

Full Length Research Paper

Chemical and physico-chemical characterization of seeds of melon cultivars: Valenciano and Pele de Sapo, cultivated in the Amazon

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The aim of this work was to perform chemical and physical-chemical analyzes of the oil of the cultivars Valenciano Amarelo melon (VA) and *Pele de Sapo* melon (PS) (*Cucumis melo* L.) produced in Boa Vista, Roraima, Brazil, by GC -FID, IR, ¹H NMR and the thermogravimetric behavior TG/DTG as well as yield of that obtained oil. Thus, the oil yield of Valenciano melon seeds was 28.47% and that of Pele de Sapo melon was 26.41%. The chemical composition of the oils of the two cultivars presented major fatty acids, such as palmitic acid, linoleic acid (57.5-59.4%) and oleic acid (22.8-23.3%). The physico-chemical characterization of these oils showed for Valenciano melon and Pele de Sapo melon, respectively, 125.02 and 120.96 g I₂ 100 g⁻¹ for the iodine value and 187.80 and 185.65 mg KOH g⁻¹ for saponification index. The behavior of the thermal degradation by TG/DTG of the melon seeds oils VA and PS occurred between 341.08 and 522.03°C, and 334.83 and 524.29°C, respectively.

Key words: Oleic acid, cucurbitaceas, biotechnology, essential fatty acids.

INTRODUCTION

Melon is one of the olerícolas belonging to the family Cucurbitaceae, genus *Cucumis*. It is an herbaceous and

creeping plant of African origin (Bisognin, 2002), cultivated mainly in India and in tropical countries, with

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varieties and cultivars (Mansouri et al., 2015), introduced in Brazil by the Europeans in the decade of the 60s (Frizzone et al., 2005).

Melon cultivation is carried out in regions with a very dry and bright climate good drainage soil and temperature ranging from 25 to 35 °C. The temperature and luminosity favor the sweetest and tasty fruits, as it helps the sugar production. The variations of melon grown in Brazil, have pleasant organoleptic characteristics, highlighting the pleasant aroma (Senar, 2007).

Melon cultivars found in Brazil are Honey Dew, Pele-de-sapo, Orange Flesh, Cantaloupe, Gália, Orange and an AF-522 hybrid commercially classified as a yellow melon type (Melo et al., 2000). The main melon growing regions for the year 2013 were the San Francisco Valley (Pernambuco and Bahia), Rio Grande do Norte and Ceará in a total of land area of 14,950 hectares (2,950 in the São Francisco Valley and 12,000 in the Rio Grande do Norte and Ceará) from August /2013 to March / 2014 (Nascimento, 2014). Among the melons cultivated in Brazil, the cultivars of the odorless group, represented by the Valenciano and Pele-de-sapo types, are preferred by the producers, totaling about 90% of the planted area (Nunes et al., 2005).

In the food industry, after the use of fruit pulps the seeds of these fruits are discarded in the environment. This is due to the lack of alternatives to the use of these vegetable residues, being used as organic fertilizers or animal feed, without adequate treatment (Miguel et al., 2008). These seeds could be used as an alternative source of socioeconomic value and by generating employment and income through vegetable (Kobori and Jorge, 2005; Uchoa et al., 2008).

In this work, the chemical composition and physicochemical properties of fatty acids extracted from the seeds of two varieties of melon (Valenciano and Pele-de-sapo) cultivated in the State of Roraima in Brazil were studied in order to be used as a biotechnological source for the production of other derivative products.

MATERIALS AND METHODS

Material and extraction of oil

Samples of the two melon cultivars were collected at the producer's fair in Boa Vista-Roraima (Brazil) in March 2015, in total 10 melons of each species with good appearance and in a ripe state suitable for consumption and taken to the Laboratory of Environmental Chemistry of the Graduate Program in Chemistry of the Federal University of Roraima the seeds were separated, washed with distilled water and dried in an air circulating oven at 50 °C for 48 hours until constant weight. After drying the seeds were ground and sieved in a 30-40 mesh sieve. The extraction of oil, was done in a Soxhlet extractor using cellulose cartridges covered with hydrophilic cotton and anhydrous sodium sulfate to control excessive humidity (Jorge and Luzia, 2012).

The solvent was hexane, the contact time between the solvent and the sample was 3 hours. The solvent was removed using a

rotary evaporator to give melon seeds oil as the final product. The reagents and solvents were in analytical purity in all procedures performed. The oils were stored in amber flasks in an atmosphere of gaseous nitrogen in order to protect the oil and conserve its properties. These were refrigerated until further analysis.

Profile of fatty acids by CG-FID

Free fatty acids were measured by Gas Chromatography using HP7820A (Agilent) system equipped with flame ionization detector. An Innowax column (HP) 15 m × 0.25 mm × 0.20 µm was used and the following temperature gradient: 100 °C min and 0.7 °C min⁻¹ up to 240 °C; injector (1/30 split) to 250 and 260 °C detector. Hydrogen was used as carrier gas (3 mL min⁻¹) and injection volume was 1 µL. The data acquisition program used was EZChrom Elite Compact (Agilent). The peaks were identified using FAME Mix C14-C22, CRM18917 Supelco fatty acid methyl esters standard (Christie, 1989).

Physicochemical properties of the oil by ¹H-RMN

In order to determine the physico-chemical properties of melon oil, the values of ¹H-RMN spectra, previously studied by Carneiro (2005) and Reda and Carneiro (2006) were utilized.

Thermal analyses (TG/DTG) were conducted on Shimadzu 60 DTG equipment using approximately 10 mg heated sample in an alumina crucible. The tests were performed with a heating rate of 10°C min⁻¹, from room temperature to 900°C, under nitrogen gas atmosphere (flow 50 mL.min⁻¹).

RESULTS AND DISCUSSION

Extraction yield

Table 1 shows the yields of the two varieties of melon studied in this work compared to the literature. The data are expressed as the mean value of the three readings with the standard deviation.

The density of the Valenciano melon seed oils was about 0.90 and 0.86 mg ml⁻¹, respectively. The values found in the seeds oil of the melon cultivars studied was in the range proposed by the literature, as shown by the yields of the oil of the Yellow Melon (Malacrida et al., 2007) and extraction of the Japanese Melon (Melo et al., 2007).

Among the cultivars studied, the Valenciano melon seeds had higher yields compared to the *Pele de Sapo* melon species. The oils obtained were yellowish with a sweet odor.

Determination of fatty acids in seeds using CG-FID

In Table 2, the fatty acid profile for the seeds of the two melon varieties compared to the literature is presented. The oils of the seeds of the cultivars Valenciano Melon and *Pele de Sapo* Melon, respectively, show an average composition of 81.00 and 83.00% for unsaturated fatty acids and 19.00 and 17.00% for saturated fatty acids.

Table 1. Oil yields for *Valenciano* and *Pele Sapo* melons.

| Sample | Valenciano melon | Pele de Sapo melon | Melão Amarelo (Malacrida et al., 2007) | Melão Japonês (Melo et al., 2007) |
|-----------|------------------|--------------------|---|--------------------------------------|
| Yield (%) | 28.47 ± 0.10 | 26.41 ± 0.09 | 25,2 ± 0,6 | 29 |

Table 2. Composition of fatty acids in the oils of the seeds of two melon cultivars by gas chromatography in comparison to the literature.

| Fatty acid | Valenciano melon (%) | Pele de Sapo melon (%) | P.E. (%) | A (%) | ANVISA |
|--------------------------------------|----------------------|------------------------|----------|-------|-------------|
| Miristic acids (C _{14:0}) | 0.1 | 0.1 | 0.22 | 0.13 | < 0.3 |
| Palmitic acid (C _{16:0}) | 10.2 | 9.3 | 11.08 | 28.29 | 5.5 - 11.0 |
| Margaric acid (C _{17:0}) | 0.1 | 0.1 | - | - | - |
| Oleic acids (C _{18:1}) | 22.8 | 23.3 | 19.32 | 49.74 | 12.0 - 28.0 |
| Linoleic acids (C _{18:2}) | 57.5 | 59.4 | 40.19 | 7.57 | 58.0 - 78.0 |
| Linolenic acids (C _{18:3}) | 0.7 | 0.3 | 0.61 | 1.49 | < 1.0 |
| Araquidic acids (C _{20:0}) | 0.3 | 0.2 | - | - | < 1.0 |
| Behenic acids (C _{22:0}) | 0.3 | - | - | - | - |
| Other | 8.0 | 13.1 | 0.42 | 1.49 | - |
| Saturated | 19.00 | 17.00 | 15.67 | 39.09 | - |
| Unsaturated | 81.00 | 83.00 | 84.3 | 60.91 | - |

The values obtained by the CG-FID for the composition of saturated fatty acids of the seeds oils of the cultivars *Valenciano* Melon and *Pele de Sapo* Melon shown in Table 2, present a very close composition with *Passiflora edullis* (Silva, 2011) and quite different from *Andiroba* (Farias, 2013).

Among the unsaturated fatty acids, the oils of the seeds of the cultivars *Valenciano* Melon, *Pele de Sapo* Melon and *Passiflora edullis* (Silva, 2011), the ω -9 acid presented very close values, whereas in *Andiroba* seed oil (Farias, 2013), the value found was higher than the others. The ω -6 oil of the seeds of the cultivars *Melão Valenciano Amarelo* and *Melão Pele de Sapo* presented values similar to those of the oil of the passion fruit *Passiflora edullis* (Silva, 2011), whereas in *Andiroba* seed oil (Farias, 2013), the value found was lower than the others.

A high content of linoleic acid was observed in melon seed oils which may characterize this oil as having nutritional properties and beneficial physiological effects in the prevention of diseases such as cancer and coronary heart disease (Azhari et al., 2014). The ω -3 oil of the seeds of the *Melão Valenciano Amarelo* and *Passiflora edullis* (Silva, 2011) seeds were similar. For the oil of the seeds of the cultivar *Melão Pele de Sapo*, the value obtained was lower than the former two, while for the *Andiroba* seed oil (Farias, 2013) the value found is superior to all.

As for the saturated fatty acid composition, palmitic acid presented the highest concentration followed by myristic acid for the oils studied and those in the literature.

Thermogravimetric analysis of melon seeds

Figures 1 and 2 present the TG / DTG curves of the melon seed oil where there is only one mass loss stage attributed to the volatilization and/or decomposition of triacylglycerides.

In the temperature range of 210 to 330°C, a low and continuous mass loss is observed. However, higher mass loss occurs at approximately 390°C, which can be attributed to the volatilization and/or decomposition of triacylglycerides (Garcia et al., 2004).

It was observed through the TG/DTG curves that the seed oils of the two melon species (Figure 1 and 2) undergo decomposition at temperatures below the stability temperatures of the oils. The oils analyzed presented an increasing order of stability as described below: *Melão Pele de Sapo* and *Melão Valenciano Amarelo*.

The analyzed oils had similar profiles with mass loss of 99.82 to 99.78%, where the process of volatilization and/or thermal decomposition occurred in a single stage, between 334 and 341°C, with a final temperature between 522 and 527°C (Table 3).

This similarity was observed in the curves profiles between the compositions of fatty acids in the oils of melon seeds which mainly present linoleic and oleic acids also known as omega-6 and omega-9 (Antolin and Meneses, 2000).

In comparison with other species such as *Andiroba* oil, a loss of mass of 96.16% was observed, while grape and soybean oils presented 97.02 and 94.49% of loss,

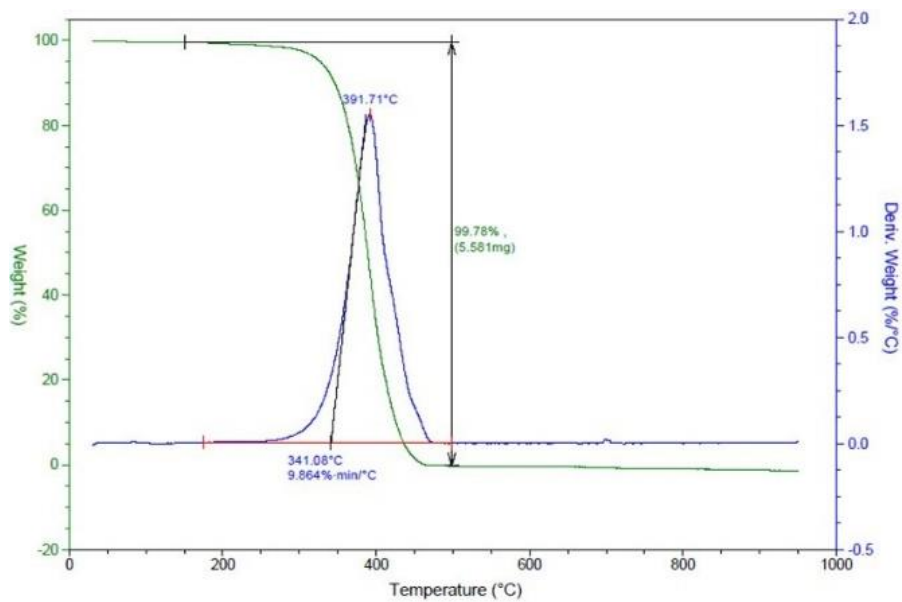


Figure 1. TG/DTG Yellow Valenciiano Melon.

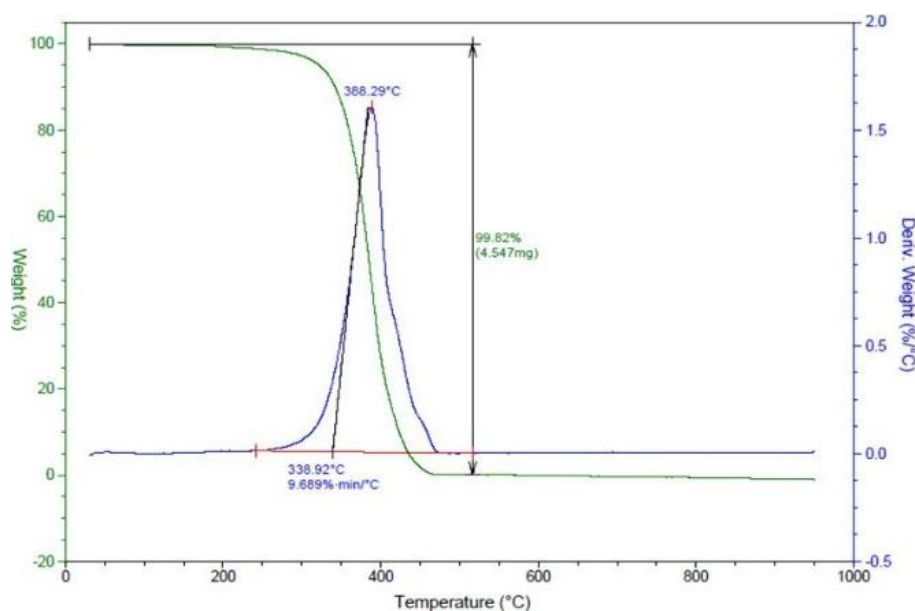


Figure 2. TG/DTG Pele-de-sapo Melon.

respectively, where the process of volatilization and/or thermal decomposition of the Andiroba oil was produced in the stages of 332.90°C with a final temperature of 641.78°C, and the Andiroba oil presented a thermal stability within the range found for the grape and soybean oils studied by Barreto (2009).

The profile of the curve of Figures 1 and 2 is due to the similarity between fatty acid compositions of the oils, which mainly present palmitic and oleic acid (Antolin and

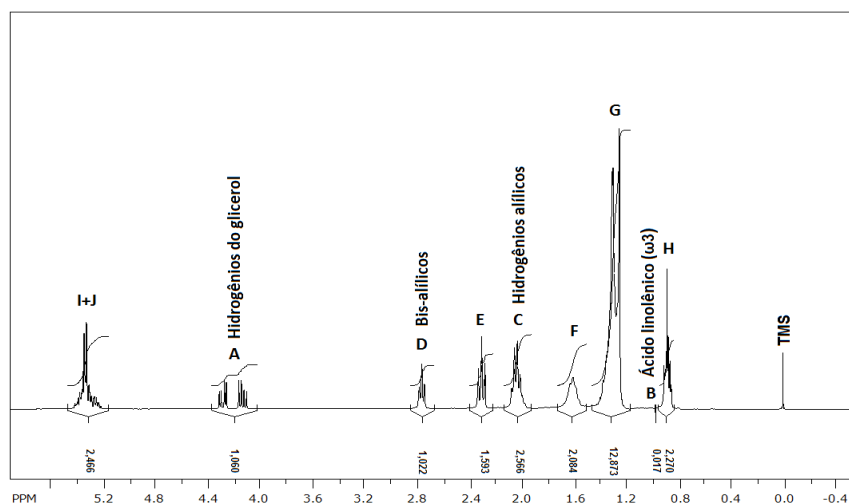
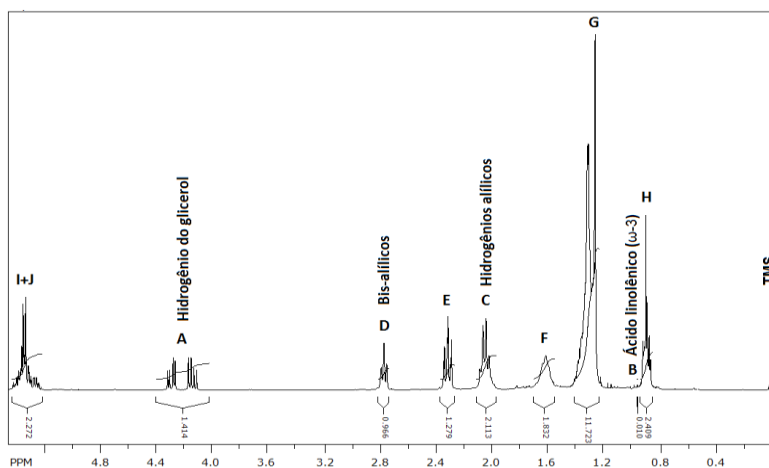
Meneses, 2000).

Samples of melon seed oil were found to follow a pattern, where the degradation started at 310°C and ended at approximately 527°C. At 527°C, mass loss of approximately 99.9% was found.

The results obtained by TG/DTG in nitrogen atmosphere showed that the thermal behavior of the oils of melon seeds was similar, especially with respect to the beginning and end temperatures of the degradation, for all the samples.

Table 3. Values for the different initial and final temperatures, ell as the values of mass loss obtained the TG/DTG curves.

| Sample | T _i (°C) | T _f (°C) | Weight loss (%) |
|--|---------------------|---------------------|-----------------|
| Valenciano melon | 341.08 | 522.03 | 99.78 |
| Peleda Sapo melon | 334.83 | 524.29 | 99.82 |
| Andiroba | 332.90 | 522.93 | 96.16 |
| White Niagara grape (Barreto, 2009) | 345.01 | 522.93 | 97.02 |
| Commercial soybean oil (Barreto, 2009) | 324.49 | 527.50 | 94.49 |

**Figure 3.** ¹H-NMR spectrum of *Valenciano* melon seeds.**Figure 4.** ¹H-NMR spectrum of *Pele Sapo* melon seeds.

Physicochemical properties of melon seeds by ¹H-NMR

The values of ¹H Nuclear Magnetic Resonance spectra (Figures 3 and 4) were used to obtain the acid number, iodine, and saponification of the average molecular mass of the seeds of the three melon cultivars according to the

equations previously studied by Reda and Carneiro (2006).

The iodine index indicates the degree of fatty acid instabilities present in vegetable oils; the greater the degree of saturation the more the oil becomes unfit for human consumption (Reda and Carneiro, 2006). The oil of the seeds of the two melon cultivars presented an

Table 4. Physical-chemical characterization of the oil of the seeds of two melon cultivars, in relation to the literature.

| Physical-chemical parameter | (mg I ₂ 100g ⁻¹) (II) | (mg KOH g ⁻¹) (IS) | (mg KOH g ⁻¹) (IA) | (g mol ⁻¹) (MM) | R _{o,A} |
|----------------------------------|---|-----------------------------------|-----------------------------------|--------------------------------|------------------|
| Valenciano Melon | 125.02 | 187.78 | 0.73 | 893.33 | 3.85 |
| Pele-de-sapo Melon | 120.96 | 185.65 | 0.75 | 902.33 | 3.64 |
| Crimson Sweet(Citrullus lanatus) | 101.04 | 193.47 | 0.17 | 869.14 | 0.93 |
| Andiroba(Caraca guianensis) | 48.41 | 161.67 | 1.84 | 1004.02 | 0.27 |

iodine content of 125.02 mg I₂ 100 g⁻¹ for the oil of the *Valenciano* Melon seeds and 120.96 mg I₂ 100 g⁻¹ for the oil of the *Pele de Sapo* Melon seeds.

In Table 4, the values of the oils of the seeds of the two melon cultivars were higher than that the Crimson Sweet watermelon seeds (*Citrullus lanatus*) studied by Holanda, (2013) and the oil of *Caraca guianensis* studied by Farias (2013). However, due to the low values of saturation index expected, it leads to the iodine index values being within the established values.

The saponification index is an approximate measure to establish the average molecular weight, being indicative of the presence of high and low molecular fatty acids (Solomons and Fryhle 2012; Morreto and Fett, 2008). The oil of the seeds of the two melon cultivars presented a saponification index of 187.78 mg KOH g⁻¹ for the oil of the *Valenciano* melon seeds and 185.65 mg KOH g⁻¹ for the oil of the *Pele-de-sapo* Melon seeds. The value found for the saponification index indicates that the oil of the Crimson Sweet watermelon seeds has a low degree of deterioration (Holanda, 2013).

The values found for the saponification index of the oils of the seeds of the two melon cultivars were lower than the oil of the Crimson Sweet watermelon seeds studied by Holanda (2013) and higher than the *Caraca guianensis* oil studied by Farias (2013).

The oil of the seeds of the two melon cultivars had an acid value of 0.73 mg KOH g⁻¹ for the oil of the *Valenciano* Melon seeds and 0.75 mg KOH g⁻¹ for the oil of the *Pele-de-sapo* Melon seeds respectively. The observed values from this study were higher acidity index than the value found in Crimson Sweet watermelon oil (Holanda, 2013) and lower than the value found in *Caraca guianensis* oil by Farias (2013). However, the acid values of the melon oils remain between the maximum value established by ANVISA, (2000) which is 0.6%. Since the acidity index establishes the degree of conservation of an oil, the values found indicate that the oils were well conserved for further analysis.

A value greater than or equal to 0.66 indicates that vegetable oil is suitable for human consumption. This parameter needs to be calculated to obtain the acidity index of a vegetable oil (Reda et al., 2005). The oil of the seeds of the two melon cultivars presented oleophilic/aliphatic hydrogen ratio of 3.85 for the oil of the melon yellow seeds, 3.64 for the oil of the *Pele de Sapo* Melon

seeds.

Table 4 shows the values obtained for the oleophilic/aliphatic hydrogen R_o ratio of the oils of the seeds of the two melon cultivars, which were higher than the value found in Crimson Sweet watermelon oil (Holanda, 2013) and the value found in the oil of *Caraca guianensis* (Farias, 2013). The values indicate that the oils of the melon seeds are suitable for human consumption.

The average molecular mass of a triglyceride is inversely proportional to the saponification index (Moretto and Fett, 2008). The oil of the seeds of the two melon cultivars presented a mean molecular mass of 893.33 g mol⁻¹ for the oil of the *Pele-de-sapo* Melon seeds and 902.33 g mol⁻¹ for the oil of the *Pele-de-sapo* Melon seeds. The values found show that the lower the value found for the average molecular mass of the vegetable oils of the larger melon seeds was the saponification index.

Conclusion

The oil *Valenciano* Melon seeds and *Pele-de-sapo* Melon seeds presented good values of 28.47% and 26.41% respectively, appearing as an alternative source for utilization of two agroindustrial rejects.

The analysis of the composition of the major fatty acids present in the oil of the *Valenciano* Melon and *Pele-de-sapo* Melon seeds demonstrates the presence of Palmitic, Arachidonic, Linoleic (ω -6), Oleic (ω -9), Linolenic (ω -3) and Behenic.

The thermogravimetric analysis showed, through the graphs obtained by TG/DTG, the thermal behavior of the oils of the melon seeds, evaluating their stability, being this a determinant factor in the quality control, besides characterizing its viability of degradation through temperature and industrial use.

The quality parameters of the seeds oils of the two melon cultivars showed that they have a good state of conservation, since their quality parameters point to a possible use in human consumption, being able to be used in the food, pharmaceutical and cosmetic industries.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

- Antolin IP, Meneses MM (2000). Aplicación de la espectrofotometría UV-visible al estudio de la estabilidad térmica de aceites vegetales comestibles. *Grasas y Aceites* 51(6):424-428.
- ANVISA (2000). RESOLUÇÃO 482, de Setembro de 1999. Republicada em jul, 2000. Disponível em: http://www.anvisa.gov.br/legis/resol/482_99.htm.
- Azhari S, Xu YS, Jiang QX, Xia WS (2014). Physicochemical properties and chemical composition of Seinat (*Cucumis melo* var. tibish) seed oil and its antioxidant activity. *Grasas y Aceites* 65(1):1-9.
- Barreto HCS (2009). Estudo da qualidade do óleo de semente de uva de diferentes variedades cultivadas em Boa Vista-RR. Dissertação de mestrado em Química. Universidade Federal de Roraima-Brasil.
- Bisognin DA (2002). Origin and evolution of cultivated cucurbits. *Ciencia Rural* 32(4):715-723.
- Christie WW (1989). *Gas chromatography and lipids*, The Oily Press: Ayr, 184 p.
- Farias ES (2013). Propriedades físico-químicas e perfil dos ácidos graxos do óleo da semente de andiroba (*Carapa guianensis* Aublet) de Roraima. 98p. Dissertação (Mestrado em Química) - Programa de Pós-Graduação em Química, Universidade Federal de Roraima.
- Frizzone JÁ, Silva SC, Rezende R (2005). Produtividade e qualidade de frutos de meloeiro cultivado em ambiente protegido com aplicação de dióxido de carbono e de potássio via água de irrigação. *Acta Scientiarum Biological Sciences* 27(4):707-717.
- Garcia JU, Santos HI, Fialho A P, Garro FLT, Antonio Filho NR, Leles MIG (2004). Estudo da estabilidade térmica de óleos de peixes em atmosfera de nitrogênio. *Eclética química* 29(2):41-46.
- Holanda LC (2013). Quantificação dos ácidos graxos e propriedades físico-químicas do óleo das sementes da cultivar de melancia Crimson Sweet. Trabalho de Conclusão de Curso. Universidade Federal de Roraima. Boa Vista-Brasil.
- Jorge N, Luzia DMM (2012). Caracterização do óleo das sementes de *Pachira aquatica* Aublet para aproveitamento alimentar. *Acta Amazon* 42:149-156.
- Kobori NC, Jorge N (2005). Caracterização dos Óleos de Algumas Sementes de Frutas como Aproveitamento de Resíduos Industriais. *Ciência e Agrotecnologia* 29(5):1008-1014.
- Malacrida CR, Angelo PM, Andreo D, Jorge N (2007). Composição química e potencial antioxidante de extração de sementes de melão amarelo em óleo de soja. *Revista Ciência Agronômica* 38(4):372-376.
- Mansouri A, Mirzabe AH, Raufi A (2015). Physical properties and mathematical modeling of melon (*Cucumis melo* L.) seeds and kernels. *Journal of the Saudi Society of Agricultural Sciences*. 16(3):218-226.
- Melo MLS, Athayde-Filho PF, Botelho JR, Souza AG, Lira BF, Barbosa-Filho JM, Wanderley PA, Bora PS (2007). Obtenção e caracterização do biodiesel das sementes do melão japonês. Congresso Internacional de Agroenergia e Biocombustível 1:11-15.
- Melo MLS, Narain N, Bora PS (2000). Characterisation of some nutritional constituents of melon (*Cucumis melon* hybrid AF-522) seeds. *Food Chemistry* 68(4):411-414.
- Miguel ACA, Albertini S, Begiato GF, Dias JRPS, Spoto HF (2008). Agroindustrial use for the solids wastes deriving from minimally processed. *Ciência e Tecnologia de alimentos* 28(3):733-737.
- Moretto E, Fett R, Gonzaga L, Kuskpski E (2008). Introdução à ciência de alimentos. 2 ed, ampliada e revisada, Florianópolis: Ed. da UFSC <https://www.editorametha.com.br/livros-de-nutricao/introduc-o-a-ciencia-de-alimentos.html>
- Nunes GHS, Santos JJJ, Andrade FV, Bezerra FN, Menezes JB, Pereira EWL (2005). Desempenho de híbridos de melão do grupo inodoros em Mossoró. *Horticultura Brasileira*. 23(1):90-93.
- Reda SY, Carneiro PIB (2006). Parâmetros Físico-químicos do óleo de milho in natura e sob aquecimento calculado pelo programa proteus RMN H1. *Publicatio UEPG: Ciências Exatas e da Terra, Ciências Agrárias e Engenharias* 12(2):31-36.
- Reda SY, Carneiro PIB, Carneiro EBB (2005). ¹H NMR Characterization of Seed Oils from Rangpur Lime (*Citrus limonia*) and "Sicilian" Lemon (*Citrus limon*). *Annals of Magnetic Resonance* 4(3):64-68.
- Serviço Nacional de Aprendizagem Rural (SENAR) (2007). Cultivo de melão. Colheita, pós-colheita e comercialização. Brasília: Coleção SENAR-131, 104 p.
- Silva SR (2011). Perfil dos ácidos graxos, atividade antioxidante e caracterização físico-química do óleo das sementes de três espécies de maracujá cultivadas no Estado de Roraima. Dissertação de Mestrado. Universidade Federal de Roraima. Boa Vista, RR.
- Solomons TWG, Fryhle CB (2012). *Química Orgânica*. 10 ed. v 2. Rio de Janeiro: LTC. 616 p.
- Uchôa AMA, Costa JMC, Maia GA, Silva EMC, Carvalho AFFU, Meira TR (2008). Parâmetros físico-químicos, teor de fibra bruta e alimentar de pós alimentícios obtidos de resíduos de frutas tropicais. *Segurança Alimentar e Nutricional* 15:58-65.