Sensory and phytochemical quality of *passiflora setacea* nectar, a wild passiflora from Brazilian Savanna

ET 2 - Formacion professional - Análisis sensorial

MARIANA CARVALHO[1]; LÍVIA PINELI[2] ; ISADORA CELESTINO[2]; ISABELAFREITAS[3]; MARCOS SODRÉ [3];ANA MARIA COSTA[4]

1- Federal Institute of Brasilia (IFB); 2- University of Brasília 3- Catholic University of Brasilia; 4- Embrapa Cerrados, Brasilia, Brazil.

Abstract: It is estimated that 150 *Passiflora'*s species (passion fruits) are native from Brazil, which is considered the top world producer. *Passiflora setacea* is a native fruit from Brazilian savannah, and a good source of phenolics and others bioactive compounds,with highconcentrationin the seeds. We aimed to evaluate the influence of *P setacea* pulp processing with seeds in sensory acceptance and phenolic compounds content.The fruits of *Passiflora setacea* were taken from Experimental Farm of Embrapa Cerrados, 15 ° 36'13.02 "S, 47 ° 43'17.34, in physiological ripeness. Sensory analysis was performed with 54 tasters, aged between 18 and 35 years, 35% male. The global acceptance test of *P. setacea* juice samples was conducted using 9-point hedonic scale. *P setacea* juices were prepared by using 33% of frozen pulp containing 25% of *P setacea*`s seeds. The samples werecrushed for zero (only by shaking), 15 Seconds, 60 and 180 seconds. All samples were sweetened with 4.5% sugar. Total phenolics were assessed by Folin–Ciocalteu method. Data was submitted to analysis of variance (ANOVA) and means compared by Tukey test ($p<0.05$).Samples processed during zero, 15 and 60 seconds did not statistically differ ($p>0.05$), with hedonics mean between 5.57 and 6.01. The 180 seconds processed sample was strongly rejected, with a 4.84 hedonic mean and 49% of rejection. No significant difference was observed in total phenolic compounds of zero and 15 seconds of processed pulp (2.624 - 2.893 mgGAE.100g^{-1}). *P setacea* pulp processed for 60 seconds presented higher total phenolic content (3.744 mgGAE.100g^{-1}). *P setacea* pulp with seeds consumption is recommended due to its high content of phenolic compounds, associated to antioxidant properties and their involvement in the prevention of various diseases. The processing for 60 seconds is recommended, due to its higher content of phenolics compounds and good acceptability.

Keywords: *Passilfora setacea;* Fruit quality; sensory analysis; functional food; passion fruit

1 Introduction

Several epidemiologic studies suggest that consumption of fruits reduces the risk of chronic diseases such as cardiovascular disease and cancer (Liu, 2013; Nile & Park, 2014). In particular, the intake of fruits grown in an arid climate and acid soils, such as the Brazilian savannah biome, has been consistently associated to health benefits.

Savannah flora is one of the most abundant sources of bioactive material in the world due to its biodiversity (Roesler, Catharino, Malta, Eberlin, & Pastore, 2008). According to Siqueira, Rosa, Fustinoni, Sant'Ana, and Arruda (2013), its rusticity in relation to abiotic factors such as soil acidity, excessive exposure to sunlight and frequent fire during the dry season, common in the Brazilian savannah, determined the selection of species with function of defense against oxidative processes and with the presence of bioactive compounds such as phenolics (Vanessa Rios de Souza, Pereira, Queiroz, Borges, & Carneiro, 2012).

Brazil is the largest global producer and consumer of passion fruit, which is high economic significance to the country. In 2012 it was produced 776 tons of passion fruit in Brazil and this production is increasing annually (IBGE., 2016)

Passion fruit belongs to the Family Passifloraceae and the genus *Passiflora*, which has the highest expression of the Family. It is estimated that 150 species are from Brazil. The most cultivated species are *Passiflora edulis* f. *flavicarpa*. (Faleiro, Junqueira & Braga, 2005).

setacea D.C is a passion fruit native from Brazilian savannah known as *maracujá do cerrado* (savannah passion fruit) or *maracujá do sono* (sleep passion fruit), in association with its properties of sleep modulation attributed by the popular knowledge (Bomtempo, Costa, Lima, Engeseth, & Gloria, 2016). In Brazil, *P. setacea* native distribution, non-endemic, ranges Brazilian savanna, Caatinga Savanna and areas of semi -arid transition (Braga et al., 2006).

P. setacea is characterized by its rusticity for resistance to pathogens which attack fruits and resilience to adverse abiotic factors typical of the Brazilian savanna (Braga et al., 2006). The biological activity of *P setacea* is directly related to its bioactive compounds known as phytochemicals and secondary plant metabolites (Siqueira, Rosa, Fustinoni, de Sant'Ana, & Arruda, 2013).

Phytochemicals are biologically active, naturally occurring chemical compounds found in plant tissues such as in the roots, stems, leaves, flowers, fruits or seeds. Phytochemicals provide health benefits for humans further than those attributed to macronutrients and micronutrients (Saxena, Saxena, Nema, Singh, & Gupta, 2013). Polyphenolic compounds is the most common chemical class of phytochemicals, having a hydroxyl group (-OH) directly bonded to an aromatic hydrocarbon group. Due to this chemical arrangement, Polyphenolic compounds have an important role as defense, with antioxidant properties which play role as protecting agents against free radical-mediated disease processes (Appel et al., 2011) (Nabavi, Habtemariam, Daglia, & Nabavi, 2015).

Polyphenolic compounds, when consumed in fruits and vegetables forms, possess a multiple range of beneficial effects for health such as antioxidant activity, antimicrobial effect, modulation enzymes, stimulation of the immune system, decrease of platelet aggregation and anticancer property (Saxena et al., 2013).

P setacea stands out for its high content of Polyphenolic compounds, which are mainly concentrated in the seeds. *P setacea* had the high quality regarding the total content of phenolics compounds in the *P setacea* seeds was 26 times higher than that found in *P edulis* (commercial passion fruit (Vieira, 2013).

In this context, we aimed to evaluate the influence of *P setacea* pulp processing with seeds in sensory acceptance and phenolic compounds content.

2 Methods

2.1 Fruit harvest

Ripe *Passiflora setacea* fruits were harvested at Experimental Farm of Embrapa Cerrados, 15 ° 36'13.02 "S, 47 ° 43'17.34,in the week of higher productivity of the crop (the height of the crop). Fallen fruits were harvested to guarantee their ripeness. The fruits were sanitized, pulped and frozen. The pulp and the seeds were frozen separately.

2.2 Extracts preparation

The extracts of pulp with seeds (25%) were prepared with 1.5 g of lyophilized sample homogenized with methanol 50% for overnight, followed by centrifugation and supernatant collection. After, acetone 70% was homogenized with the pellets for three times during 15 min in agitation, followed by centrifugation and supernatant collection (Larrauri, Rupérez, & Saura-Calixto, 1997).

2.3 Chemical analyses

The extracts were analyzed due to their total Polyphenolic compounds by Folin Ciocalteau colorimetric method (Singleton & Rossi, 1965), expressed in mg of galic acid equivalent in fresh mass (mg GAE.100 g^{-1} FM); Total dimeric anthocyanin content by DMAC (4-dimethylaminocinnamaldehyde) method, performed according to Prior et al. (2010), expressed in Proantocyanidins B2 on fresh mass (mg PB2.100 g^{-1} FM).

Total antioxidant activity (TAA) was determined by methods DPPH (1.2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging activity) and FRAP (Ferric reducing antioxidant power). The capacity to scavenge the DPPH radical was assessed using the method of Brand-Williams (1995). The radical scavenging activity was calculated based in inhibition percentual of DPPH radical and expressed as trolox equivalent (µmol TE.g^{-1} FM) and Ec50 (to DPPH method), which is the amount of antioxidant required to reduce the initial concentration of DPPH by 50%. FRAP assay was described by Benzie and Strain (1996) Benzie, & Strain (1996) and modifications proposed by Pulido, Bravo, and Saura-Calixto (2000). The analytical standard Trolox (6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid) was used to construct the calibration curve and the results were expressed as equivalents of Trolox per gram of *P setacea* pulp (µmol TE.g^{-1} FM.)

Data was submitted to analysis of variance (ANOVA) and means compared by Tukey test ($p<0.05$)

2.6 Sensory evaluation

P.setacea nectars were prepared using 33% of frozen pulp containing 25% of *P setacea*'s seeds. Four samples were evaluated; they differed from each other with regard to the processing time (time the seed + pulp were shaken in the blender): zero (without processing, only one pulse for shaking), and shaking for 15, 60 or 180 seconds. All samples were sweetened with 4.5% sugar.

2.7 Acceptance

Sensory analysis was performed in Sensorial Analysis Laboratory of University of Brasilia. Acceptance test was conducted with 54 untrained consumers. This project was submitted and previously approved by Ethics Committee of the College of Health (number 38386414.0.0000.0030) , University of Brasilia.

Approximately 30mL of each sample at 4°C±1 was served monadically in a plastic cup identified with a three-digit random code number. The acceptance test was designed in a randomized complete block for the consumers, who evaluated the product through an acceptability test using a nine-point structured hedonic scale ranging from "like extremely" (9 points), "neither like nordislike" (5 points) to "dislike extremely" (1 point). Global acceptance and percentages of acceptance, indifference and rejection of the samples were calculated (Meilgaard, Civille, & Carr, 2006).

3 Results and discussion

3.1 Chemical analyses

Total Polyphenolics and total anthocyanins are associated with strong antioxidant activity (AA) (Leo et al., 2008). AA describes the ability of redox molecules in foods and biological systems to scavenge free radicals, playing a useful role of antioxidants on oxidative stress mediated diseases (Puchau, Zulet, de Echavarri, Hermsdorff, & Martinez, 2010). Total Polyphenolics (TP) content was lower in samples zero and 15 seconds in comparison to 60 seconds and 180 seconds samples (Table 1). No significant difference was observed in TP compounds of zero and 15 seconds of processed pulp (401.60-442.74 mgGAE.100g^{-1}). *P setacea* pulp processed for 180 seconds presented higher TP content (696.14 mgGAE.100g^{-1} (Table 2).

Analyzing the polyphenolic data (Table 1), it is concluded that the processing time provide a smaller particle size (granulometry) and higher content of polyphenolics. A similar result was found by Stork (2015), where grape residuo flour smaller particle size showed a higher polyphenolics content.

Table 1– Total phenolics and Proantocyanidins content of *Passiflora setacea* pulp prepared with seeds.

Samples (processing time)	Total Phenolics (GAE.100 g^{-1} FM)	Proantocyanidins(mg PB2.100 g^{-1} FM)
Zero	442.74 c	138.25 c

15 seconds	401.60 c	153.99 b
60 seconds	572.92 b	180.85 a
180 seconds	696.14 a	190,03 a

Different small letters in the same column indicate significant statistical differences (Tukey's Test, $p < 0.05$) among varieties.

TP compounds of 60 seconds juice (572.93 mg GAE,100g-1 FM) were high and comparable to important sources, in fresh mass, such as goji fruit (350 mg GAE.100 g-1FM) (Ionică, Nour, & Trandafir, 2012) and strawberry produced in the Brazilian savannah (211 mg GAE.100 g-1 FB) (L.; Pineli et al., 2011).

Lessa (2011) found 204 g GAE.100 -1 FM of TP in *P setacea* pulp. The mean values of the present study demonstrate that the processing of the pulp with the seeds favors the increase of polyphenolic compounds content in more than twenty times

Condensed tannins, as proanthocyanidins, play an essential role in defining the sensory properties of fresh fruit and pulps. They are responsible for the tart taste and changes in the color of fruit and fruit juice (Jimenez-Garcia, Guevara-Gonzalez, Miranda-Lopez, Feregrino-Perez, & Torres-Pacheco, 2013)

Proantocyanidins (PA) contents were also higher in high processed samples (60 seconds and 180 seconds), presenting the following descending order: 180 seconds≥60 seconds>15 seconds≥ Zero. Pulp with seeds processed for 60 seconds showed high contents of PA (180.85mg PB2.100 g^{-1} FM), when compared with dark nonfat chocolate (46 mg PB2.100 g^{-1} FM) (Cooper et al., 2008), red-fleshed apples (29.80mg PB2.100 g^{-1} FM) (Wang et al., 2014) and Cabernet sauvignon wine (2 mg PB2.100 ml^{-1} FM) (Caceres et al., 2012)

3.2 Total antioxidant activity (TAA)

Ec 50 values of *P setacea* pulp processed with seeds (20.06- 36.59g FM. g^{-1} DPPH) (table 2) indicates that this product is an excellent source of antioxidants. When compared with well known fruits as rich in antioxidants, such as blackberry (Ec50 2141g), blueberry (Ec50 7775g) (V. R. de Souza et al., 2014), *P setacea* pulp with seeds may also be considered a good source of antioxidants.

Table 2– Total antioxidant activity (TAA) by methods DPPH and FRAP of *Passiflora setacea* pulp prepared with seeds.

Samples (processing time)	Ec 50 DPPH (g FM. g^{-1} DPPH).	DPPH (µmol TE.g^{-1} FM)	FRAP (µmol TE.g^{-1} FM)
Zero	26.36 ab	35.72 a	536.35 a
15 seconds	36.59 a	44.95 a	690.40 a
60 seconds	20.62 b	30.81 a	604.04 a
180 seconds	20.06 b	33.97 a	663.92 a

Different small letters in the same column indicate significant statistical differences (Tukey's Test, $p < 0.05$) among varieties.

The sample 15 seconds presented the highest AAT by DPPH (36.59 µmol TE.g-1 FM) and there was no significant difference among 60 and 180 seconds samples. *P. setacea*'s pulp with seeds have highter AAT than Apple golden delicious (2.45 µmol TE.g^{-1} FM) and Apple Honeycrisp (3.59 µmol TE.g^{-1} FM), whose are considered a good source of antioxidant (Xu et al., 2016).

There was no statistical difference significant in FRAP values, between 536 and 663µmol TE.g^{-1} FM. Our results of FRAP method suggest a higher antioxidant activity of *P setacea* pulp processed with seeds than others yellow fruits frozen pulps as yellow passion fruit (*Passiflora edulis*) (3,9 µmol TE.g^{-1} FM), guava pulp (*P. guajava*) (14,62 µmol TE.g^{-1} FM), papaya (*C. papaya*)(1,74 µmol TE.g^{-1} FM**)**, and cajá (*S. mombin*) (12,64µmol TE.g^{-1} FM) (Zielinski et al., 2014).

3.3 Sensory evaluation

For the acceptance test, participants, consumers of passion fruit juice, aged between 18 and 35 years and were composed by 65% female.

P setacea juice samples processed during zero, 15 and 60 seconds did not show statistically difference ($p>0.05$), with hedonics mean between 5.57 and 6.01 (Table 3). L. Pineli et al. (2016) assessed the acceptance of orange juices reduced in sugar and observed that the highest orange juice's acceptance (overall liking 6.12 to 8.5% sugar concentration sample) similar than that reported in this study (overall liking 6.01). Rocha and Bolini (2015) determined the acceptance of passion fruit nectar sweetened with sucrose or different sweeteners and evidenced that the overall liking found in passion fruit nectar was 6.1 to the sample sweetened with sucrose (9.4%).

In the present study, the mean of *P. setacea* nectars overall liking was greater than the observed by Rocha and Bolini (2015) It is important to note that *P. setacea* nectar samples were sweetened with only 4.5 g/100g of sucrose, which highlights the importance of using *P. setacea* as a functional healthier option, given the World Health Organization's recommendation to reduce added sugar intake. (WHO, 2015)

Table 3–Global acceptance and percentages of acceptance, indifference and rejection of juice *Passiflora setacea* pulp with seeds samples

Samples (processing time)	Global acceptance	% Acceptance	% Indifference	% Rejection
Zero	6.01 a	63.16	7.02	29.82
15 seconds	5.59 ab	59.65	8.77	31.58
60 seconds	5.57 ab	57.89	10,.3	31.58
180 seconds	4.84 b	47.37	3.51	49.12

Different small letters in the same column indicate significant statistical differences (Tukey's Test, $p < 0.05$) among varieties.

Only samples zero and 180 seconds had statistically difference in global acceptance (p>0,05). The sample zero, prepared with whole seed (without processing), showed the higher acceptance percentage (63.16%) and the lowest percentages of indifference and rejection while the sample 180 seconds had lower average global acceptance and the higher percentage of rejection (49.12%). This demonstrates that the intense time processing of the juice does not favor its acceptability since almost 50% of the consumers gave notes between " dislike moderately " and " dislike extremely " to 180 seconds sample.

The comments of the evaluators reported a "bitter taste" the sample processed for three minutes.

4 Conclusion

Passiflora setacea juice with seeds, from a chemical point of view, stands out for presenting relevant amounts of phenolic compounds and high antioxidant activity. It was concluded that *P setacea* juice with seeds showed different degrees of suitability as a functional beverage and have potential for the development of other forms of consumption, beyond the filtered passion fruit juice

The processing of *P setacea* pulp with their seeds the average ratio found in this fruit (25%) is an important recommendation from a nutritional point of view, since it increases the concentration of bioactives compounds associated with antioxidant properties its participation in several diseases prevention.

The processing for 60 seconds is recommended, due to its higher content of phenolics compounds and good acceptability. The processing for 180 seconds or more is not recommended due to its high rate of rejection among consumers.

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