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Research Article

# FATTY ACIDS CONTENT IN UNGURAHUA OIL (*OENOCARPUS BATAUA*) FROM ECUADOR. FINDINGS ON ADULTERATION OF UNGURAHUA OIL IN ECUADOR

**CARRILLO W*, CARPIO C, MORALES D, ÁLVAREZ M, SILVA M**

**Laboratory of Functional Foods, Faculty of Foods Science and Engineering, Technical University of Ambato, Av. Los Chasquis y Rio Payamino, Campus Huachi, CP 1801334, Ambato, Ecuador. Email: wi.carrillo@uta.edu.ec**

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**ABSTRACT**

**Objective:** The aim of this study was to determine the fatty acids composition in an ungurahua seeds oil (*Oenocarpus bataua*) sample cultivated in Ecuador and to determine eventual adulteration in the composition of commercial ungurahua oil.

**Methods:** Oil was obtained from ungurahua seeds using the cold pressing method. Fatty acids analysis was performed using the gas chromatography (GC) method with a mass selective detector and using the database library NIST14.L to identify the compounds.

**Results:** Methyl esters fatty acids were identified from ungurahua (*O. bataua*) using the GC mass spectrometer analytical method. Ungurahua oil presented a high content of monounsaturated fatty acids with 82.03% of oleic acids. A fraud in the composition of fatty acids present in commercial ungurahua oil was found as fatty acids had a value of only 36.77% of oleic acids. The content of linoleic acid can be used to determine adulteration of this oil.

**Conclusions:** Ungurahua seeds are a good source of monounsaturated and fatty acids. The content of oleic acid is higher than in olive oil. Ungurahua can help reducing cardiovascular diseases risk in Ecuador due to its good composition of monounsaturated fatty acids. Ungurahua oil is a good option to be used in the food industry for different uses.

**Keywords:** Ungurahua oil, *Oenocar pus bataua*, Fatty acids, Lipids, Omega 9.

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## INTRODUCTION

*Oenocarpus bataua* belongs to the *Arecoideae* subfamily, and it is a lesser-known palm tree. This fruit is named patawa, ungurahui, and ungurahua. Ungurahua is present throughout the Amazon and northern South America. The fruit pulp is not well characterized and could present an interesting nutritional value [1,2]. The mesocarp is eatable and nutritious, containing high-quality oil. Fruit pulp has a content of 29.1% fat, 7.4% of protein, and 44.7% fiber [3,4]. Amazonian fruits are rich in fat, but more than 61% of this fat is unsaturated and could be considered healthy fat, which can be used to cardiovascular risk prevention [5]. Monounsaturated fatty acids (MUFAs) are the predominant fatty acids in fruits and contribute, on average, approximately to 62% of the total fat. It is widely recognized that dietary fat type influences plasma cholesterol levels to a greater extent than does total fat intake [6]. Therefore, replacing saturated fat with unsaturated fat may be more effective in lowering the risk of coronary heart disease (CHD) than reducing fat intake [7]. Amazonian fruits also have high levels of tocopherols, which are present in the unsaponifiable lipid fraction of foods. Ungurahua oil profile is similar to the olive oil composition; ungurahua oil has a high content of oleic acid (omega 9) in similar proportions to the ones of the olive oil [8]. Frauds in various consumer sectors of the food industry are now commonly practiced in the world for a long time. This practice is increasing in developing countries. Vegetal oils are commonly adulterated with the addition of cheaper seeds oils [9-11]. Olive oil can be adulterated with soy oil, sunflower, and corn oil which are cheaper [12]. The analytical technique most used to determine this fraud is the chromatography and mass spectrometry (MS) [13,14]. The aim of this work was to identify the fatty acids composition present in ungurahua (*O. bataua*) seeds from Amazonia region of Ecuador using the gas chromatography MS (GC-MS) and determine fraud in the composition of fatty acids from the commercial ungurahua oil of Ecuador.

## METHODS

### Total lipid extraction

Ungurahua oil was obtained in a regular supermarket in Ecuador. Ungurahua seeds were obtained in the Amazonia region. Oil sample was obtained from ungurahua seeds using the cold pressing method. Oil was then stored at 4.0±2°C. Oil extraction was conducted 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 [15].

### Fatty acid methyl esters (FAME)

Methyl esters (FAME) were prepared with 0.020–0.025 g of total lipids of ungurahua oil using the two-step methylation method: 2 ml 0.5 M KOH/MeOH was added and then 1 ml of 5% HCl/MeOH was added; both steps were performed at 50°C. 25 min FAME were extracted with 10 ml of hexane [16].

### Analysis of FAME from ungurahua by (GC-MS)

The fatty acid composition of oil extracted from ungurahua seeds was analyzed by injecting FAME [17] into an Agilent technologies 7980A system GC (Agilent, Santa Clara, CA) equipped with a mass selective detector (MSD) 5977A GC, an autosampler 7693, column (60 m×250 µm×0.25 µm, DB-WAX Agilent 122–7062). The oven

temperature was programmed as follows: From 80°C; ramp 1: To 100°C at 20°C/min for 1 min; ramp 2: At 200°C at 25°C/min during 10 min; and 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.

Spectra were compared with the NIST14.L library and the fatty acids mass spectra archive [18]. All GC analyses of fatty acids were carried out in triplicate, and results were expressed as the mean value ± standard deviation.

## RESULTS

Fig. 1 shows ungurahua seeds fruit (*O. bataua*) with or without skin. Fig. 1a shows the dark color of the whole ungurahua fruit and the inside fruit being of white color.

Ungurahua oil sample was obtained in the laboratory using the cold pressing method; fatty acids were subsequently methyl esterified. Fatty acids from ungurahua oils were identified using the GC/MSD. The precursor ions were compared to the three database Library NIST14. L. Five majority peaks were identified with their associated retention time: C16:0 with a retention time of 19.409 min; C18:0 with a retention time of 26.095 min; C18:1c with a retention time of 26.974 min; C18:2 with a retention time of 28.974 min; and finally, C18:3 with a retention time of 31.090 min (Fig. 2).

Fatty acids of commercial oil ungurahua from Ecuador were methyl esterified. Fatty acids from ungurahua oil were identified using the GC/MSD. The precursor ions were compared to three database library NIST14. L. Five majority peaks were identified with their associated retention time: C16:0 with a retention time of 19.354 min; C18:0 with a retention time of 26.028 min; C18:1c with a retention time of 26.891 min; C18:2 with a retention time of 28.658 min; and finally, C18:3 with a retention time of 31.21 min (Fig. 3).

The concentration of fatty acids in ungurahua oil obtained in the laboratory was calculated with a peak area percentage. FAMEs were characterized: C16:0 palmitic acid with 9.90% of fatty acids content, C18:0 stearic acid with 3.08% of fatty acids content, C18:1 oleic acid with 82.03% of fatty acids content, C18:2 linoleic acid with 1.60% of fatty acids content, and finally C18:3 linolenic acid with 1.82% of fatty acids content (Table 1). The content of oleic acid (omega 9) was very high. The content of oleic acid in olive oil is reported to have a value between 62% and 80% of oleic acid. The content of oleic acid from ungurahua oil was higher with a value of 82.03% of oleic acid. The content of monounsaturated lipids was very high. Our results are in accordance with values reported by other authors. Darnet *et al*., 2011 [3], reported the composition of fatty acids of *O. bataua* from the Brazilian Amazonia with values of 13.5% of palmitic acid, 4.2% of stearic acid, 76.8% of oleic acid, 3.9% of linoleic acid, and 0.0% of linolenic acid. Rodrigues *et al*., 2010 [4], also have reported the content of fatty acids of *O. bataua* from the Brazilian Amazonia with values of 13.30% of palmitic acid, 4.10% of stearic acid, 76.70% of oleic acid, 3.90% of linoleic acid, and 0.10% of linolenic acid.

The concentration of fatty acids in commercial ungurahua oil obtained in a regular supermarket in Ecuador was calculated using the peak area percentage. FAMEs were characterized: C16:0 palmitic acid with 19.47% of fatty content, C18:0 stearic acid with 5.11% of fatty content, C18:1 oleic acid with 36.77% of fatty content, C18:2 linoleic acid with 35.78% of fatty content, and finally C18:3 linolenic acid with 2.86% of fatty content (Table 2). The profile of ungurahua oil is different to the commercial ungurahua oil when compared to the ungurahua oil obtained in the laboratory. The oleic acid is much lower with a value of only 36.77% while the linoleic acid is higher with a value of 35.78%.

## DISCUSSION

When the ungurahua fatty acids composition is compared to some other common vegetable oils, it can be seen that olive oil has a high content of monounsaturated fatty acids and C18:1 named oleic acid with 77.6% of oleic acid. Ungurahua oil from Ecuador has a higher content of monounsaturated fatty acids with a content of 82.03% of oleic acid. Ungurahua has a low content of polyunsaturated fatty acids

**Table 1: Content of fatty acids of ungurahua oil obtained in the laboratory**

| Retention time | Peak area ratio (%) | Carbone number: double bound | Type of fatty acids | FAMEs name |
|---|---|---|---|---|
| 19.409 min | 9.900±0.182 | C16:0 | Saturated | Palmitic acid |
| 26.095 min | 3.084±0.140 | C18:0 | Saturated | Stearic acid |
| 26.974 min | 82.032±1.630 | Δ9C18:1 | Monounsaturated | Oleic acid |
| 28.717 min | 1.603±0.483 | Δ9. 12 C18:2 | Polyunsaturated | Linoleic acid |
| 31.090 min | 1.823±2.454 | Δ9. 12. 15 C18:3 | Polyunsaturated | Linolenic acid |

FAMEs: Fatty acid methyl esters

**Table 2: Content of fatty acids of commercial ungurahua oil**

| Retention time | Peak area ratio (%) | Carbone number: double bound | Type of fatty acids | FAMEs name |
|---|---|---|---|---|
| 19.354 min | 19.470±0.142 | C16:0 | Saturated | Palmitic acid |
| 26.028 min | 5.110±0.115 | C18:0 | Saturated | Stearic acid |
| 26.891 min | 36.775±0.730 | Δ9C18:1 | Monounsaturated | Oleic acid |
| 28.658 min | 35.780±0.283 | Δ9. 12 C18:2 | Polyunsaturated | Linoleic acid |
| 31.121 min | 2.863±0.826 | Δ9. 12. 15 C18:3 | Polyunsaturated | Linolenic acid |

FAMEs: Fatty acid methyl esters

**Table 3: Content of fatty acid of common vegetal oils**

| Ref | Vegetal oil | C16:0 | C16:1 | C18:0 | C18:1 | C18:2 | C18:3 |
|---|---|---|---|---|---|---|---|
| 25 | Olive oil | 13.8 | 1.4 | 2.8 | 71.6 | 9.00 | 1.0 |
| 25 | Sunflower oil | 5.2 | 0.1 | 3.7 | 33.7 | 56.5 | 0.0 |
| 25 | Palm oil | 44.8 | 0.0 | 4.6 | 38.9 | 9.5 | 0.4 |
| 25 | Soybean oil | 10.1 | 0.0 | 4.3 | 22.3 | 53.7 | 8.1 |
| 25 | Corn oil | 11.6 | 0.0 | 2.5 | 38.7 | 44.7 | 1.4 |
| 26 | Sacha inchi oil | 3.98 | 0.0 | 3.12 | 8.58 | 34.98 | 47.04 |
| 27 | Sambo oil | 9.33 | 0.0 | 6.84 | 41.36 | 33.98 | 0.0 |
| | Ungurahua oil | 9.90 | 0.0 | 3.08 | 82.03 | 1.60 | 1.82 |

with 3.426%. Olive oil contains few omega-6 and omega-3 fatty acids with 9.0% and 1.0%, respectively (Table 3).

The content of linoleic acid can be used to determine fraud in vegetal oils. Christopoulou *et al*., 2004, reported that linolenic acid (C18:3) can be used to determinate fraud in olive oil when mixed with other oils such as soybean oil and sunflower oil [19]. In this study, we used linoleic acid to determine fraud in ungurahua oil because the content of linoleic acid was high. Sunflower and soybean oils both have a high content of linoleic acid (Table 3). It is possible that fraud in ungurahua oil was committed using any of these vegetal oils. Vegetal oils with high quality in their composition of lipids are susceptible of adulteration. Olive oil is one of the oils with more adulteration in the past; this situation affects a high number of foods which have olive oil in their composition resulting in high economic losses in the food industry. Techniques such as high pressure liquid chromatography, GC, near infrared, and RMN are used to identify adulterants present in vegetal oils [20,21].


**Fig. 1: Fruit of ungurahua (*Oenocarpus bataua*) (a) whole fruit, (b) fruit without skin, (c) fruit without fiber, and (d) pulp fruit**

Food is an important element for human life and for social and economic prosperity and progress. Problems related to food have a big varied during different historic times, from continent to continent, and from country to country and cities [22]. The problem of foodstuff adulteration has been a major one, and the protection of the consumer has occupied the attention of many governments for a long time. Food authentication is an important aspect of food quality control in the food industry. Foodstuff is considered adulterated if it contains poisons or other substances which can be dangerous to the health of the consumers, if it contains impurities; if it contains a chemical components such as coloring agent or other food additive, that is not approved or contains materials that produce inferior quality; if any important constituent has been wholly or in part abstracted or any specified ingredient has been changing by other ingredients without the specified ingredient; if it contains any component that alters its weight and bulk or changes its strength to improve appearance. A food is mislabeling if it is illicitly labeled or it is a food for which standards of identity have been written, and it fails to comply with these standards [23,24]. The detection of adulteration of foodstuff is a technical problem that is needed to solve with many quality control for the government and with good norms of control.

Oleic acid is recommended for food and drug administration (FDA) as an intake of MUFAs to reduce the risk of cardiovascular diseases in the

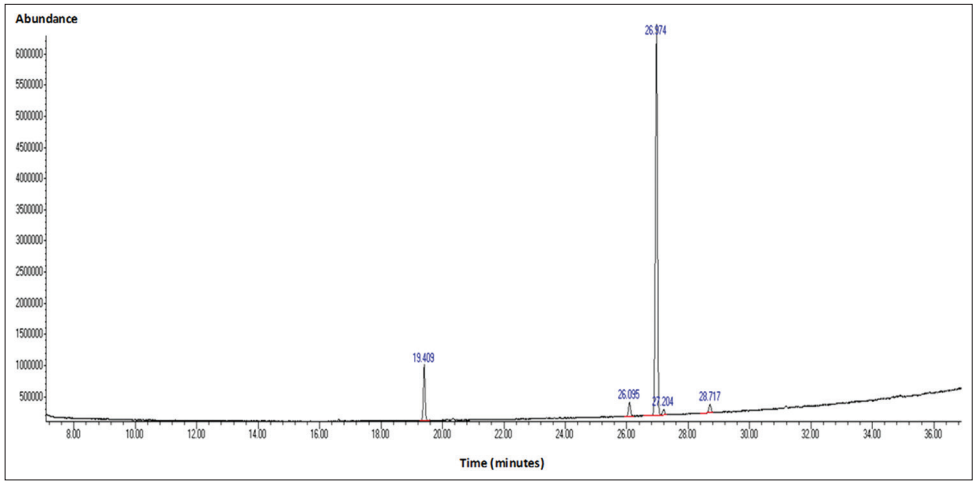


**Fig. 2: Chromatography gases analysis of ungurahua oil obtained in the laboratory**

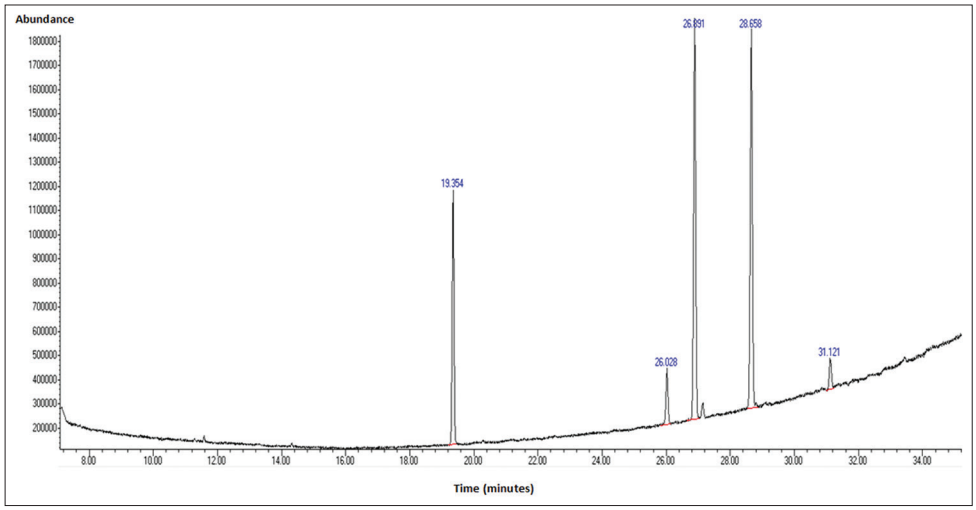


**Fig. 3: Chromatography gases analysis of commercial ungurahua oil from ecuador**

world. In 2004, the FDA authorized a health claim on olive oil on CHD: "Limited and not conclusive scientific evidence suggests that eating about two tablespoons (23 g) of olive oil daily may reduce the risk of CHD due to the monounsaturated fat in olive oil. To achieve this possible benefit, olive oil is to replace a similar amount of saturated fat and not increase the total number of calories you eat in a day" [28]. A recent study from the European food safety authority supports the effects of virgin olive oil phenols on low-density lipoproteins (LDL) oxidation [29]. Extra virgin olive oil contains MUFA (oleic acid) and phenols compounds with antioxidant capacity. It is well known that oxidation of LDL cholesterol is a key important factor in the development of atherosclerosis, promoting the formation of foam cells in the subendothelial space of the vascular wall. Oleic acid and phenols help avoiding this oxidation when taking in the daily human diet. It is estimated that by the year 2050 over 1.5 billion people are hypertension disease. It is known that diabetes mellitus Type 2 can cause cardiovascular risk. The cardiovascular disease caused the highest mortality in 2012 including 7.4 million for CHD and 6.7 million for stroke [30,31]. Ungurahua oil has a good composition of fatty acids with a high content of MUFAs (oleic acid omega 9). This oil can be help preventing the cardiovascular risks and reducing cholesterol. Ungurahua oil due to its composition of fatty acids can be considered as a healthy oil.

## CONCLUSION

Ungurahua oil (*O. bataua*) presents a high content of monounsaturated fatty oil with a value of 82.03% of oleic acid. Ungurahua oil content low palmitic and stearic acid with a value of 9.90% and 3.08%, respectively. Ungurahua oil has a good composition of fatty acid and for their high content of oleic acid can be consumed to the prevention of cardiovascular risk. Commercial ungurahua oil presents adulteration in its composition of fatty acid.

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## AUTHOR'S CONTRIBUTIONS

Carrillo W, Carpio C, and Morales D conceived and designed the experiments. Silva M and Alvarez M performed the GC analyses. Carrillo W wrote the paper.

## CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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