

YELLOW PITAYA (*HYLOCEREUS MEGALANTHUS*) FATTY ACIDS COMPOSITION FROM ECUADORIAN AMAZONIA

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ABSTRACT

Objective: The aim of this study was to determine the composition of methyl esters fatty acids (FAMES) in yellow pitaya (*Hylocereus megalanthus*) seeds cultivated in the Palora, Ecuador Amazonian region.

Methods: Yellow pitaya oil was obtained from yellow pitaya seeds using the Soxhlet technique. FAMES identification and quantification were carried out using the gas chromatography (GC) with mass spectrometry (MS) and the database Library NIST14.L to identify the FAMES present in yellow pitaya oil.

Results: Yellow pitaya oil from Ecuador Amazonian region was analyzed by GC-MS, to obtain the five main fatty acids, palmitic acid (11.52%), stearic acid (4.29%), oleic acid (11.09%), vaccenic acid (3.08%), and linoleic acid (69.98%). Omega 6 was the most abundant fatty acid, total content in yellow pitaya seeds oil.

Conclusions: Yellow pitaya seeds content a good proportion of polyunsaturated fatty acids (omega 6). For their fatty acid composition, yellow pitaya seeds can be considered as healthy food and can be used in the food industry for different purposes. Regular consumption of yellow pitaya can improve human health.

Keywords: Dragon fruit, Yellow pitaya, Fatty acid, Methyl esters fatty acids, Lipids.

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INTRODUCTION

Yellow pitaya (*Hylocereus megalanthus*), also named dragon fruit, belongs to the Cactaceae family. This plant is a native of Mexico, Central and South America (Colombia, Peru, Venezuela, and Ecuador) [1]. In these countries, different cactus fruit crops are marketed as yellow pitaya, including the species *Acanthocereus pitajaya*, *Selenicereus megalanthus*, *Acanthocereus colombianus*, *Hylocereus triangularis*, and *H. megalanthus* [2,3]. Dragon fruit is cultivated in many countries in Asia such as Taiwan, Vietnam, Philippines, and Malaysia, due to their high acceptance as an exotic fruit [3,4]. Red pitaya has been described with antioxidant and antiproliferative activities. Antioxidant activity was determined using DPPH and ABTS methods, obtaining values of EC50, 22.4 ± 0.29, and 118 ± 4.12 µmol Vitamin C equivalents/g for the flesh and the peel dried extract and 28.3 ± 0.83 and 175 ± 15.7 µmol of Trolox equivalents antioxidant capacity/g for the flesh and for the peel dried extract. The antiproliferative study on B16F10 melanoma cells revealed that the peel (EC50 25.0 µg of peel matter) component was a stronger inhibitor of the growth of B16F10 melanoma cancer cells than the flesh [5]. Pitaya seeds also have a content of oil like most grain seed, such as flaxseed, canola, sesame seed, quinoa seed, and grape seed. In common bean, *Phaseolus vulgaris*, protein concentrate, antioxidant activity, and zebrafish larvae. In the cactus plant, the most important fruit pigments are the betacyanins and betaxanthins. Betalains compounds, content red-violet betacyanin and yellow betaxanthins, these compounds are water-soluble pigments that provide colors in flowers and fruits. The known betacyanin pigments of *Hylocereus polyrhizus* flesh are betanin, named as phyllocactin and a recently discovered betacyanin, hylocerenin Betanin, from red beet, effectively inhibited lipid peroxidation, and heme decomposition, suggesting that these pigments may provide protection against certain oxidative stress-related disorders [6-8]. Oil

is obtained when the mucin surmounting the seeds is retired, and oil is extracted from these seeds. Oil of these seeds has a high content of linoleic acid (omega 6) fatty acid which is an essential fatty acids, EFAs, as the human body cannot synthesize this EFA [9,10]. In Ecuador, 500 hectares are dedicated to the crop of yellow pitaya in the Amazonian region cantón palora.

In 2015, Ecuador exported to different countries 344 mil ton of yellow pitaya valued at 3.2 million USD. Yellow pitaya is an important crop for Ecuador from the economic point of view. The aim of this study was to characterize the composition of fatty acids methyl esters (FAMES) present in yellow pitaya oil samples cultivated in this Amazonian region of Ecuador using a gas chromatography-mass selective detector (GC-MSD).

METHODS

Oil extraction

Yellow pitaya (*H. megalanthus*) was obtained from FINCA PROCEL in Palora-Ecuador Amazonian region. Yellow pitaya oil sample was obtained using a Soxhlet apparatus for approximately 5 h with hexane as solvent, with a solid to solvent ratio of 1/7 m/v. After the extraction process, the flask contents were filtered, and the liquid fraction containing the lipid extract and solvent was poured into a 250-mL flask of a rotary film evaporator to remove the solvent. The obtained oil was collected, evaporated under nitrogen, weighed, and stored in sealed amber glass vials at -20°C until analysis [11].

Fatty acids analysis by GC-MSD

The fatty acid composition of oil extracted from yellow pitaya seeds was analyzed by injecting fatty acid methyl esters [12,13] into an Agilent Technologies 7980A system Gas Chromatography (Agilent, Santa Clara, CA) equipped with a Mass Selective Detector 5977A GC/MSD (Agilent,

Santa Clara, CA), an autosampler 7693, column (60 m × 250 μm × 0.25 μm, Agilent 122-7062). The oven temperature ramp 2: At 200°C at 25°C/min for 10 min; ramp 3: At 250°C at 2°C/min. The injector and detector temperatures were set at 250°C. Helium was used as carrier gas at a linear flow velocity of 1.4 mL/min. All assays were made in triplicate (n=4).

RESULTS

Yellow pitaya fruits used in this study were cultivated in the company FINCA PROCEL in Palora-Ecuador, Amazonia region (Fig. 1a and b). Fig. 1c shows yellow pitaya fruits in pitaya tree with their thorns. Fig. 1d shows yellow pitaya fruit without thorns. Fig. 1e shows yellow pitaya list for exportation after quality control.

FAMES from yellow pitaya seeds (*H. megalanthus*) were analyzed using the GC-MS method, and the identification of fatty acids was made using the spectrum of a database Library NIST14.L. The GC chromatogram presents five abundant peaks separated with an excellent resolution of each peak with the help of a column Agilent DB-WAX 122-7062 and were identified with a Mass Selective Detector 5977A GC/MSD (Agilent,



Fig. 1: Photographs of dragon fruit (yellow pitaya) grown in Ecuador. (a and b) Cultivar of FINCA PROCEL (Palora and Ecuador), (c and d) yellow pitaya fruit, and (e) yellow pitaya fruits with export packaging

Santa Clara, CA). Fig. 2 shows the peaks observed in the chromatogram after analysis with the GC/MS. The first peak presents a retention time of 13.779 min and was identified as C16:0, the second peak presents a retention time of 16.469 min and was identified as C18:0, the third peak presents a retention time of 17.203 min and was identified as C18:1, the fourth peak presents a retention time of 17.324 min and was identified as C18:1 *trans*, and finally the fifth peak presents a retention time of 18.367 minutes and was identified as C18:2. The separation and definition of the five relevant peaks were excellent in the GC chromatogram obtained.

The concentration of FAMES present in yellow pitaya seeds was determined using the peak area ratio with the help of the instrument software. Table 1 shows the percentage of main fatty acids of yellow pitaya seeds oil. C16:0 presents a value of 11.52% of palmitic acid, total content, C18:0 shows a 4.29% of stearic acid, C18:1 presents a value of 11.09% of oleic acid, total content, C18:1 *trans* 11 shows a 3.08% vaccenic acid, and C18:2 presents a value of 69.98% of linoleic acid, total content. Yellow pitaya oil from Amazonian of Ecuador presents a high content of polyunsaturated fatty linoleic acid.

Figure 3a-d shows a typical mass spectrum of palmitic acid, stearic acid, oleic acid, vaccenic acid, linoleic acid, and linolenic acid. They present a typical fragmentation of ions in the mass spectrum. These mass spectrums were used to identify the structural formula and chemical name of fatty acids in yellow pitaya (*H. megalanthus*).

DISCUSSION

Vegetal oils are rich in fatty acids. Fatty acids can be classified into three groups (1) saturated fatty acids (SFAs), (2) monounsaturated fatty acids (MUFAs), and (3) polyunsaturated fatty acids (PUFAs). Unsaturated fatty acids have a special group named omega designed with letter Greek (ω) which indicates the position of last carbon of the cadent opposite to the functional carboxylic group. For example, ω -9 has a first double bond between C9 and C10. Omega 9 (ω -9) oleic acid is a non-essential fatty acids (NEFAs) not being essential to the human body [14]. Omega 6 (ω -9) linoleic acid and omega 3 (ω -3) linolenic acid are Essential Fatty Acids, as those acids cannot be synthesized by the human body and they need to be incorporated in the food diet. The fatty acid NEFAs, EFAs, SFAs, MUFAs, and PUFAs profiles in vegetable

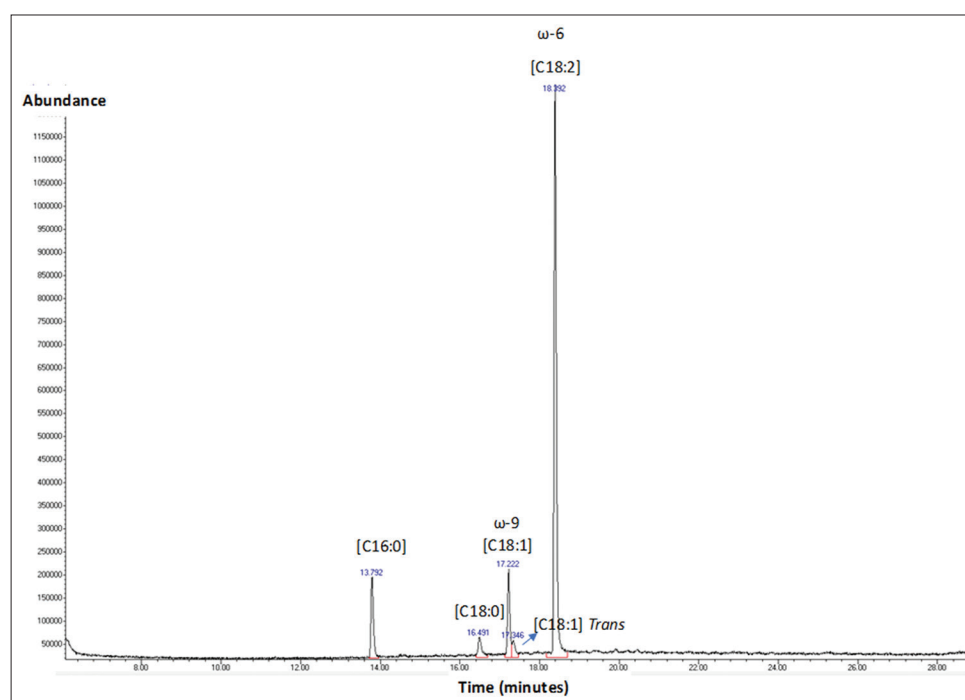


Fig. 2: Gas chromatography chromatogram of methyl esters fatty acids of yellow pitaya from Ecuador

oils are then very important to know [15,16]. With the fatty acid profile, we can evaluate the value of each oil in terms of health, technology, and economy. PUFAs are reported being able to reduce cholesterol levels and be used to the prevention of cardiovascular risk. In the market, consumers appreciate vegetable oils with a high content of omega 3, 6, and 9. These oils are considered healthy and appropriate for a healthy diet. From the technology point of view, good content of MUFA, such as the one of olive oil, allows high stability in lipid oxidation. On the other hand, vegetable oils rich in PUFAs with a high degree of unsaturation are susceptible of an oxidation process with a deterioration of the vegetable oil. Vegetable oil with a high content of MUFAs is most expensive due to their high stability with a high degree of α -tocopherol natural antioxidant in oils. Yellow pitaya oil has a high content of omega 6 (69.98%), these results are in accordance with other authors. Ariffin *et al.*, 2009, reported content of red pitaya with a value of 49.6% of linoleic acid (*H. polyrhizus*) and 50.1% of linoleic acid (*Hylocereus undatus*) [17]. We can observe that the percentage of linoleic acid in yellow pitaya is higher than in the two species of red pitaya from Malaysia. Yellow pitaya oil, due to its high content of omega 6, can be marketed as healthy vegetable oil and can be used in the food industry to manufacture functional foods. Rui *et al.*, 2009, reported a fatty acids profile in white pitaya of Malaysia. FAMES of pitaya oil were extracted by different methods. Linoleic acid presented values of 33.31% (Soxhlet extraction method), 25.22% (Microwave-assistant extraction method),

35.73% (Aqueous enzymatic extraction method), 40.15% (Microwave-assistant extraction/Aqueous enzymatic extraction method), and 54.43% (supercritical fluid extraction method), respectively [18]. The result of the linoleic acid obtained in our study (69.98%) is higher than Rui *et al.*, 2009 results obtained in white pitaya.

Liaotrakoon *et al.*, 2013, reported content of linoleic acid (45–55%) of pitaya oil (*Hylocereus* spp.) our linoleic acid value is also higher than these values [19]. Lim *et al.*, 2010, reported the composition of FAMES in two species of dragon fruit (red pitaya), they reported a content of red pitaya of 48.0% of linoleic acid (*H. polyrhizus*) and 55.63% of linoleic acid (*H. undatus*) [20]. It can be observed that the percentage of linoleic acid in yellow pitaya is higher than the value obtained in the two species of red pitaya from Malaysia. When the content of omega 6 (C18:2) of pitaya oil with other vegetable oils produced in Ecuador, it can be observed that only kahai oil (*Caryodendron orinocense* Karst) and tocto oil (*Juglans neotropical* Diels) have a high content of omega 6 with values of 68.04% and 65.81%, respectively. Pitaya oil presents a higher value of omega 6 than both oils with a value of 69.98% [21,22]. On the other hand, pitaya oil has a higher content of palmitic acid than previously mentioned oils. Pitaya oil presents 11.52% of palmitic acid while kahai oil has a value of 7.0% of palmitic acid and tocto oil 5.05% of palmitic acid. The content of SFAs in pitaya oil was slightly higher than in kahai and tocto oils. Other vegetable oils from Ecuador presenting low content of omega 6 than pitaya oil are corn oil (*Zea mays* L.) with a value of 52.68% of omega 6 [13], sacha inchi (*Plukenetia volubilis* L.) with a value of 34.98% of omega 6 [23], sambo oil (*Cucurbita ficifolia* L.) with a value of 33.98% of omega 6 [24], chia oil (*Salvia hispanica* L.) with a value of 31.03% of omega 6 [11], macadamia oil (*Macadamia intergrifolia*) with a value of 3.79% of omega 6 [12], and unguahua oil (*Oenocarpus bataua*) with a low value of 1.60% of omega 6 [25]. In the production of pitaya pulp for export tons of seeds are generated as food waste. Obtaining oil from these seeds can be an alternative use for these companies. Bearing in mind that pitaya oil has a high omega 6 content, it could be considered a healthy oil with possibilities to use in food, cosmetic, and pharmaceutical industries in Ecuador.

Table 1: Fatty acids composition of yellow pitaya seeds oil (*H. megalanthus*)

FAMES	Number of carbons	% Peak area
Palmitic acid	C16:0	11.52±0.85
Stearic acid	C18:0	4.29±0.41
ΣSFA		15.81±1.26
Oleic acid	C18:1	11.09±0.77
Vaccenic acid	C18:1 <i>trans</i> 11	3.08±0.18
ΣMUFA		14.17±0.95
Linoleic acid	C18:2	69.98±1.49
ΣPUFA		69.98±1.49

SFA: Saturated fatty acid, MUFA: Monounsaturated fatty acid and PUFA: Polyunsaturated fatty acid. Data are expressed as the mean±standard deviation (n=4). FAMES: Methyl esters fatty acids

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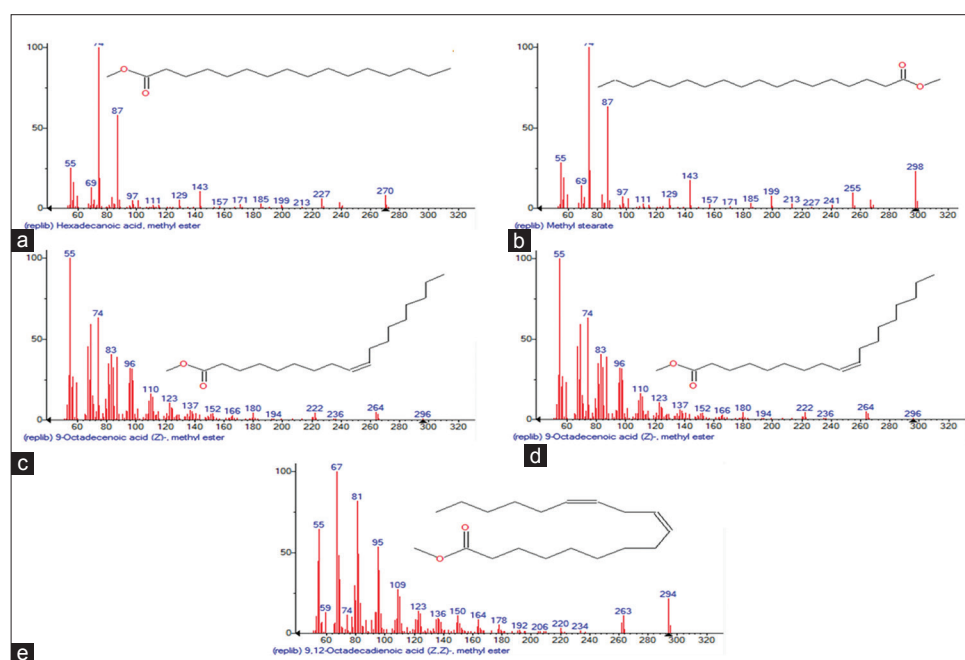


Fig. 3: Mass spectrum of methyl esters fatty acids from yellow pitaya. (a) Mass spectrum of palmitic acid, (b) mass spectrum of stearic acid, (c) mass spectrum of oleic acid, (d) mass spectrum of vaccenic acid, and (e) mass spectrum of linoleic acid

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AUTHORS' CONTRIBUTIONS

Carrillo W, Altuna JL, Quinteros MF, and Morales D conceived and designed the experiments. Silva M and Alvarez M performed the gas chromatography analyses. Carrillo W wrote the paper.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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