expressed in mg of equivalent gallic acid per gram of sample (mg AGE/g of sample).

To analyze the antioxidant activity the extract was prepared with 1g of sample mixed to 40 mL of methanol solution (50%) for 1h in room temperature, centrifuged for 15 min and the supernatant transferred to 100 mL volumetric flask. 40 ml of acetone (70%) was added to the precipitant, homogenized and allowed to stand for 1 h, then centrifuged for 15 min. This second supernatant was transferred to the volumetric flask with the first one and the volume was completed com distilled water, resulting in the analyzed extract. From this 3-4 distilled water dilutions were prepared (Rufino et al., 2007a; 2007b).

Determination of antioxidant activity by DPPH was performed by adding 3.9 mL of the radical DPPH (0.06mM) and 0.1 mL of each extract dilution, the mixture being homogenized and read at 515 nm in a UV-VIS spectrophotometer (Biochrom, Libra model), and methyl alcohol P.A. as negative control. The same procedure was used to the control solution prepared with methyl alcohol (50%), acetone (70%) and distill water. The standard curve of DPPH was built using methyl alcohol in different concentrations (10 μM to 60 μM). The absorbance readings of each dilution were performed in triplicate. A linear regression was performed, and the result was obtained on concentration of antioxidant required to reduce the original quantity of free radicals by 50% (EC^{50}); the value was expressed in g of sample per g of DPPH (g/g DPPH).

In the determination using the ABTS radical capture method 3.0 mL of ABTS radical and 30 μL of each dilution of the extract were added, homogenized and incubated for 6min sheltered from light; the absorbance was read in a 734 nm

wavelength spectrophotometer. Ethylic alcohol P.A. was used as negative control. A standard curve was built with Trolox standard solution at different concentrations (100 μM to 2000 μM), and the results expressed as micromolar of Trolox per gram of sample (μM trolox/g de amostra).

Statistical analysis

Mean of repetitions, standard deviation and variance analyzes (ANOVA) were used for statistical treatment of the samples, being the comparison of averages made by Tukey test to the level of significance of 5% by the software STATISTICA 8.0 (StatSoft, Inc, Tulsa, EUA, 2008).

RESULTS AND DISCUSSION

The contents of humidity (88.58 g/100g) and fixed mineral residue (13.77 g/100g) of the leaves were similar to Taioba leaves analyzed by Leterme et al., (2005), meanwhile the petiole showed higher contents of humidity (93.86 g/100g) and fixed mineral residue (22.12 g/100g) than the leaves as also shown by Pinto et al. (2001b) (Table 1). The high content of humidity in Taioba (>70%) hinders its conservation restricting its commercialization *in natura* (Falade and Okafor, 2015).

Leaf calcium amount was 1.79 g/100g and the petiole showed 0.98 g/100g diverging the values reported in the literature; Oliveira et al. (2012) found lower values of calcium in fresh (0.27 g/100g) and cooked leaves (0.37 g/100g), while Pinto et al. (1999, 2001b) obtained 2.23 g/100g with the raw leaf and 1.54 g/100g with the petiole. Taioba calcium amount indicates that the species is an important source of the mineral and can be used as dietary or therapeutic supplement in the prevention and treatment of osteoporosis (Oliveira et al., 2012).

Osteoporosis is a silent disease that shows high mortality rates, related to insufficient calcium ingestion, being postmenopausal women and elderly the groups most likely to develop this deficiency (Radominski et al., 2017; Zhang et al., 2018). Dietary calcium recommendation for adults is 1- 1.2g per day (Ross et al., 2011) what can be supplied by daily consumption of 56-67 g of leaves or 100-123 g of petioles.

The values obtained for magnesium are close to those found in the literature for leaves (0.5 g/100 g) and petioles (0.25 g/100g) (Table 1). Taioba leaves present large photosynthetic surface than petioles, therefore the levels of Magnesium are higher once it is the main constituent of chlorophyll (Saga and Tamiaki, 2012). From the functionality standpoint, high levels of Magnesium inside muscle cells improve their insulin sensitivity, since the mineral interferes in the composition of the cellular phospholipid layer (Jackiz, 2015).

Lipids showed higher levels in leaf (7.60 g/100g) than in petiole with values close to those obtained by Leterme et al. (2005). In relation to petioles, the values were higher than the ones found by Pinto et al. (2001b), which was 1.88 g/100g. Overall, plants have low lipid content in vegetative organs, such as leaves.

Protein levels in leaves were higher than the reported in the literature (Leterme et al., 2005; Pinto et al., 1999, 2001b), differences that may be related to different growing conditions, climate, soil and plant genetic (Gonçalves, 2000). Besides, the concentration of nutrients in the plant varies due to the kind of tissue is being analyzed and the phenological stage (Robinson, 2005). Resolution n.269 of National Health Surveillance Agency (ANVISA, 2005) recommends daily consumption of 50 g of protein for adults and 34 g for children up to 10 years-old. Ingestion of 50 g of Taioba leaves can provide 60% the recommended daily intake of protein for adults and 86% for children.

Table 1: Nutritional composition and calcium oxalate amount of leaf and petiole of *X. sagittifolium* (L.) Schott

Constituents (g/100g)	Leaf			Petiole	
	Current study	Leterme et al., (2005)	Pinto et al., (1999; 2001b)	Current study	Pinto et al., (1999; 2001b)
Humidity*	88.58±0.10[b]	86.1 a 90.1	89.74	93.86±0.16[a]	94.39
Fixed mineral residue	13.77±0.39[b]	11.5 a 13.9	15.03	22.12±1.04[a]	17.95
Calcium	1.79±0.06[a]	1.97-2.62	2.23	0.98±0.17[a]	1.54
Magnesium	0.50±0.004[a]	0.37-0.73	0.27	0.25±0.004[a]	0.16
Proteins	58.50±1.66[a]	23.1 a 24.0	27.59	30.90±0.32[b]	10.62
Lipids	7.60±0.68[a]	8.0 a 9.7	6.00	5.86±0.48[b]	1.88
Gross fiber	23.39±0.90[a]	12.4 a 13.0	15.53	16.66±0.43[b]	19.00
Carbohydrates	8.70±2.11[b]	19.7 a 22.9	30.29	34.99±0.86[a]	41.58
Calcium Oxalate**	648[b]	--	--	846.72[a]	-

*Humidity and calcium oxalate were determined in wet basis. The others were analyzed in 100g of dry mass. **calcium oxalate expressed in mg/100g. Values expressed within means and standard deviation (n=3), equal letters in the same line means they do not diverge significantly among them at 5% (p>0.05) by Tukey Test

Regarding the fibers, the values obtained for the leaf were higher than those reported by Leterme et al. (2005), while in the petiole the value obtained (16.66 g/100) was lower than that reported by Pinto et al. (2001b). Fiber consumption is relevant for human health improving intestinal motility (Bernaud and Rodrigues, 2013). Besides that, it helps in the treatment of Diabetes Mellitus, reducing blood glucose (Carvalho et. al., 2017), and obesity (Post et al., 2012), contributing to reduce the risk of both cardiovascular and coronary diseases once it is related to the improvement of modifiable risk factors such as hypertension and hypercholesterolemia (Threapleton et al., 2013). Recommended daily consumption of fiber is 38 and 25 g/day for men and women, respectively (Jackix, 2013), what means that 100 g of Taioba leaves can provide 61% and 93.56% of recommended daily value.

The amount of carbohydrates in the petiole (34.99 g/100g) was higher than the leaf (8.70 g/100g); Leterme et al. (2005) reported values between 19.7 g/100g and 22.9 g/100g for Taioba leaves and Pinto et al. (2001b) reported 41.58 g/100g in the petiole and 30.29 g/100g in leaf blades. The difference can occur due to hydrolysis of carbohydrates from reserve tissues (petiole) and their transportation to aerial parts (leaf blades) to be used in plant metabolism explaining the variation as the result of metabolic activity in the moment of sampling (Santos et al., 2014).

Other leafy vegetables such as lettuce (*Lactuca sativa* L.), spinach (*Tetragonia expansa*), broccoli (*Brassica oleracea* var. *italica*), cabbage (*Brassica oleracea* var. *acephala*) and arugula (*Eruca sativa* L.) present, on average, lower values of nutritional constituents than Taioba (Table 2) (Lima, 2011).

Calcium Oxalate present in various food crops such as spinach, rhubarb, chard, beets, tomatoes, nuts and cocoa (Scardelato et al., 2013) is considered an anti-nutritional factor because it causes reduced availability of Calcium (Liu et al., 2018). Calcium oxalate amount was 648 mg/100g in Taioba leaves which is lower than the value found in spinach (822 mg/100g) by Franco (1986), while in the petiole these values were higher than the leaf blades (846.72 mg/100g). Calcium oxalate acts as a protection factor of the plant against herbivory, and the petiole can serve as a reserve of that substance (Saito and Lima, 2009). One way to reduce the quantity of oxalate is by cooking (Oliveira et al., 2012; Lima and Krupek, 2016; Liu et al., 2018) since calcium oxalate is soluble in water and migrates during cooking to the water, reducing its content by leaching and making the leaves of Taioba a safe food for consumption (Seganfredo et al., 2001).

Vitamin C contents presented a significant difference ($p>0.05$) between leaf blade (87 mg/100g) and the petiole (83 mg/100g), with higher value for the leaf blades (Table 3). Leterme et al. (2005) and Pinto et al. (2001b) found 40 mg/100g in leaf blades, while for the petiole Pinto et al. (2001b) found 19 mg/100 g. The differences obtained in relation to these studies may be related to the storage temperature, the stage of development of the plant and the respective part of the plant analyzed (Rivelli et al., 2017). The values reported at the present study can be compared with the orange considered a reference because it presents 40 to 70 mg/100g of this vitamin (Pinto et al., 2001b; Lima, 2011). The amount of vitamin C in Taioba was higher than conventional leafy vegetables as lettuce (21.4 mg/100g), broccoli (34.3 mg/100g), cauliflower (36.1 mg/100g), spinach (2.4 mg/100g), cabbage (18.7 mg/100g) and arugula (46.3 mg/100g) (Lima, 2011).

The values obtained for carotenoids in Taioba leaf were lower (83.19 mg/100g) than those reported for common sorrel (*Rumex acetosa*) 95.64 mg/100g by Viana et al. (2015), reinforcing what Kobori and Rodriguez-Amaya (2008) affirm about the leaves of unconventional Brazilian food plants, which generally present a higher concentration of carotenoids than common leafy vegetables such as parsley (0.07 mg/100g) and coriander (0.05 mg/100) considered important sources of carotenoids.

Total chlorophyll amount was similar between leaf blade and petiole of Taioba (Table 3); Ozkan and Bilek (2015) obtained 11.36±0,17 mg/100g of chlorophyll in fresh leaves of spinach. Regarding lycopene Taioba leaves presented higher levels (31 mg/100g) when compared to *Pereskia grandifolia* (6.44±1.32 mg/100g) studied by Almeida

Table 2: Nutritional composition of conventional leafy vegetables (Lima 2011)

Constituent (g/100g)	Conventional leafy vegetables				
	Lettuce	Spinach	Broccoli	Cabbage	Arugula
Fixed mineral residue	0.8	1.2	0.8	1.3	1.1
Calcium	0.03	0.1	0.09	0.13	0.12
Magnesium	0.01	0.08	0.03	0.03	0.02
Protein	1.7	2.0	3.6	2.9	1.8
Lipids	0.1	0.2	0.3	0.5	0.1
Gross fiber	2.3	2.1	2.9	3.1	1.7
Carbohydrates	2.4	2.6	4.0	4.3	2.2

Table 3: Bioactive compounds (vitamin C, chlorophyll, carotenoids e lycopene) of leaf blade and petiole of *X. sagittifolium* (L.) Schott

Bioactive compounds	Leaf blade	Petiole
	Mean±SD	Mean±SD
Vitamin C (mg/100g))	87±0.79[a]	83±1.27[b]
Total carotenoids (mg/100g)	83.19±0.54[a]	54.07±0.70[b]
Lycopene (mg/100g)	31±0.51[a]	20±0.39[b]
Total chlorophyll (mg/100g)	8.94±0.02[a]	7.0±0.15[a]
Phenolic compounds (mg AGE/g)	5.33±0.18[a]	2.80±0.04[b]

*In dry basis. Values show mean and standard deviation (n=3), equal letters in the same line means they do not diverge significantly among them at 5% (p>0,05) by Tukey Test

Table 4: Antioxidant activity of leaf and petiole of Taioba obtained by radical sequestration of DPPH* and ABTS**

Constituints	Leaf	Petiole
	Mean±SD	Mean±SD
ABTS (µM trolox/g)	26.48±0.23[a]	17.25±0.17[b]
EC_{50} DPPH (g/g DPPH)	0.72±0.00[b]	1.43±0.01[a]

Values show mean and standard deviation (n=3), equal letters in the same line means they do not diverge significantly among them at 5% (p>0.05) by Tukey Test.

et al. (2014). Rodriguez-Amaya (2008) assert that foods which contain more than 2 mg/100g of carotenoids are considered important to health.

The values of phenolic compounds of Taioba differed significantly between leaf blade and petiole (Table 3), the leaves having the highest values (5.33 mg AGE/g). These compounds (phenolic acids, tannins and flavonoids) are one of the greater classes of secondary metabolites found in plants (Viana et al., 2015), being a complex composition of phytochemicals that varies according to the method of cultivation, the presence of Oxygen, the luminous intensity, the temperature and the type of soil (Jackix, 2015). Arruda et al. (2004) evaluated the capacity of *Xanthosoma sagittifolium* leaves in reducing the oxidative stress induced by vitamin A deficiency evidencing the protective effect of the leaf against the lipid peroxidation, caused by the deficiency of this vitamin. This beneficial effect may be related to the content of carotenoids, phenolic compounds and other antioxidant compounds, such as vitamin C.

The most common natural pigments in leafy vegetables are chlorophyll and carotenoids, being the carotenoids responsible for the color diversity in plants, providing protective effects for human health (Hounsome et al., 2008; Volp et al., 2009; Agbaire, 2011). These compounds are assigned antimutagenic (Volp et al., 2009; Osuna-Ruiz et al., 2016) and antigenotoxic properties (Serpeloni et al., 2013; Osuna-Ruiz et al., 2016) besides helping to correct dyslipidemia and to be antioxidants (Volp et al., 2009; Osuna-Ruiz et al.,2016). β-carotene and chlorophyll can still be used as natural colorants in food products (Medeiros et al., 2012; Ozkan and Bilek, 2015).

The leaves showed higher antioxidant activity (26.48 µM trolox/g and 0.72 g/g DPPH) than the petioles in both employed methods (ABTS and DPPH) (Table 4). Dos Reis et al. (2015) have analyzed the antioxidant activity of broccoli and cauliflower reporting respectively the values 0.03±0.03 and 0.016±0.67 g of sample/g of DPPH. Suresh et al. (2017) have showed that the broccoli extract has antioxidant potential in the pancreatic tissue of diabetic rats, suggesting that leaves and petioles of Taioba could also present antioxidant action.

In addition to the nutritional and functional properties useful to human health, Taioba has its optimum development in the rainy summer period, when conventional leafy vegetables have growing difficulties (Seganfredo et al., 2001); its adaptability to higher temperatures and moist soils (MAPA, 2010) show its food potential that can be harnessed to combat malnutrition, propitiate new flavors and increase nutritional content in food mixtures. Taioba combines nutritional characteristics superior to most conventional vegetables and can be consumed safely opening perspectives of use not only in the domestic menu, but also as raw material for the elaboration of functional food products.

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Authors' contributions

Sarah Araújo designed and did the experiment with the help of Priscila Araújo and Aline Giunco. Eliana Sanjinez-Argandona designed the experiment and contributed to the preparation of the manuscript in Portuguese. Sandro Menezes Silva contributed with the determination and registration of the species, preparation of the manuscript in Portuguese and the English version.

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