Nutritional composition of Sacha inchi (*Plukenetia Volubilis* L.) as affected by different cooking methods

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**ABSTRACT**

The objective of this study was to determine the effect of cooking method on the fatty acid composition, mineral content, and physicochemical properties of Sacha inchi. The analysis showed that roasting at 160 °C for 6 minutes significantly increased (*p* < .05) most of the mineral contents of the Sacha inchi, whilst decreasing its potassium and sodium content. Contrarily, boiling at 100 °C for 13 minutes significantly decreased (*p* < .05) the mineral contents of the Sacha inchi (except for calcium and sodium). Unsaturated fatty acid content was similarly affected. Roasting at 160 °C for 6 minutes significantly increased (*p* < .05) the omega 3, 6, and 9 of the Sacha inchi, but boiling at 100 °C for 13 minutes significantly decreased (*p* < .05) its unsaturated fatty acids. These results show that the roasting at 160 °C for 6 minutes is a superior processing method of Sacha inchi for production and highlight why it is important to correctly perform the cooking process in order to both avoid nutritional value loss and the worsening of physicochemical properties. Therefore, the results of this study indicate the possible utilization of Sacha inchi in food industry.

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**Introduction**

Sacha inchi (*Plukenetia Volubilis* L.), also known as the “Inca peanut”, “Wild peanut”, “Mountain peanut” or “Inca inchi”, is a plant belonging to the Euphorbiaceae family and grows at altitudes between 200 ~ 1,500 m in the Amazonian forest. At the present times, this plant is widely cultivated in Peru and Southern Colombia for its great potential as an economic crop.

Sacha inchi exhibits two main qualities that make it desirable for study. First, the different parts of the plant have varied chemical constituent, each with high nutritional values. The seeds contain 35 ~ 60% lipids, 25 ~ 30% proteins (including essential aminoacids such as cysteine, tyrosine, threonine, and tryptophan), vitamin E, polyphenols, making it suitable for dietary use. The leaves are a source of terpenoids, saponins, and phenolic compounds (flavonoids). Because of these nutrients, roasted seeds, cooked leaves, and seed oil are part of the traditional diets in Peru. Second, Sacha inchi has large edible seeds that are rich in omega 3 (ω-3; linolenic acid), omega 6 (ω-6; linoleic acid), omega 7 (ω-7; vaccenic acid), and omega 9 (ω-9; oleic acid) unsaturated fatty acids (FAs) and mineral content. Beneficial effects of these FAs include the ability to prevent cardiovascular disorders, lower glycercide levels, and antithrombotic action.[1]

Sacha inchi is consumed as oil or cooked traditionally by boiling, steaming, roasting, and other methods. Based on other food studies, it may be expected that this diminishes nutritional properties, bioactive compounds, and nutraceutical properties. In addition, Devi et al.[2] reported that cooked plants exhibit poor color and quality in comparison to the fresh ones. Moreover, morphological and nutritional characteristics of this plant can be influenced by cooking and preparation methods.
Despite pieces of evidence on component analysis of raw Sacha inchi seeds, there are only a few studies on the effects of processing condition on its nutritional properties, edibility, and tastefulness. On that account, the present experiment was conducted in order to study the effect of cooking method on the FA composition, mineral contents, and physicochemical properties of Sacha inchi. As other papers mentioned, Sacha inchi is nutritionally superior, but it can be consumed only by cooking because of its astringency. Therefore, this study will suggest a variety of cooking methods on Sacha inchi and examine suitable cooking methods for consuming Sacha inchi.

**Materials and methods**

**Sample preparation**

Through preliminary experiments, we figured out roasting Sacha inchi in a heated pan at 160 °C for 6 minutes and boiling it at 100 °C for 13 minutes with water (1 L) were the optimal conditions for the results. Sacha inchi (≈ 300 g) were cleaned from broken seeds, homogenized, and divided into three portions. The first portion was used for analysis as raw. The second portion was roasted in a heated pan at 160 °C for 6 minutes. The third portion was boiled at 100 °C for 13 minutes with water (1 L) to ensure enough softness to make the seed edible. Softness was determined by pressing and feeling the boiled seed between the fingers.

**Mineral analysis**

The mineral composition of each Sacha inchi sample was analyzed using the method described by Morgano et al. [3] Each Sacha inchi sample was ashed at 550 °C and the ash boiled with 10 mL HCl (10%). After filtration, 0.7 g of Sacha inchi samples were weighed into a Teflon digestion flask, added by 10 mL of nitric acid and 3 mL of 30% hydrogen peroxide. Digestion was performed in two steps, using 1000 W power at a maximum temperature of 200 °C. After that, samples were cooled at room temperature and the content was transferred to a 25 mL volumetric flask with 5% HCl solution (v/v).

The mineral elements were quantified by inductively coupled plasma optical emission spectrometer (ICP-OES; Vista MPX, Varian, Mulgrave, Victoria, Australia) equipped with radio frequency source of 40 MHz, charge coupled devices (CCD) simultaneous solid-state detector, peristaltic pump, seaspray nebulizer connected to cyclonic spray chamber, and high-purity argon (99.996%, Air Liquid, São Paulo, Brazil). The system was controlled by ICP Expert software: 1000 W of forward power, 1.5 L min⁻¹ of auxiliary argon (Ar) flow, 0.9 L min⁻¹ of nebulizer Ar flow, 15 L min⁻¹ of cooling Ar flow rate, 2 points of background correction, 10s of integration and reading time, and 3 of replicate number. The analytical line wavelengths were 317.9 nm of calcium (Ca), 324.8 nm of copper (Cu), 234.4 nm of iron (Fe), 766.5 nm of potassium (K), 280.3 nm of magnesium (Mg), 260.6 nm of manganese (Mn), 202 nm of molybdenum (Mo), 589 nm of sodium (Na), 213.6 nm of phosphorus (P), 196 nm of selenium (Se), and 206.2 nm of zinc (Zn).

**Fatty acid analysis**

The FA composition of each Sacha inchi sample was analyzed using the method described by Kim et al. [4] Each Sacha inchi sample (≈ 20 mg) was saponified with 0.5 N methanolic NaOH (3 mL) at 85 °C for 10 minutes and cooled to room temperature. All FAs present in the Sacha inchi sample were then converted to their methyl esters by methylation with 14% BF₃ in methanol (3 mL) at 85 °C for 10 minutes. After recooling to room temperature, isooctane (3 mL) and saturated NaCl solution (5 mL) was added to the mixture, followed by vortexing. The upper isooctane layer containing the FA methyl esters was then collected and passed through an anhydrous Na₂SO₄ column. The FA methyl esters were analyzed by gas-liquid chromatography using a gas chromatograph (Agilent technologies 7890-A, Palo Alto, CA, USA), equipped with a flame ionization detector and a fused silica capillary column (100 m × 0.25 mm i.d. × 0.2
\( \mu \text{m film thickness, Supelco SP-2560, Bellefonte, PA, USA}. \) The sample (1 \( \mu \text{L} \)) was injected in split mode with a split ratio of 200:1. Helium, at a flow rate of 1 mL min\(^{-1}\), was used as the carrier gas. The injector and detector temperatures were maintained at 225 and 285 \( ^\circ \text{C} \), respectively. The oven temperature was initially held at 100 \( ^\circ \text{C} \) for 4 minutes before increasing to 240 \( ^\circ \text{C} \) at a rate of 3 \( ^\circ \text{C} \) min\(^{-1}\), after which the temperature was held at 240 \( ^\circ \text{C} \) for 17 minutes. The FA methyl esters were identified by a comparison of their retention times with those of reference standards (Supelco 37 component FA methyl esters mix, Bellefonte, PA, USA).

**Physicochemical properties**

*Moisture:* A moisture analyzer (MB45, Ohaus, Switzerland) with a 10 cm diameter aluminum sample pan was used for the compression tests. The test settings were: sample weight 3 g, temperature program fast, drying temperature 180 \( ^\circ \text{C} \), switch-off criterion A60.

*Instrumental hardness:* A texture analyzer (TA-XT Express 20096, Stable micro systems, Godalming, UK) with a 40 mm diameter cylinder probe (P/40) was used for the compression tests. The test settings were: test speed 1 mm/s, target mode: distance, distance 5 mm, trigger 10 g. The compression distance was the maximum possible to fracture the samples into pieces but to avoid overloading the texture analyzer.

*Color:* The color of each Sacha inchi samples was measured with a color difference meter (JP7200F, Juki Co. Ltd., Tokyo, Japan) and standard \((L = 105.52, a = -0.07, b = 4.70)\). Tristimulus color coordinates were used to measure the degree of lightness (L), redness (a), and yellowness (b).

**Statistical analysis**

Results were expressed as mean \( \pm \) S.D. of three separated determinations. Data sets were evaluated using the one-way analysis of variance (ANOVA) by using SPSS version 23 (SPSS Institute, Chicago, IL, USA) at a significance level of 0.05. Tukey’s test was used to assess correlations between means.

**Results and discussion**

**Mineral composition**

The mineral compositions of raw, roasted, and boiled Sacha inchi are compared in Table 1. Our analyses significantly \((p < .001)\) detected 9 different minerals in the raw Sacha inchi samples. P is the most abundant mineral with a mean content of 5196.7 mg/L (range of 5180.7 ～ 5228.7mg/L), followed by K, Mg, Ca, Zn, Fe, Mn, Cu, and Na.

Comparatively, the boiled Sacha inchi samples had significantly \((p < .05)\) lower values for Cu, Fe, K, Mg, Mn, P, and Zn content than those of raw Sacha inchi (except Ca and Na content). Reduction of mineral content in boiled Sacha inchi sample might be due to the removal of hulls and leaching of the minerals into the water during boiling. The loss of element was also due to their binding to protein and formation of phytate-cation-protein complexes.\(^5,6\) This indicates that boiling at 100 \( ^\circ \text{C} \) for 13 minutes of Sacha inchi is not suitable for the preservation of minerals.

Contrarily, roasting shows promising results. The mean content of Ca was found to be 2291.7 mg/L (range of 2287.6 ～ 2299.7mg/L) which is significantly \((p < .001)\) higher than the raw and boiled Sacha inchi samples. This shows that roasting is a proper treatment to increase the amount of Ca, which helps in bones and dental development and also helps in enzyme formation and hormonal release.\(^7\) The mean content of Cu was found to be 8.1 mg/L, which is significantly \((p < .01)\) higher than the raw and boiled Sacha inchi samples. This shows that roasting is an adequate treatment to increase the amount of Cu, which is a component of many enzymes and is essential for many physiological activities.\(^8\) Likewise, the mean content of Fe in roasted Sacha inchi (47.8 mg/L) is significantly \((p < .001)\) higher than the raw and boiled Sacha inchi samples. This also shows that roasting is the...
adequate treatment to increase the amount of Fe which is an essential element in the cellular respiratory process. However, there are side effects of excessive up taking, whose main consequences include poor growth, an increase of mortality, diarrhea, and histopathological damage to liver cells. So the need for daily Fe is strictly regulated with the range from 0.3 to 170 mg/L, varying according to population variation. But fortunately, Fe contents of 47.1 ~ 48.3 mg/L were detected in the roasted Sacha inchi in this study, which is suitable for human consumption. This data suggests that there is much variability in Fe concentration in roasted Sacha inchi. Unlike Ca, Cu and Fe, the mean content of K was significantly \((p < .001)\) lower than the raw Sacha inchi in roasted Sacha inchi. However, K content of roasted Sacha inchi is still significantly \((p < .001)\) higher than the boiled Sacha inchi samples, and this result suggest that roasting is the adequate treatment to increase the amount of K which plays a vital role in the maintenance of cellular water balance and enhances protein and carbohydrate metabolism. It is similar to the result of Farinde et al. study in which K was also highest in raw Sacha inchi and least in the boiled Sacha inchi. \[^5\]

In the case of Mg, the mean content of that in roasted Sacha inchi (3667.5 mg/L) is significantly \((p < .001)\) higher than the raw and boiled Sacha inchi samples. As a result, roasting is a suitable treatment to increase the amount of Mg which enhances enzymatic activities and maintains the electrical potential in the nerves. The mean contents of Mn and P in roasted Sacha inchi (11.9 and 5442.7 mg/L) are also significantly \((p < .001)\) higher than the raw and boiled Sacha inchi samples. These show that roasting is a suitable treatment to increase the amount of Mn and P which is an essential component of nucleic acids and cell membranes and its deficiency causes low growth, food inefficiency, and bone mineralization.\[^6\] The Zn content in roasted Sacha inchi (42.3 mg/L) is significantly \((p < .001)\) higher than the raw and boiled Sacha inchi samples as well. This data shows that roasting is a good method to increase the amount of Zn which helps in enhancing immune activities and it is important for proper sense of taste and smell. Notably, Na shows a different outcome compared to the other elements. Mean content of Na of 15.3 mg/L is significantly \((p < .001)\) higher than the mean contents in raw and roasted Sacha inchi. This shows that the adequate method to increase the amount of Na is not roasting but boiling. Finally, the measurements show that Mo and Se were not significantly detected in any of raw, roasted, and boiled Sacha inchi samples.

According to this study, roasting at 160 °C for 6 minutes is a superior treatment compared to boiling to increase the number of minerals which play important functions in the human body such as:

| Table 1. Measured mineral content (mg/L) of raw, roasted, and boiled Sacha inchi samples. |
|---------------------------------|---------------------------------|---------------------------------|------------------|
|                                  | Treatment                      | F-value\(^b\)                  |
|---------------------------------|---------------------------------|------------------|------------------|
|                                 | Raw                            | Roasting          | Boiling          |
|---------------------------------|---------------------------------|------------------|------------------|
| Ca                              | 1263.2 ± 6.9\(^c\)             | 2291.7 ± 7.0\(^a\)  | 1626.0 ± 14.5\(^b\)  | 6430.133 *** (0.000) |
| Cu                              | 8.0 ± 0.2\(^a\)                | 8.1 ± 0.0\(^a\)    | 6.9 ± 0.0\(^b\)   | 76.750 *** (0.001)  |
| Fe                              | 40.2 ± 0.5\(^b\)               | 47.8 ± 0.6\(^a\)   | 38.0 ± 0.2\(^c\)   | 330.500*** (0.000)  |
| K                               | 4892.9 ± 107.1\(^a\)           | 4789.1 ± 14.0\(^a\) | 3830.4 ± 56.7\(^b\) | 296.802 *** (0.000) |
| Mg                              | 3441.8 ± 20.8\(^b\)            | 3667.5 ± 32.1\(^a\) | 3281.4 ± 33.3\(^c\) | 95.000 *** (0.000)  |
| Mn                              | 10.3 ± 0.0\(^b\)               | 11.9 ± 0.2\(^a\)   | 9.0 ± 0.2\(^c\)    | 314.263 *** (0.000) |
| Mo                              | 0.0 ± 0.0                      | 0.0 ± 0.0          | 0.0 ± 0.0          | 10938.250 *** (0.000) |
| Na                              | 3.2 ± 0.0\(^b\)                | 0.0 ± 0.0          | 15.3 ± 0.2\(^b\)   | 106.731 *** (0.000) |
| P                               | 5196.7 ± 27.7\(^b\)            | 5442.7 ± 42.8\(^a\) | 4886.5 ± 50.8\(^c\) | 397.923 *** (0.000) |
| Se                              | 0.0 ± 0.0                      | 0.0 ± 0.0          | 0.0 ± 0.0          |                  |
| Zn                              | 41.1 ± 0.4\(^a\)               | 42.3 ± 0.4\(^a\)   | 32.2 ± 0.5\(^b\)   |                  |

\(^a\) All values are expressed as mean ± S.D. of three replicates.  
\(^b\) *** Significant at \(p < 0.001\), respectively.
as many enzymatic reactions, energy production, the transmission of nerve impulses, and multiple biological reactions in Sacha inchi.

**Fatty acid composition**

The FA compositions of raw, roasted, and boiled Sacha inchi are compared in Table 2. Our analyses significantly \( p < .05 \) detected 8 different FAs in the raw Sacha inchi samples. Linolenic acid (18:3 (n-3)) is the most abundant FA with a mean content of 26.3 g/100g (range of 25.4 ~ 27.3 g/100g), followed by linoleic acid (18:2(n-6)), and oleic acid (18:1(n-9)). Less abundant are the saturated FAs; palmitic acid (16:0), stearic acid (18:0), and vaccenic acid (18:1(n-7)). Linolenic acid content in the roasted and boiled Sacha inchi is also the most abundant FA with a mean content of 28.0 and 21.9 g/100g (range of 28.2 ~ 29.8 and 21.7 ~ 22.1 g/100g), followed by linoleic acid, oleic acid. Again, less abundant are saturated FAs; palmitic acid, stearic acid, and vaccenic acid. This shows that Sacha inchi could be a good choice for food due to its low saturated FA content. The Institute of medicine (IOM) also reported that the intake of saturated FA should be avoided in a balanced diet because the excessive consumption of lipids is related to a higher frequency of myocardial infarction cases, hyper-cholesterolemia, increased low-density lipoprotein cholesterol and blood pressure, atheroma, lipid disorders, and other disorders.\(^7\) Also, Sacha inchi is a nutritious food because of its prevalence of unsaturated FA that is involved lowering the risk of cancer and of chronic diseases such as cardiovascular disease, and inflammatory and autoimmune diseases. Furthermore, the ratio of \( \omega-6 \) and \( \omega-3 \) of the Sacha inchi is near the ideal value (from 1:4 to 1:10) which is important due to the hypo-cholesterolemic effect.\(^9\)

A close look at the roasted Sacha inchi samples shows significantly \( p < .05 \) higher \( \omega-3 \) (range = 25.9 ~ 29.8 g/100g, mean = 28.0 g/100g), \( \omega-6 \) (range = 17.8 ~ 20.7 g/100g, mean = 19.3 g/100g), \( \omega-7 \) (mean = 0.3 g/100g), and \( \omega-9 \) (range = 3.8 ~ 4.4 g/100g, mean = 4.1 g/100g) content than the raw Sacha

| Table 2. Measured fatty acid content (g/100g) of raw, roasted, and boiled Sacha inchi samples. |
|---------------------------------------------------|----------------|-----------------|------------------|---------------|
| **Element**                                      | **Raw** | **Roasting** | **Boiling** | **F-value** |
| **Saturated fatty acid**                         |         |               |               |              |
| 14:0                                             | 3.3 ± 0.1\(a\) | 3.4 ± 0.3\(a\) | 2.7 ± 0.1\(b\) | 15.250 *    |
| 16:0                                             | 1.9 ± 0.1\(ab\) | 2.1 ± 0.2\(a\) | 1.6 ± 0.1\(b\) | 12.700 *    |
| 18:0                                             | 1.4 ± 0.1\(a\) | 1.4 ± 0.1\(a\) | 1.1 ± 0.1\(b\) | 22.750 **   |
| **Unsaturated fatty acid**                       |         |               |               |              |
| 16:1                                             | 49.1 ± 1.7\(a\) | 51.6 ± 3.7\(a\) | 41.2 ± 0.7\(b\) | 17.224 *    |
| 18:1(n-7)                                        | 0.3 ± 0.0\(ab\) | 0.3 ± 0.0\(a\) | 0.2 ± 0.0\(c\) | 12.323 *    |
| 18:1(n-9)                                        | 3.9 ± 0.1\(a\) | 4.1 ± 0.3\(a\) | 3.1 ± 0.1\(b\) | 28.964 **   |
| 18:2(n-6)                                        | 18.5 ± 0.6\(ab\) | 19.3 ± 1.5\(a\) | 15.9 ± 0.4\(b\) | 10.941 *    |
| 18:3(n-3)                                        | 26.3 ± 1.0\(a\) | 28.0 ± 2.0\(a\) | 21.9 ± 0.2\(b\) | 20.927 **   |
| **Total body fat**                               | 52.2 ± 1.8 | 55.1 ± 4.0 | 43.8 ± 0.7 | 14.920 **   |
| **Crude fat**                                    | 48.1 ± 0.8 | 48.7 ± 2.3 | 43.1 ± 3.4 | 6.927 *     |

\(a\) All values are expressed as mean ± S.D. of three replicates.  
\(b\) ** Significant at \( p < 0.01 \), respectively.
inchi samples. In contrast, the boiled Sacha inchi samples had significantly ($p < .05$) lower $\omega$-3, $\omega$-6, $\omega$-7, and $\omega$-9 content than those of the raw and roasted Sacha inchi.

This indicates that roasting at 160 °C for 6 minutes of Sacha inchi is suitable for the preservation of FA and the remarkably high content of $\omega$-3, $\omega$-6, $\omega$-7, and $\omega$-9 makes the roasted Sacha inchi especially important as an alternative plant-based $\omega$-3 source in the diet. According to a survey on dietary intake across China, people in the north-west region receive sufficient $\omega$-3 FAs from soybean and chia seed, but in other regions, the $\omega$-3/$\omega$-6 FA is lower than the world health organization (WHO) recommended ratio of 1:4. Therefore, it is important for people to increase $\omega$-3 intakes for optimum health.$^{[10]}$ The roasted Sacha inchi has great potential to serve as an alternative $\omega$-3 source in the diet either as an edible seed for cooking or through nutraceutical supplements.

According to this study, roasting at 160 °C for 6 minutes is better treatment with higher unsaturated FA than the raw and boiling method. These findings suggest that in general the Sacha inchi can be considered as a potential source of unsaturated FA by expanding the use of Sacha inchi in the food industry through a variety of cooking methods. Of the three cooking methods, the roasting method is more susceptible to oxidation because of its susceptibility.

**Physicochemical properties**

*Moisture content:* Table 3 shows that the moisture content in Sacha inchi under boiling treatment was significantly ($p < .01$) higher than in the uncooked sample. On the contrary, under the roasting method the moisture content in Sacha inchi was significantly lower (range = 9.4 ~ 11.0%, mean = 10.2%) in comparison to the uncooked sample. This result indicated that different treatments cause a significant change in the moisture content of Sacha inchi. The overall result indicated that boiling at 100 °C for 13 minutes exhibits comparatively higher moisture content in Sacha inchi among all the treatments.

*Instrumental hardness:* The hardness of Sacha inchi under roasting treatment (range = 1405.3 ~ 1509.8 g, mean = 1448.0 g) was significantly ($p < .01$) higher than uncooked sample. On the contrary, the hardness of Sacha inchi was decreased under the boiling method in comparison to roasting treatment. This result indicated that different treatments cause a significant change in hardness of Sacha inchi.

*Color:* The raw Sacha inchi samples had significantly ($p < .001$) higher L value than the roasted and boiled Sacha inchi samples. Whereas the roasted and boiled Sacha inchi samples had significantly ($p < .001$) higher a value and b value than the raw Sacha inchi samples.

**Conclusion**

It is known that cooking has typical advantages, such as flavor, taste, texture, color, and content of nutrients, but it must be conducted in the correct way. This work was focused on the importance to

| Table 3. Analyzed physicochemical properties of raw, roasted, and boiled Sacha inchi samples. |
|-----------------------------------------------|
| **Element** | **Treatment** | **F-value** |
| Raw | Roasting | Boiling | **(p-value)** |
| --- | --- | --- | --- |
| Moisture (%) | 12.4 ± 0.1 b | 10.2 ± 0.8 b | 21.5 ± 2.2 a | 49.121 ** (0.002) |
| Hardness (g) | 1324.7 ± 42.2 b | 1448.0 ± 54.8 a | 1237.6 ± 16.9 b | 18.890 ** (0.009) |
| Lightness | 78.2 ± 0.6 a | 67.5 ± 0.2 b | 64.4 ± 1.3 c | 459.553 *** (0.000) |
| Redness | 2.2 ± 0.1 b | 6.7 ± 0.0 a | 2.2 ± 0.0 b | 17959.000 *** (0.000) |
| Yellowness | 15.5 ± 0.1 b | 19.1 ± 0.0 a | 14.0 ± 0.1 c | 6139.000 *** (0.000) |

a All values are expressed as mean ± S.D. of three replicates.
b *** Significant at $p < 0.001$, respectively.
perform proper cooking for studying Sacha inchi. Three types of the cooking process were selected: uncooked, boiled at 100 °C for 13 minutes, roasted at 160 °C for 6 minutes. The results of present study indicated that Sacha inchi is distinguishable for its high content of minerals and FAs. Although the uncooked Sacha inchi contained minerals and unsaturated FAs higher than the boiled one due to a possible migration to theses trace elements into the water during boiling treatment, Sacha inchi cannot be consumed raw because of the astringency. More notably, 7 out of 9 elements and ω-3, ω-6, ω-7, and ω-9 unsaturated FAs studied in the roasted Sacha inchi were significantly higher than boiled and raw samples. This means roasting is a process for enhancing mineral and FA contents in Sacha inchi, whereas, boiling was found to have a significant detrimental effect on the nutrients evaluated. The result of this study shed light on preventing nutritional loss in with appropriate cooking methods. The achieved results showed that roasting treatment of Sacha inchi can become good or moderate dietary sources of important nutrients such as minerals and FAs, so their consumption should be increased, for the sake of healthier diet, considering also their high mineral contents and good FA compositions of seed origin. It could be concluded that roasting not only saves time but effectively retains and increased the nutritive values in the Sacha inchi. Further research should be focused on optimal roasting techniques, temperatures, and durations.

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