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Fatty acid in raw and heated coconut oil in eleven coconut oil food preparations analysed by gas chromatography

Emmanuela Prado de Paiva Azevedo [a,*,1,2], Eryka Maria dos Santos Alves [b,1], José Roberto Botelho de Souza [c,1], Katarynna Santos de Araújo [d,1], Samuel de Santana Khan [e,1], Carla Eliária Alves de Mendonça [e,1], Maria Inês Sucupira Maciel [e,1]

[a] *Rural Technology Department, Federal Rural University of Pernambuco, Dom Manoel de Medeiros St. N/n, Dois Irmãos, PC: 52171-900, Recife, PE, Brazil*
[b] *Nutrition Department, Federal University of Pernambuco, Prof. Moraes Rego Av. N/n, University Campus, PC: 50670-901, Recife, PE, Brazil*
[c] *Zoology Department, Federal University of Pernambuco, Prof. Moraes Rego Av. N/n, University Campus, PC: 50670-901, Recife, PE, Brazil*
[d] *Centre of Strategic Technologies of the Northeast, Prof. Luis Freire Av. N/n, University Campus, PC: 50740-545, Recife, PE, Brazil*
[e] *Consumer Sciences Department, Federal Rural University of Pernambuco, Dom Manoel de Medeiros St. N/n, Dois Irmãos, PC: 52171-900, Recife, PE, Brazil*

A R T I C L E I N F O

Keywords:
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Dry heat
Moist heat
Medium-chain fatty acids

A B S T R A C T

The study evaluated the fatty acid profile of raw and heated virgin coconut oil by using eleven food preparations submitted to two treatments: dry and moist, and crude and heat. The fat extraction was performed by the Soxhlet method and the fatty acid profile was analysed using gas chromatography. Kuskal-Wallis test was utilised to evaluate the differences among food preparation methods. The lauric acid was present in the coconut oils analysed (16.07g/L ± 1.28) and in all the preparations in which coconut oil was used. The highest concentration of lauric acid was found in Corn starch cookies (16.60g/L ± 0.32). The cookie and the cake were the preparations that showed the lowest concentration, 6.14 g/L ± 0.05 and 5.05 g/L± 0.05, respectively. The results obtained in this study are unprecedented and enable professionals in the field of food and nutrition to prescribe the best usage of coconut oil in cooking.

Introduction

Coconut oil belongs to the group of edible oils being obtained from the kernel or coconut meat. It is a natural source of lauric acid in proportions ranging from 45 to 50%, making coconut oil a unique product for the presence of this fatty acid (HAMSI, 2015). Lauric acid, a vegetable-exclusive oil found mainly in coconut oil, palm kernel oil and laurel oil, has been studied, compared to other fats and linked to the improvement of fat-free mass, plasma HDL-C and insulin sensitivity in men. Benefits like these corroborate with increase in the recommendation of coconut oil and coconut milk consumption, products commonly consumed in some Asian countries (KORRAPATI, 2019).

The lauric acid is a medium chain fatty acid which is liquid at room temperature. It has a low melting point, and low energy density, presenting 0.8 kcal less than fatty acids in general. This set of characteristics influences the way in which this fatty acid is absorbed and metabolized in the body (DAYRIT, 2014). Due to its discussed therapeutic value, coconut oil has become popular with a significant increase in its consumption.

Oils rich in saturated fats, such as virgin coconut oil, do not go through purifications or fractionation processes, therefore preserving their nutritional quality. In addition to that, they have a low amount of polyunsaturated fatty acids, which reduces the oxidation of these fats - even when exposed to oxygen and light (NEVIN, 2008; BABU, 2014).

Studies with domestic and industrial cooking using coconut oil show that the use of this oil produces less thiobarbituric acid reactive substances during the heating process, indicating that coconut oil undergoes less oxidative stress during cooking (PRABHU, 2000; HAMSI 2015).

Among all fatty acids, lauric acid may contribute to the lowest accumulation of adipose tissue. These properties of lauric acid are consistent with observations that coconut oil is a source of energy that

* Corresponding author.
E-mail address: paiva.ufrpe@gmail.com (E.P.P. Azevedo).
[1] These authors contributed equally to this work.
[2] EPPA and EMSA are the Senior Authors.

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may not directly influence in body weight gain (NEVIN, 2006; SARASWATHI et al., 2020).

The metabolism of lauric acid and palmitic acid has been studied and compared in order to identify the establishment of the biological benefits cited to lauric acid, among them as mitochondrial dysfunctions e metabolic, as mentioned by Tham and collaborators (2020) who confirmed insulin resistance and mitochondrial biogenesis for palmitic acid consumption and the reverse for lauric acid consumption.

Lauric acid has the highest antimicrobial activity among all saturated fatty acids against Gram-positive bacteria, some viruses and fungi. These compounds are unique in their ability to prevent the development of microbial resistance that may be due to their multiplicity of antimicrobial actions, which include cell wall disruption and interference from cell signalling and transcription. Numerous beneficial effects have been claimed for coconut oil such as cardioprotective effect (BABU et al., 2014), alleviation of symptoms related to Alzheimer's disease (BANSAL et al., 2019), attenuator of obesity and its metabolic and inflammatory alterations (ZICKER, 2019), among others. The medium-chain fatty acids (C6–C12) have shown to be promising for their metabolic and physiological properties (MARINA, 2009).

However, there are no studies that have evaluated the availability of their fatty acids, especially of lauric acid in the cooking and food preparation processes. The data on its properties are still limited, therefore, the aim of this study was to evaluate the fatty acid profile and to identify them in virgin coconut oil, in heated coconut oil and in eleven food preparations submitted to cooking by dry heat, moist heat and a food preparation without the use of heat.

Material and methods

Samples and reagents

Three samples of virgin coconut oil from different brands, and the other ingredients were purchased at the local supermarket, located in the metropolitan region of Recife, in the state of Pernambuco, Brazil. The criterion of purchase was the shelf life and the description of the ingredients according to the recipes used in this study.

Samples were in their own packaging, polyethylene (PE) or PET bottles, and the manufacture dates shown were according to each manufacturer's production date. The preparations containing coconut oil used the following ingredients: extra virgin coconut oil, wheat flour, chicken eggs, salt, sugar and vegetables-. The food preparations were chosen according to 4 factors: the cooking method and the type of heat it uses (1, 2), the least ingredients used in the recipes (3) and also how often they are used in the local gastronomy (4). In this way, the preparations chosen were: *Acarajé*, orange cake, cornstarch cookies, chocolate chips cookies, popcorn, cheese biscuits, Samosa dough, mayonnaise, white cream sauce, *Hollandaise* sauce and *Ceviche*. The techniques used to make the different food preparations are described in item 2.2. Fatty acid standards with chromatographic purity or purity greater than 99% were used. They were: C8: 0 = octanoic acid, C10: 0 = decanoic acid, C12: 0 = dodecanoic acid, C14: 0 = myristic acid, C16: 0 = palmitic acid, C18: 0 = stearic acid, C20: 0 = arachidic acid, C22: 0 = nervonic acid, C24: 0 = lignoceric acid, C14: 1 = myristoleic acid, C16: 1 = palmitoleic acid, C18: 1 = oleic acid, C18: 2 = linoleic acid, C18: 3 = linolenic acid and C20: 1 = eicosenoic acid purchased from SIGMA®. The water used was obtained from a Milli-Q ultra-purification system (Millipore, Bedford, MA, USA).

Food preparations

The preparations submitted to dry and moist heat used three cooking methods: conventional oven, deep frying and water bath. There was also a food preparation without heat applied. The recipes were elaborated following the techniques obtained from the recipe book "*Professional Chef*" (2017). The recipes are described below:

Acarajé

500 g of black-eyed beans (*Vigna unguiculata*) were placed in a food processor and processed for a few seconds just to break them, but being careful not to grind the beans. Following that, they were placed in a small container, covered with water and left to soak for no longer than 12 h. After the soaking time, with the help of a spoon, the peels from the beans were removed by pressing the beans on a small plastic sieve. When most of the peels were removed, the beans were rinsed with running water for the peeling process to be continued, removing as much peels as possible, until there were no peels left on the beans. The beans were then set aside. 500 g of peeled onions were cut into large pieces, put inside a food processor with the beans and grinded for 3 min, or until a smooth and uniform paste was obtained. The paste was removed from the food processor and put inside a deep, large bowl. With the aid of a wooden spoon, the *Acarajé* paste was mixed until it tripled in volume. The coconut oil (500 mL) along with one whole onion with the peel (160 g) was put inside a medium sauce pan, which was brought to high heat. The *Acarajés* were shaped using two tablespoons: some of the paste was taken with one of the spoons and transferred to the other using the first spoon, repeating the process until it had a smooth surface. The shaped *Acarajés* were put inside the pan with the already hot coconut oil for deep frying at 170 °C. They were fried for 3 min on one side, turned over with the help of a skimmer and fried until golden brown. The oil temperature was monitored when necessary. The *Acarajés* were removed from the oil with a skimmer and placed on absorbent paper to remove excess oil.

Orange cake

4 medium eggs (180 g), 400 g of sugar, 470 mL of coconut oil, 100 mL of orange juice and 15 g of orange peel were homogenised in the blender. The mixture was then transferred to a bowl where 250 g of wheat flour and 9 g of baking powder were added, homogenising everything again. The final mixture was poured into a greased and floured Bundt pan and baked in a conventional oven for 45 min at 185 °C. After baking, the cake was removed from the pan and moistened with orange juice.

Corn starch cookies

500 g of corn starch, 40 mL of coconut oil, salt to taste, 2 lightly beaten large eggs (100 g) and 9 g of baking powder were placed inside a bowl. All the ingredients were hand mixed and, when necessary, more corn starch was added to give consistency to the dough. After mixing, the dough was kneaded on a smooth surface. The cookies were shaped using the hands rolling small amounts into balls and then lightly pressing them with a fork. They were then placed in a rectangular greased and floured baking pan, and put inside a preheated oven at 200 °C for 20 min.

Cookie

At first, the oven was preheated at 180 °C. 470 mL of coconut oil, 200 g of white sugar and 220 g of brown sugar were placed in a bowl and mixed with a spatula until homogenised. 9 g of baking sodawas dissolved in warm water and mixed along with 1.2 g of salt and 2.5 g of vanilla essence. This mixture was poured into the sugar mixture. 500 g of wheat flour were added gradually and mixed to make the cookie dough. A tablespoon was used to regulate the amount of dough used for each cookie, reasonably separated from each other inside the pan. A greased and floured rectangular baking pan was used to bake the cookies. The cookies were baked for about 45 min at 185 °C or until they obtained a soft golden colour.

Popcorn

40 mL of coconut oil, 50 g of popcorn and salt to taste were placed in a covered pan, mixed and left over low heat until all the corns popped and turned into popcorn.

Cheese biscuits

In a large bowl 1 kg of wheat flour, 700 mL of coconut oil, salt to taste and 100 g of grated Parmesan cheese were mixed. Then the dough was kneaded using the hands until it was smooth and stopped sticking on the fingers. The cheese biscuits were shaped in small balls of 15 g, placed in a greased pan and baked in a conventional oven at 180 °C for approximately 20–25 min.

Samosa dough

350 g of wheat flour, 60 mL of coconut oil and salt to taste were placed in a medium bowl. 240 mL of warm water was slowly added and mixed. The mixture was kneaded using the hands until a homogeneous dough was obtained and divided into small balls of 60 g which were then rolled out thick with a rolling pin. The samosas were then transferred to a greased and floured rectangular pan and, unlike the usual deep frying, they were baked in a medium heat conventional oven at 190 °C until they were golden brown on both sides.

Mayonnaise

The yolk of one large 50 g egg, 6 drops of lemon juice, salt and black pepper to taste were put inside a bowl and mixed using a fouet. The coconut oil was added very slowly as the mixture was being beaten, with a constant stream of oil, until it had the consistency of mayonnaise. When reaching the desired texture, 5 g of mustard and 25 g of minced garlic gloves were added and mixed again.

White sauce

In a medium sauce pan, 25 g garlic and 85 g of onion were minced and sauté in 40 mL of coconut oil at 170 °C. After that, the heat was lowered to 160 °C and 27 g of wheat flour were added and mixed. 200 mL of milk was gradually added as the mixing continued and salt to taste was added as the sauce was being stirred until it thickened. The heat was lowered to 150 °C and the sauce was left to cook for 5 min. The pan was removed from the heat followed by the addition of 50 g of grated Parmesan cheese and more mixing.

Hollandaise sauce

In a bowl with 90 mL of water, the yolk from 3 large 50 g eggs, salt and freshly ground black pepper to taste and 50 mL lemon juice were added. The ingredients were all beaten using a fouet, until the mixture was foamy and homogeneous. The bowl was placed on top of a pan with water on a heating source at around 160 °C to mimic a water bath on a cooktop. The mixture was beaten again with a fouet until it obtained a creamy texture, but being careful not to cook the egg yolks. The pan was removed from the heat source and, instead of butter, 250 mL of coconut oil was gradually added, as the sauce was still being beaten with the fouet. The mixture continued to be beaten until the sauce gained *Hollandaise* structure and taste.

Ceviche

The kernel of two medium green coconuts and 120 g of red pepper cut into strips, 50 mL of lemon juice, salt and ground peppers to taste and 50 mL of coconut oil were mixed in a bowl and left to marinate for about 15 min.

Analysis of fatty acids by gas chromatography

Fat extraction

To extract the fat, 25 mg of oil or the prepared food was weighed and 500 μL of KOH methanolic solution (0.5 M) added to it and vortexed for 2 min. Following that, 2 mL of analytical grade n-hexane was added and vortexed again for 2 min. The sample was then centrifuged at 4500 rpm for 6 min at room temperature (25 °C) and approximately 1.5 mL of the supernatant was removed and filtered with a 0.22 μm membrane. The samples were conditioned in a freezer (-20 °C) until the chromatographic analysis was performed (AOAC, 2012). All determinations were performed in triplicate.

Table 1

Mean (±SD; n = 3) Concentration of fatty acids, in grams per litre, of samples of virgin coconut oil and coconut oil submitted to water bath, deep frying and conventional oven. Fatty acids were identified using external standards. C_8:0 = octanoic acid, C_{10}:0 = decanoic acid, C_{12}:0 = dodecanoic acid. Letters denote significant differences between treatments, $p < 0.05$.

Coconut oil	Fatty acids (g/L)		
	C8:0	C10:0	C12:0
Virgin coconut oil			
Brand A	$2.48^{a} \pm 0.13$	$2.12^{a} \pm 0.10$	$15.18^{a} \pm 0.99$
Brand B	$2.64^{a} \pm 0.21$	$2.17^{a} \pm 0.20$	$15.51^{a} \pm 1.86$
Brand C	$2.52^{a} \pm 0.49$	$2.45^{a} \pm 0.30$	$17.54^{s} \pm 2.69$
Coconut oil submitted to cooking methods			
Deep frying	$2.72^{a} \pm 0.13$	$2.27^{a} \pm 0.10$	$16.33^{a} \pm 0.85$
Conventional Oven	$2.61^{a} \pm 0.15$	$2.12^{a} \pm 0.12$	$15.52^{a} \pm 1.10$
Water bath	$2.86^{a} \pm 0.11$	$2.39^{a} \pm 0.09$	$17.49^{a} \pm 0.86$

Chromatographic conditions

The analyses to determine the fatty acid profile of the virgin coconut oil, both fresh and heated, and after being used in food preparations submitted to different cooking methods, were carried out in a gas chromatograph with flame ionization detector (FID), Model Trace GC, (Thermo-Finnigan®), equipped with autosampler, model AS 3000, (Thermo-Finnigan®) and DB-5ms (30 m length × 250 μm diameter × 0.25 μm) column. Helium was used as the carrier gas with the flow rate of 1 mL/min, having the synthetic auxiliary air at a flow rate of 350 mL/min and hydrogen at 35 mL/min. The following operating conditions were used: initial temperature of 80 °C without initial isotherm, heating rate of 10 °C per minute with a maximum temperature of170 °C without isotherm. New heating rate of 3 °C per minute with a maximum temperature of 230 °C, with isotherm for 24 min, resulting in a total analysis time of 53 min. The split injection with 1:50 rate was used and the injector temperature was at 250 °C, while the FID detector (flame ionization detector) was operated at 255 °C (AOAC, 2012).

Identification was performed by comparing sample retention times with the standard. The quantification was performed by external standardisation of the individual standards. The calibration curve was constructed in the range of 8,0 to 1,0 g/L for octanoic acid r = 0,983; 12.0 to 1.5 g/L for decanoic acid, r = 0.992 and 18.0 to 3 mg/L for dodecanoic acid, r = 0.985. The analyses for the determination of fatty acids by gas chromatography were developed at the Centre of Strategic Technologies of the Northeast - CETENE of the Ministry of Science, Technology, Innovations and Communications (MCTIC).

Statistical test

The Kruskal-Wallis test was used to evaluate the differences among treatments after the normality and homoscedasticity test. The preparations were grouped in control (treatment 1), dry heat (treatment 2) and moist heat or by addition of water (treatment 3). Among the treatments, the z test of multiple comparisons was performed for independent samples. Statistica 7.0 software (StatSoft, Tulsa, USA) was used to perform the tests at the 5% level of significance.

Results and discussion

Profile of fatty acids of virgin coconut oil and coconut oil submitted to the cooking methods

The fatty acids octanoic, decanoic and dodecanoic presented significant differences among them (Table 1).

The profile of the fatty acids was similar to the lipid composition of coconut oil reported in previous studies (NEVIN & RAJAMOHAN, 2004; MARINA, 2009; PEEDIKAYIL, 2015). The fatty acid with the highest concentration was the dodecaenoic acid (C12:0) and, according to the

Table 2
Mean (±SD; n = 3) Concentration of fatty acids, in grams per litre, of the food preparations submitted to dry heat; the fatty acids were identified using external standards. C_8:0 = octanoic acid, C_{10}:0 = decanoic acid, C_{12}:0 = dodecanoic acid.

Samples	Fatty acids (g/L)		
	C8:0	C10:0	C12:0
Acarajé	2.28 ± 0.04	1.99 ± 0.04	13.50 ± 0.53
Cake	1.10 ± 0.04	1.01 ± 0.00	5.05 ± 0.05
Corn starch cookies	2.33 ± 0.10	2.12 ± 0.04	16.60 ± 0.32
Cookies	1.15 ± 0.02	1.07 ± 0.00	6.14 ± 0.05
Cheese biscuits	2.10 ± 0.07	1.90 ± 0.04	12.41 ± 0.34
Samosa dough	2.34 ± 0.05	2.07 ± 0.06	14.11 ± 0.38
Popcorn	2.18 ± 0.03	1.90 ± 0.04	12.47 ± 0.39

data presented (Table 1), its content remained around 15.51 g/L ± 1.86 being considered the main saturated medium-chain fatty acid in coconut oil (NEVIN & RAJAMOHAN, 2004; KUMAR, 2011; DEBMANDAL et al., 2011; PEEDIKAYIL, 2015; MANIVANNAN, 2018). Myristic acid (C14:0) is the second most present fatty acid (19.58% ± 0.30), confirming that the oil extracted from the coconut pulp is composed mainly (more than 50%) of medium-chain saturated fatty acids corroborating with the results of the study developed by Ibrahim et al. (2019).

As for the cooking methods applied, the results shown in Table 1 showed no significant difference in octanoic (C8:0), decanoic (C10:0) and dodecanoic (C12:0) fatty acids between virgin coconut oil and the coconut oil, by itself, submitted to the cooking methods (deep frying, conventional oven and water bath). Even when comparing the different heat treatments, the fatty acid content remained similar to that reported in virgin coconut oil, confirming the thermal stability profile of the saturated fats in the coconut oil.

The results confirm that the coconut oil submitted to the cooking methods, in the absence of other ingredients that could interfere in its stability, maintained its fatty acid content similar to those profiles found in the same raw matrix, proving the little interference of the time and the type of heat used on this vegetable oil. There are no reports in the literature on the stability of octanoic, decanoic and dodecanoic fatty acids present in coconut oil exposed, by itself, to a variety of cooking methods.

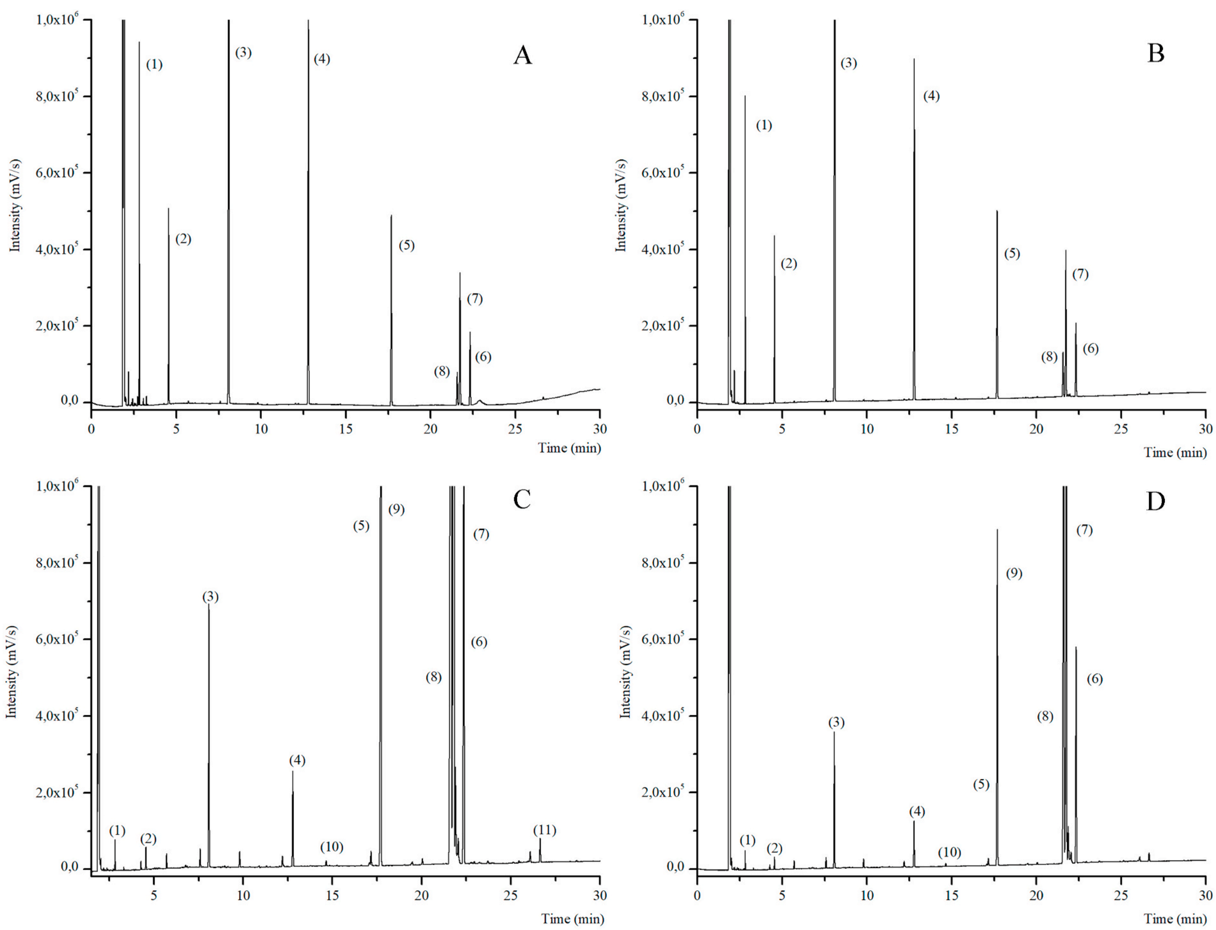

Fig. 1. Chromatograms of the fatty acids profile in *Acarajé* (A), cheese biscuit (B), cookie (C) and cake (D) samples.
Peak 1: C8:0 =
octanoic acid, Peak 2: C10:0 =
decanoic acid, Peak 3: C12:0 =
dodecanoic, Peak 4: C14:0 =
myristic acid, Peak 5: C16:0 =
palmitic acid, Peak 6: C18:0 =
stearic acid, Peak 7: C18:1 =
oleic acid e Peak 8: C18:2 =
linoleic acid, Peak 9: C:18:3 linolenic acid, Peak 10: C:16:1 palmitoleic acid an
Peak 11: C:20:0 arachidic acid.

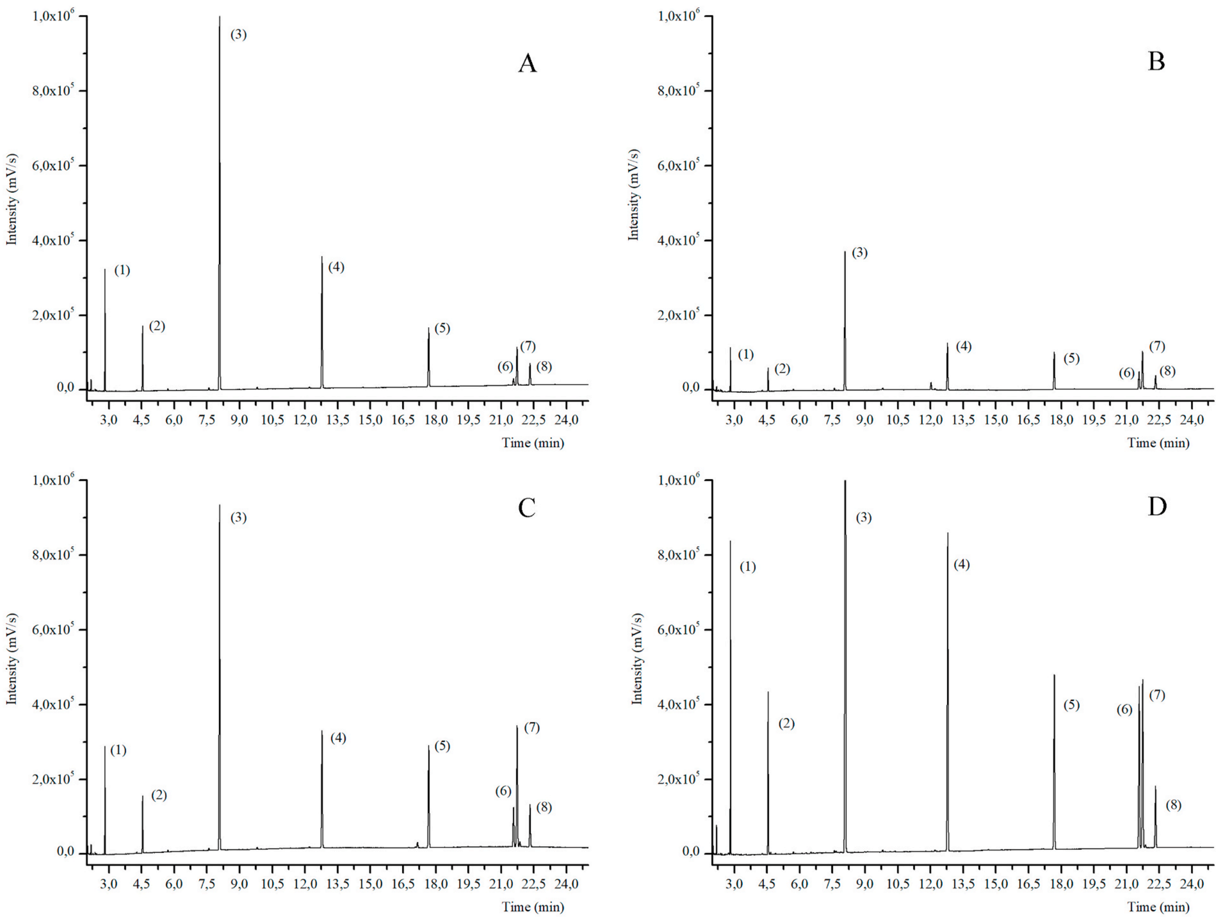

Fig. 2. Chromatograms of fatty acids profile in *Ceviche* (A), White sauce (B), *Hollandaise* sauce (C) and popcorn (D) samples.
Peak 1: C8:0 = octanoic acid, Peak 2: C10:0 = decanoic acid, Peak 3: C12:0 = dodecanoic, Peak 4: C14:0 = myristic acid, Peak 5: C16:0 = palmitic acid, Peak 6: C18:0 = stearic acid, Peak 7: C18:1 = oleic acid e Peak 8: C18:2 = linoleic acid.

Evaluation of the retention of fatty acids from coconut oil used in food preparations submitted to the different cooking methods

Table 2 shows the concentrations (g/L) of octanoicacid (C: 8), decanoicacid (C: 10) and dodecanoic acid (C: 12) found in the coconut oil-containing preparations submitted to dry heat.

Among the preparations, it was observed that the corn starch cookies, Samosa dough, *Acarajé*, popcorn and cheese biscuits had the highest concentrations of dodecanoic acid (C12:0), from highest to lowest, in this order, followed by the highest concentrations of fatty acids for octanoic acids (C8:0) and decanoic (C10:0), respectively. The cookie had the lowest concentration of dodecanoic acid (6.14 g/L $\pm$ 0.05) followed by the orange cake (5.05 $\pm$ 0.05).

The food preparations containing coconut oil submitted to dry heat showed the same levels of octanoic, decanoic and dodecanoic acids observed in the virgin coconut oil when submitted, in an isolated way, to the same cooking method (Table 2 and Fig. 3), except for the orange cake and cookie preparations. For these two preparations, the lowest concentrations observed for dodecanoic acid can be explained by the longest cooking time applied (45 min), thus exposing the samples to heat for a longer time in comparison to the time used for the other elaborations. The time that the food is submitted to heat directly influences the process of lipid oxidation and, consequently, the content of dodecanoic acid. Researchers proved that the time-temperature binomial influences on lipid oxidation, showing that the reduction of the heating time decreases the lipid deterioration from oxidation (PRABUH, 2000).

Deep frying is an efficient method for the preservation of fatty acids, as observed for *Acarajé*, because of its quick cooking time. The main characteristics of this process are high temperature and rapid heat transfer, so this explains the low impact of deep frying in the reduction of the dodecanoic acid content in the *Acarajé*.

When comparing the composition of the coconut oil samples obtained in this study with the preparations listed in the Brazilian Table of Food Composition () it was possible to observe that the traditional *Acarajé* without coconut oil showed only traces of dodecanoic acid (0.10g/100 g) and also no information regarding other medium-chain fatty acids were found. Popcorn prepared with soybean oil did not show any amount of medium-chain fatty acids, such as dodecanoic acid. For the other preparations submitted to dry heat, no dodecanoic acid contents were reported in the Brazilian Food Composition Table (TACO).

Fig. 1 shows the chromatographic profile of *Acarajé*, cheese biscuits, cookie and orange cake, respectively. A greater variety of fatty acids is observed in the cookies and the cake when compared to the *Acarajé*,

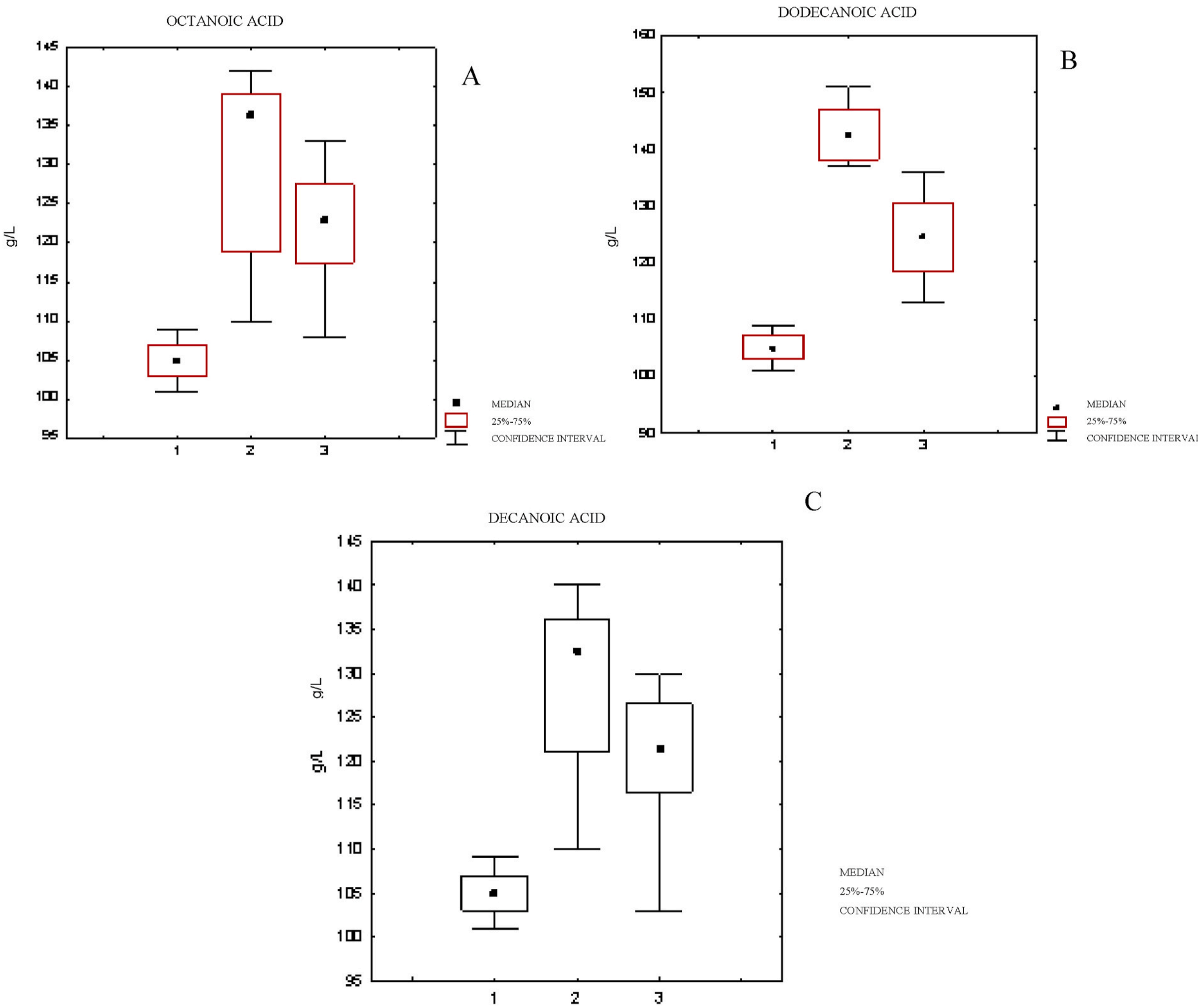

Fig. 3. Boxplot by groups. From left to right and down: octanoic acid (A), dodecanoic acid (B) and decanoic acid (C) and their evaluation of the cooking method used. 1 =
Water Bath; 2 =
Deep frying and 3 =
Conventional oven.

showing that in addition to the time and type of cooking method applied for the cookies and cake. The complexity and types of fatty acids present in the food matrix may be one of the possible causes of the bioavailability decrease of lauric acid in these food preparations (GREGORY, 2017; NIEVA-ECHEVARRÍA et al., 2017).

The concentrations (g/L) of octanoic acid (C:8), decanoic (C:10) and dodecanoic acid (C:12) found in the coconut oil-containing preparations submitted to moist heat and without heat are presented in Table 1.

Fig. 2 shows the fatty acid profile of *Ceviche*, white sauce, *Hollandaise* sauce and popcorn.

Out of all the samples without heat and submitted to moist heat, it was observed that the *Hollandaise* sauce had the highest concentration of dodecanoic acid (6.79 ± 0.20) followed by the white sauce (*Ceviche* (6.83 ± 0.67). The lowest concentrations for the same fatty acid were observed for the white sauce (5,25 ± 0,41) followed by the mayonnaise (4.26 ± 0.14).

The preparations containing coconut oil submitted to moist heat presented a profile of preservation of octanoic and decanoic acids. For dodecanoic acid, unlike reported for virgin coconut oil (Table 1 and Fig. 3) and in the dry heat coconut oil preparations (Table 2 and Fig. 1), the moist heat preparations showed the lowest concentrations of dodecanoic acid meaning that the amount of water present in the food preparation influenced the content of that fatty acid.

Table 3
Concentration of fatty acids of food preparations submitted to moist heat and without heat are shown in grams per litre.

Samples	Fatty acids (g/L)		
	C8:0	C10:0	C12:0
Mayonnaise[a]	1.23 ± 0.04	1.03 ± 0.01	4.26 ± 0.14
White sauce[a]	1.21 ± 0.04	1.09 ± 0.05	5.25 ± 0.41
Hollandaise sauce	1.41 ± 0.02	1.26 ± 0.02	6.79 ± 0.20
Ceviche[a]	1.42 ± 0.06	1.26 ± 0.07	6.83 ± 0.67

±SD = Standard Deviation; Medium = average calculation of 3 samples (n = 3); the fatty acids were identified using external standards C_8:0 = octanoic acid, C_{10}:0 = decanoic acid, C_{12}:0 = dodecanoic acid.
[a] No heat applied.

For mayonnaise and *Ceviche*, as shown in Table 3, considering that both were not affected by heat, the lower levels of dodecanoic acid can also be attributed to the presence of water in these preparations; which/ raises catalytic activity and, subsequently, the risk of oxidation and degradation of fatty acids as the amount of water increases (DECKER et al., 2017).

By analysing the composition of the samples with the food preparations listed in the Brazilian Table of Food Composition (), the traditional mayonnaise without coconut oil showed no traces of dodecaenoic acid. Comparison with other medium-chain saturated fatty acids in the preparations established by TACO was not possible, since TACO does not contain values related to the quantification of C8:0 and C:10 nor does it cover all preparations elaborated in this study, hence being unable to compare the data obtained in the samples of this study with the Brazilian reference values.

The availability of fatty acids is strongly influenced by the efficiency in which they are released from the food matrix structure. In this case, the cooking method is a factor that influences the extraction of the nutrient from the complex formed with other food components. On the other hand, the concentration of these nutrients may also be influenced by the possibility of degradation while cooking due to oxidation reactions.

Therefore, the use of a cooking method for extraction and better accessibility to the nutrients of food matrices with a more complex structure may be interesting, but the cooking time, the temperature, the presence of water in the food and the type of heat applied must be observed to minimize or even avoid the loss of compounds that are more sensitive to heat and oxidation (GREGORY, 2017; MAIANI, 2009).

The results presented in this study are thus unprecedented and very useful, especially when it comes to dietary guidance about cooking techniques applied to the coconut oil so to avoid a reduction on its nutritional value when consumed.

Conclusions

The profile of the fatty acids present in coconut oil is modified by the addition of other ingredients. Pure coconut oil submitted to common heating does not change its fatty acid profile. Among the preparations, it was observed that the corn starch cookies, Samosa dough, *Acarajé*, popcorn and cheese biscuits showed the highest concentrations of dodecanoic acid. The preparations containing coconut oil submitted to dry heat had the same levels of octanoic, decanoic and dodecanoic acids observed for the virgin coconut oil when submitted, by itself, to the same cooking method. The preparations submitted to moist heat had the highest losses of fatty acids, especially dodecanoic acid. The results presented in this study are unprecedented, especially with regard to the dietary guidance about the cooking techniques to be used for coconut oil.

Author statement

The author (s) declare (s) that the aforementioned academic work is original and of his authorship, with the exception of elements, such as text passages, figures, dates, which clearly identify the original source, making it explicit as appropriate authorizations owners when needed.

Declaration of competing interest

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