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CHEMICAL ANALYSIS OF PASSIFLORA EDULIS FO. FLAVICARPA LEAVES AND ITS NUTRACEUTICAL APPLICATIONS

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Abstract

Passiflora edulis fo. *Flavicarpa* is an important product of the agricultural sector in Ecuador, with its juice and concentrates used as export items. The agricultural operation results in substantial debris from the leaves, as the plants have a productive life of 24 months.

After harvest, the discarded plants, including the leaves, are buried in the ground and currently have no commercial value. The aim of this work is to find a potential application for the discarded leaves.

The analysis of aqueous leaf extracts revealed the presence of 24 compounds identified as saturated fatty acids, volatile oils, sugar, carboxylic acids and aldehydes.

These components, which include phytochemicals and flavonoids, exhibit interesting activities, such as antioxidant, anticonvulsant, antifungal, anticarcinogenic, anti-inflammatory and antihypertensive properties.

In the consulted literature, none of the compounds found have been previously reported in the leaves of yellow passion fruit.

Keywords: *Passiflora edulis* fo1, *leaves aqueous extract2, bioactivities3, hytopharmaceuticals application4.*

Introduction

Nutraceutical products receive substantial attention due to their easy access, low cost and limited side effects. *Passiflora edulis* fo. *flavicarpa* (*P. edulis*), also known as yellow passion fruit, is native to several countries around the world and belongs to the *Passifloraceae* family. *P. edulis,* an exotic fruit with a unique flavour, aroma and with nutritional and presumptive therapeutic properties, is characterized by the presence of several phytochemical constituents, such as flavonoids, alkaloids, phenols, cyanogenic compounds, glycosides, vitamins, minerals and terpenoid compounds (Kuete, 2017).

Some of these constituents may have biological activities. For example, Lim (2012) reported that dry leaf extracts from yellow passion fruit have anti-inflammatory, anxiolytic and antimicrobial effects. Other reports indicate *P. edulis* as a sedative, diuretic, anthelmintic, anti-diarrhoeal, stimulant, tonic, and antihypertensive (Kim, Lee and Lee, 2010). *P. edulis* has also been reported to present anxiolytic properties, and the neuropharmacological activity appears mediated by flavonoids (Kim, Lee and Lee, 2010). In addition, the extract of passion fruit has the effect of lowering blood pressure in mammals (Kim, Lee and Lee, 2010) and providing hepatoprotective effects (Dembitsky et al., 2011).

There are more than 500 species of *Passiflora* in the *Passifloraceae* family used in folk medicine and exploited by the food, pharmaceutical and cosmetics industries (reviewed in Correa et al., 2016); however, only one, *Passiflora edulis Sims,* has the special name of passion fruit, of which the yellow variant is identified as *Passiflora edulis fo. flavicarpa Deg* and the purple variant as *Passiflora edulis fo. edulis* (ZAS & John, 2016).

Ecuador has a substantial production of yellow passion fruit, estimated at 28,700 hectares of cultivated areas, that represent 247,973 tons of fruit and yield 8.6 TM/ha (fruits/ha) (INIAP, 2009; Plaza, Cortez, & Martínez, 2016). This fruit is mainly grown in the coastal zone in the provinces of Los Rios, Manabí and Esmeraldas, with a productive life of 24 months, after which the plants are replaced by new crops (Miranda et al., 2009). When the production cycle of the crop is ended, plants are cut and left to dry on the ground or buried until a new crop arrives. Finding a useful application for the by-products may increase the value of the agricultural operation.

Only a few studies of the compounds present in aqueous extracts of passion fruit leaves are found in the literature. The aims of this work were to characterize the chemical composition of the *Passiflora edulis f. flavicarpa Deg* (yellow passion fruit) leaves by GC-MS and to identify possible pharmacological applications of the discarded leaves.

Methods

Sample collection and botanical identification

Leaves of yellow passion fruit, *Passiflora edulis* fo. *flavicarpa* O. Deg., were collected from Canton Buena Fe, Province of Los Ríos, Latitude -00° 9574"/ Longitude -79° 4974", from a crop in its production stage.

Collection time was 5:00 pm on Monday, July 10, 2017. The botanical identification was done at The National Herbarium of Ecuador (QCNE), Quito with voucher MPF001.

Extraction procedure

Decoction of leaves of *Passiflora edulis* fo. *flavicarpa* was executed according to traditional extraction method as follows. Fresh leaves (100 g) were suspended in 200 mL of water and boiled for 20 min. The extract was allowed to cool, filtered through Whatman No.1 filter paper and subsequently freeze-dried (Davicino et al., 2007).

Gas chromatography-Mass spectrometry (GC-MS)

Freeze-dried samples (1 mg) were mixed with 100 µl of N-Methyl-N-(trimethylsilyl) trifluoroacetamide (MSTFA) and heated in a water bath at 80°C for 2 hours to allow the derivatization of compounds. GC-MS analyses were conducted with gas chromatography-mass spectrometry equipment from Agilent Technologies (7890A GC system and 5975C inert XL MSD with triple axis detector). A capillary column (DB-5MS, 30 m × 0.25 mm) with phenyl dimethylpolysiloxane was used as the stationary phase (0.25-micron film thickness), with helium as the carrier gas (1.2 ml/min). The injection of 2 µL of derivatized samples was performed at 250°C

in splitless mode. The initial temperature of the oven was maintained at 70°C for 2 min, then increased to 285°C at a rate of 5°C / min. The detector temperature was maintained at 230°C, and the MSD transfer line held at 300°C. An electron ionization energy of 70 eV was used, and the compound data were collected using the full scan mode (40-700 amu) in the quadrupole mass analyser. Finally, compound detection was completed through comparison of their mass spectra to mass reference in the Wiley 9th edition with NIST 2011 MS Library.

Results

The GC-MS analysis of the aqueous extract solution of *Passiflora edulis* fo. *Flavicarpa* revealed the presence of 24 compounds. Some of the observed compounds were saturated fatty acids, volatile oils, sugar, carboxylic acids and aldehydes (Table 1 and Figure 1).

Discussion

The Potential Health Benefits of the Detected Compounds

Several components detected in the extract from the yellow *Passiflora edulis* fo. *Flavicarpa* leaves may be associated with interesting biological activities, such as antioxidant, anticonvulsant, antifungal, anticarcinogenic, anti-inflammatory and antihypertensive properties. The major peak detected in this extract was hexadecanoic acid (Tr 29.8 min), a fatty acid with potential antibacterial and antifungal properties (Agoramoorthy, Chandrasekaran, Venkatesalu, & Hsu, 2007). This compound has also been reported as an antioxidant, hypocholesterolemic, haemolytic 5-alpha reductase inhibitor (Thampy, Ramesh, & Vijayakumar, 2014) and as being able to combat the risk of coronary heart diseases (Farzaneh, Gominho, Pererira and Carvalho, 2018).

The cis-13-octadecenoic acid, detected at 32.8 minutes, is the second compound observed with potential therapeutic importance: it is useful for the treatment of dopaminergic cell loss and tremors of Parkinson's disease, anti-inflammatory and hypocholesterolemic properties, and cancer prevention (Thampy et al., 2014). Oleanitrile was the following compound of significance and was detected at 30.4 minutes. Oleanitrile is a volatile oil with a significant synergistic effect similar to sodium pentobarbital (Shi, Dong, Zhao, Tang, & Zhang, 2014) and possesses a wide range of pharmacological properties, such as cholinesterase and monoamine oxidase inhibitory activities, antitumor, antihypertensive, anticoagulant, antidiabetic, antimicrobial, antileishmaniasis, antioxidant and anti-inflammatory properties (Li, Cheng, Wang, & Johes, 2017). In minor concentrations but also with important pharmacological properties, were found butanedioic acid 2TMS, tetradecanoic acid, 7,9-di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione and 2-piperidinecarboxylic acid. Of the butanedioic acids, the 2TMS sensed at 13.4 minutes is an intracellular metabolite, anti-stress and cognitive enhancer (Safonova et al., 2015).

Tetradecanoic acid was detected in *Excoecaria agallocha* and nutmeg and exhibits antibacterial and antifungal properties (Agoramoorthy et al., 2007; V Kuete, 2017). Another interesting compound detected was 7,9-di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione, which is a phytochemical constituent in *Punica granatum* fruit peel reportedly used in folklore medicine to prevent problems of chronic diabetes (Barathikannan et al., 2016).

Finally, 2-piperidinecarboxylic acid (14.5 minutes) is an interesting phytochemical compound that has been found important for information processing and communication in the central nervous system in the prevention and treatment of Alzheimer's, Huntington's, and Parkinson's diseases, as well as other neurodegenerative and psychoneurological diseases (Ragulin, 2018).

The observations reported here are novel and indicate passion fruit leaves as an interesting source of raw material for the preparation of phytopharmaceuticals.

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Table 1. Compounds identified by gas chromatography/mass spectrometry in an aqueous extract solution of Passiflora edulis fo. Flavicarpa

	Retention time (minutes)	Compounds	Area (%) *
1	8.3	5,8-Epoxy-15-nor-labdane	0.07 ± 0.06
2	8.6	Nonanal	0.06 ± 0.01
3	12.1	Phosphoric acid	0.28 ± 0.09
4	12.3	Glycerol	0.30 ± 0.03
5	13.4	Butanedioic acid,2TMS	0.11 ± 0.07
6	14.5	2-Piperidinecarboxylic acid	0.54 ± 0.08
7	17.8	Butanedioic acid,3TMS	0.75 ± 0.23
8	18.5	L-Proline	0.18 ± 0.09
9	20.9	Glutamic acid	0.19 ± 0.06
10	23.1	Xylitol	0.70 ± 0.06
11	24.3	L-Glutamine	0.17 ± 0.02
12	24.6	1,4-Benzenedicarboxylic acid	0.08 ± 0.03
13	25.3	4a,5,8,8a.alpha.-tetrahydro-2-methoxy-4a.beta.,8.alpha.-dimethyl-1,4-naphthalind	0.13 ± 0.03
14	25.9	Tetradecanoic acid	0.71 ± 0.09
15	26.0	7-Methoxy-1,3-dimethyl-1H-2-benzopyran-5,8-dione	0.12 ± 0.02
16	27.0	7,9-Di-tert-butyl-1-oxaspiro(4,5)deca-6,9-diene-2,8-dione	0.69 ± 0.07
17	27.9	n-Pentadecanoic acid	0.34 ± 0.07
18	28.7	Gluconic acid	0.34 ± 0.03
19	29.8	Hexadecanoic acid	2.84 ± 0.63
20	30.4	Oleanitrile	1.21 ± 0.22
21	30.9	Heptadecanenitrile	0.30 ± 0.05
22	32.8	cis-13-Octadecenoic acid	1.27 ± 0.28
23	40.3	Heptadecanoic acid, glycerine-(1)-monoester, bis-O-trimethylsilyl-	0.14 ± 0.01
24	43.3	Nonacosane	0.14 ± 0.05

***** Mean values (n=3) ± standard deviation

Figure 1. Analytical gas chromatograph of a derivatized extract of *Passiflora edulis* fo. *Flavicarpa*