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Quantificação de 6-gingerol, análise metabolômica por espectrometria de massa por spray de papel e determinação da atividade antioxidante de rizomas de gengibre (*Zingiber officinale*)

Quantification of 6-gingerol, metabolomic analysis by paper spray mass spectrometry and determination of antioxidant activity of ginger rhizomes (*Zingiber officinale*)

Cuantificación de 6-gingerol, análisis metabolómico por espectrometría de masas por paper spray y determinación de la actividad antioxidante de los rizomas de jengibre (*Zingiber officinale*)

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Resumo

O gengibre é uma planta a qual o rizoma possui um alto potencial terapêutico em combate a várias doenças devido à ação de seus constituintes. O 6-gingerol, compostos fenólicos e carotenóides, agem na modulação de macrófagos, agregação antiplaquetária e atividade imunossupressora. Este trabalho visou determinar a capacidade antioxidante total, bem como avaliar o uso de espectrometria de massas com paper spray para obter espectros de amostras de gengibre de cultivo convencional e orgânico. Os resultados demonstram que as amostras de cultivo orgânico apresentaram maiores quantidades de fibras e proteínas totais, assim como 6-gingerol. O gengibre orgânico se mostra mais intessante para o consumo visto que possui maiores quantidades de 6-gingerol, fibras e proteínas. Diversas classes químicas como açúcares, lipídios, fenilpropanóides e flavonóides foram identificados no gengibre orgânico e convencional através da espectrometria de massas com ionização por paper spray. Esta análise se mostrou muito eficiente e rápida para a obtenção de espectros do gengibre, permitindo a

identificação de 19 compostos no modo positivo e 28 no modo negativo.

Palavras-chave: Gengibre; Cultivo convencional e orgânico; Atividade antioxidante; Gingerol; Paper spray.

Abstract

Ginger is a plant whose rhizome has a high therapeutic potential in combating various diseases due to the action of several of its constituents. The 6-gingerol, phenolic compounds and carotenoids, act on macrophage modulation, antiplatelet aggregation and immunosuppressive activity. This work aimed to determine the total antioxidant capacity as well as to evaluate the use of paper spray mass spectrometry to obtain fingerprints of ginger samples of conventional and organic cultivation. The results demonstrated that organic farming samples showed higher levels of fiber and total protein, as well as 6-gingerol. One must still give preference to organic Ginger intake since it presented significant levels of 6-gingerol, fiber and protein. Several chemical classes such as sugars, fatty acids, phenylpropanoids and flavonoids were identified in organic and conventional ginger through paper spray ionization mass spectrometry. This analysis proved to be a very efficient and fast technique for obtaining fingerprints of ginger, allowing the identification of 19 compounds in the positive mode and 28 in the negative mode.

Keywords: Ginger; conventional and organic cultivation; Antioxidant activity; Gingerol; Paper spray.

Resumen

El jengibre es una planta cuyo rizoma tiene un alto potencial terapéutico para combatir diversas enfermedades debido a la acción de sus componentes. 6-gingerol, compuestos fenólicos y carotenoides, actúan en la modulación de macrófagos, agregación antiplaquetaria y actividad inmunosupresora. Este trabajo tuvo como objetivo determinar la capacidad antioxidante total, así como evaluar el uso de la espectrometría de masas con paper spray para obtener espectros de muestras de jengibre de cultivos convencionales y orgánicos. Los resultados demuestran que las muestras de cultivo orgánico presentaron mayores cantidades de fibras y proteínas totales, así como 6-gingerol. El jengibre orgánico es más interesante para el consumo ya que tiene mayores cantidades de 6-gingerol, fibras y proteínas. Se han identificado varias clases químicas como azúcares, lípidos, fenilpropanoides y flavonoides en el jengibre orgánico y convencional a través de espectrometría de masas con ionización por pulverización de papel. Este análisis demostró ser muy eficiente y rápido para obtener

espectros de jengibre, permitiendo la identificación de 19 compuestos en el modo positivo y 28 en el modo negativo.

Palabras clave: Jengibre; Cultivo convencional y orgânico; Actividad antioxidante; Gingerol; Paper spray.

1. Introduction

Ginger (*Zingiber officinale*) is a plant of Asian origin, belong to Zingiberaceae, cultivated in practically every country in the world. The rhizome of this species is used as a condiment and raw material for the manufacture of beverages, fragrances, confectionery and fruit jellies (Jiang et al., 2007). Antioxidant and anti-inflammatory activity and hepatoprotective function have been associated with the presence of various substances, such as gingerol, camphene, phellandrene and zingerone (Yu et al., 2007).

Gingerols, especially 6-gingerol, is the substance responsible for the pungent characteristic of ginger. Other related activities are antiplatelet aggregation, modulation of macrophages, immunosuppression and inhibition of lipopolysaccharides. Phenolic compounds are responsible for the antioxidant activity present in ginger (Chen et al., 2007; Gan et al., 2011; Pan et al., 2008; Yu et al., 2007).

The vegetal samples characterization is usually performed using traditional methods such as High-Performance Liquid Chromatography (HPLC), Mass Spectrometry Coupled Gas Chromatography (GC-MS) and Capillary Electrophoresis (EC). Due to the numerous sample preparation steps and long analysis time, ambient ionization mass spectrometry has been employed for ultra-fast complex matrix analysis with high sensitivity, selectivity and low-cost analysis (M. Silva et al., 2019; Wang et al., 2010). Among them, paper spray ionization mass spectrometry has been used for analysis and quality control of various types of food such as cagaita (M. Silva et al., 2019), olive oil (Mazzotti et al., 2013), coffee (Garrett et al., 2013) and tea (Deng & Yang, 2013), among others.

Plants like ginger have been gaining attention in the East as a good source of antioxidants and as a health food and, therefore, parameters like biological effects and contamination with agrochemicals become very important for most consumers. As such, this work aimed to better characterize the rhizomes of ginger, to assess their potential antioxidants and whether the type of cultivation, conventional and organic, influences the rhizome composition.

2. Experimental part

2.1 Ginger sample and material

Rhizomes of ginger utilized in the present work were cultivated in two different forms, conventional and organic, in the Southern region of Brazil. The two samples from conventional cultivation were obtained from São Paulo and Espirito Santo states. The two samples from organic agriculture were collected from two different producers from Minas Gerais state. Samples were transported to the Research Laboratory – Food Chemistry Unit of the Federal University of Minas Gerais. Fresh (*in natura*) ginger samples were sanitized by immersion in a solution of sodium hypochlorite (5 mg/L of active chlorine) for 15 min at room temperature, washed with distilled water, dried, crushed and, stored at-20°C.

All the standards for Folin Ciocalteu phenol reagent, 2,20-azino-bis(3-ethylbenzthiazoline-6-sulphonic acid) (ABTS), 2,4,6-tris(2-pyridyl)-s-triazine (TPTZ), and 6-hydroxy-2,5,7,8-tetramethylchroman-2-carboxylic acid (Trolox) were acquired from Sigma Aldric (São Paulo, SP, Brazil). Methanol HPLC grade was acquired from J. T. Baker (Phillipsburg, NJ, USA) and chromatography paper 1 CHR from Whatman (Little Chalfont, Buckinghamshire, UK).

2.2 Physical-chemical analyses

Chemical composition (moisture, total lipids, total protein and ash) of the samples was carried out according to the Association of Official Analytical Chemists (AOAC) methods. Determination of soluble and insoluble dietary fiber was performed using enzyme digestion (alpha-amylase, pepsin and pancreatin perfectly) Sigma®. Carbohydrate content was calculated by percentage difference.

2.3 Antioxidant activity and phenolic compounds determination

First, 300 mg of crushed fresh *in natura* ginger were extracted according to the procedure described by Rufino et al. 2010. The obtained extracts were used to determine the content of phenolic compounds and to evaluate the antioxidant activity. Thus, the phenolic compounds were identified following the procedure of Singleton et al. 1999. Antioxidant

activity was assessed according described by Rufino et al. 2010 to FRAP and ABTS and, the according AOAC protocol (AOAC, 2018) to DPPH method.

2.4 PS-MS fingerprints

The chemical profile analysis of the gingers was done using a mass spectrometer LCQ Fleet (Thermo Scientific, San Jose, CA, USA) equipped with a paper spray ionization source. All ginger samples were analyzed in positive and negative modes.

The chromatographic paper was cut into an equilateral triangle shape (1.5 cm). The paper was positioned in front of the mass spectrometer entrance. This material was supported by a metal connector and placed 0.5 cm away. The instrument was connected to high-voltage power of the spectrometer through a copper wire. Finally, 2.0 µL of pulp was applied on the border of the triangles, 40.0 µL of methanol was transferred to the chromatographic paper. The analyses were done in triplicate for both ionization modes (positive and negative) (Campelo et al., 2020; A. L. C. C. Ramos et al., 2020; E. Silva et al., 2020; M. Silva et al., 2019).

The instrument was operated under the following conditions, PS-MS source voltage + 4.0 kV (positive) and – 3.0 kV (negative); capillary voltage 40 V; tube lenses voltage 120 V; mass range from 100 to 1000 *m/z*; transfer tube temperature 275°C. Collision energies used to fragment the compounds ranged from 15 to 35 eV (Campelo et al., 2020; A. L. C. C. Ramos et al., 2020; E. Silva et al., 2020; M. Silva et al., 2019). The fragments obtained in this analysis were identified based on the data described in the literature.

2.5 Optimization of the 6-gingerol extraction method

The solvents acetone, methanol and acetonitrile were tested to determine the best extraction method for 6-gingerol (Yu et al., 2007)(Yu et al., 2007). Two types of extractor, ultraturrax and ultrasound were also tested. Subsequently, the samples were centrifuged by varying the speed and time of the centrifuge. From the best absorbance data, the best conditions were validated. The solvent polarity, extraction process and analysis method were chosen according to procedures already described to determine the content of gingerol in ginger rhizomes (Ok & Jeong, 2012; Pawar et al., 2011; Sanwal et al., 2010).

For the determination of 6-gingerol, ginger rhizomes were initially processed in a knife mill and subsequently freeze-dried in a Lyophilizer L101 (Liotop ®). A sample

containing 200 mg of lyophilized ginger was added to methanol (10 mL). The mixture was homogenized in ultraturrax for 5 minutes and centrifuged at 3,600 *x g* at 4°C for 20 min. The supernatant was collected, filtered in a 0.22 µm filter and analyzed by ultra pressure liquid chromatography (UPLC-Acquiuty Waters ®, USA) with a DAD detector at 280 nm, 0.3 mL/min flow, mobile phase gradient of Acetonitrile: water (40:60 to 90:10 for 16 minutes). An aliquot of the extract (1 µL) was analyzed under the same conditions on a C18 reverse-phase column (Acquity UPLC model – Waters, 1.7 µm diameter, size 2.1 x 100 mm).

The parameters peak purity, linearity, matrix effects, accuracy and precision, were evaluated. The suitability for the use of the method was assessed as a function of the parameters studied and their acceptability criteria defined (Sanwal et al., 2010). The significance level adopted in hypothesis testing was $\alpha = 0.05$.

2.6 Statistical analysis

The analysis of variance (single-factor ANOVA) and Tukey test at 5% probability were used to compare the values found in the studies. The software Statistica version 10.0 (StatSoft, Tulsa, OK, USA) was used. Xcalibur version 2.2 SP1 software (Thermo Scientific, San Jose, CA, USA) was used to collect mass spectra results.

3. Results and discussion

3.1 Physical-chemical assay

Table 1 shows the results of the physical-chemical analyses of ginger from each variety (conventional or organic). The moisture content of the samples was 85.0% (conventional cultivation Sao Paulo), 86.2% (conventional cultivation Espírito Santo), 72.3% and 72.4% organic agriculture from Minas Gerais sample 1 and 2, respectively.

Table 1. Dry chemical composition of ginger samples (Zingiber Officinale).

Chemical composition	CSP	CES	OMG1	OMG2
Ash	$6.37^{b} \pm 0.88$	$7.66^{a} \pm 0.27$	$5.91^{bc} \pm 0.36$	$5.49^{c} \pm 0.49$
Lipids	$2.04^{a} \pm 0.77$	$2.54^{a} \pm 0.43$	$1.11^{b} \pm 0.19$	$1.12^{b} \pm 0.45$
Proteins	$10.40^{c} \pm 1.03$	$14.2^{ab} \pm 2.57$	$13.3^{b} \pm 1.79$	$16.5^{a} \pm 2.69$
Dietary fiber	$49.17^{a} \pm 2.82$	$33.83^{b} \pm 16.87$	$55.80^{a} \pm 2.89$	$52.67^{a} \pm 4.16$
Soluble fiber	$4.62^{b} \pm 0.48$	$3.52^{b} \pm 1.43$	$6.44^{a} \pm 1.4$	$6.8^{a} \pm 1.43$
Insoluble fiber	$44.55^{a} \pm 3.23$	$30.30^{b} \pm 17.10$	$49.35^{a} \pm 2.45$	$45.86^{a} \pm 4.13$
Carbohydrate*	31.99 ± 3.41	41.73 ± 18.53	23.90 ± 3.27	24.17 ± 2.95

*The carbohydrate content was calculated by difference. Average values ± standard deviation (n = 6) with subscripts the same ABC on the same line do not differ significantly ($p \leq 5$; Tukey test). CSP: conventional cultivation obtained from São Paulo; CES: conventional cultivation obtained from Espirito Santo. OMG1: samples from organic cultivation obtained from Minas Gerais; OMG2: samples from organic cultivation obtained from Minas Gerais. Source: Author.

In the samples of organic ginger a higher protein and fiber content was observed. On the other hand, these samples had lower ash, lipid and carbohydrate content than conventionally cultivated ginger samples.

Ginger samples showed high percentages of dietary fiber, with levels ranging from 33.83 to 55.80% for conventional and organic ginger, respectively. There is no difference between the same type of cultivation. The samples of organic farming featured more significant levels of soluble fiber when compared with conventional cultivars.

3.2 Phenolic compounds and antioxidant activity

Table 2 presents the total phenolic compounds content and antioxidant activity of the sample ginger from each variety (conventional or organic). The ginger showed an average phenolic compounds content of 15.5 mg GAE 100 g^{-1} and there was no difference in the levels between crops.

Table 2. Total phenolic compounds and antioxidant activity of organic and conventional ginger.

Parameters	CSP	CES	OMG1	OMG2
Phenolic compounds (mg GAE 100g^{-1} sample)	16.2^{a} ± 1.50	14.9^{a} ± 1.50	15.2 ± 1.03	14.3 ± 0.7
FRAP (µM ferrous sulfate g^{-1} sample)	18.90^{b} ± 5.14	21.40^{ab} ± 4.23	19.8^{b} ± 2.7	24.5^{a} ± 1.7
ABTS (µM Trolox g^{-1} sample)	1.373.096^{b} ± 223.625	1.514.977^{b} ± 85.817	1.674.408^{a} ± 162.515	1.628.640^{a} ± 113.034

GAE = gallic acid equivalents. Means indicated by the same letters in the same line do not differ from each other at 5 % significance in comparison with different regions. CSP: Conventional cultivation obtained from São Paulo; CES: conventional cultivation obtained from Espírito Santo. OMG1: samples from organic cultivation obtained from Minas Gerais; OMG2: samples from organic cultivation obtained from Minas Gerais. Source: Author.

In this present work two methods were used to assess the antioxidant activity of ginger as shown in Table 2. As for FRAP methodology, results ranged from 18.9 to 24.5 µM ferrous sulfate g^{-1} sample and the content of the antioxidant activity in OMG2 was significant than OMG1 ginger.

When employing ABTS methods, a significant difference was observed between conventional and organic samples, the latter being significantly higher than the conventional samples (1371.1; 1515.0; 1674.4; 1628.6 mol of Trolox/g of ginger from CSP, CES, OMG1 and OMG2, respectively).

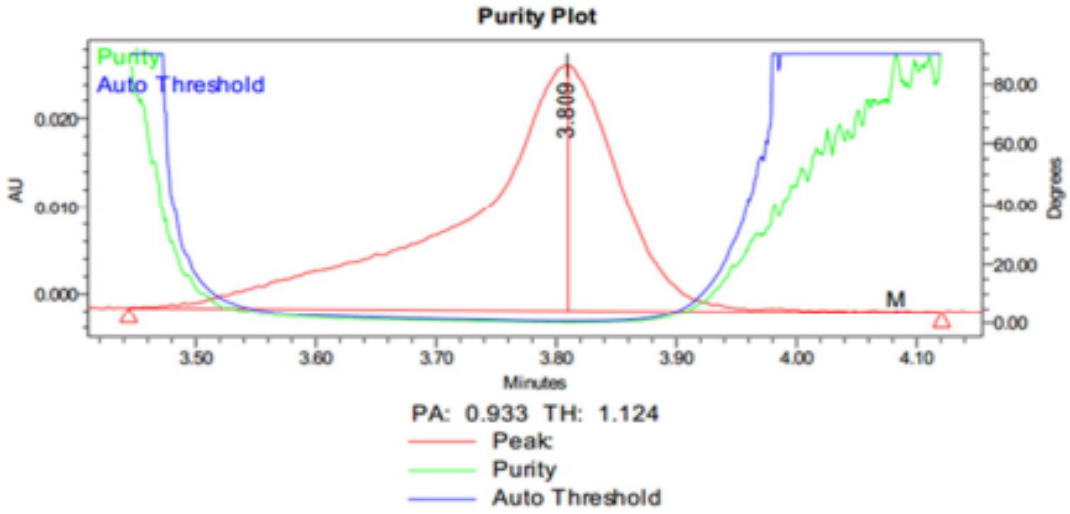
Both the ABTS and the FRAP methods showed better results for the antioxidant activity in samples of organic ginger.

3.3 Measurement and determination of 6-gingerol

The chromatographic peak purity was determined after the default and sample scan (a ginger extract) employing a DAD detector. The peak of the spectrum is considered to be homogeneous when the angle of purity is less than the edge of the line.

The figure below presents an example of a calculation peak purity of 6-gingerol on the concentration of 150 µg/mL.

Figure 1. Evaluation of the peak purity of the 6-gingerol standard.



Source: Author.

So the reading of the standard was homogeny since the value of the angle of purity (0.933) is less than the limit (1.124), indicating that the peak is only an analyte, and there is no overlap of more than one substance in the same peak.

After the examination to confirm the veracity of the data, since the significance of regression ($p < 0.001$) and the absence of significant deviation from linearity ($p > 0.05$). Therefore, the parameters evaluated confirmed the linearity of the usual curve in the range of concentration of analyte from 30 to 180 µg mL^{-1}.

The comparison of the slope of the straight lines by the t-Test did not indicate a matrix effect ($p > 0.05$). The t statistic calculated ($tb = 0.38$) was less than the critical value of t ($t = 2.04$), confirming the absence of effect of the array. Therefore, the standard curve of gingerol may be used to estimate the amount of gingerol in ginger samples.

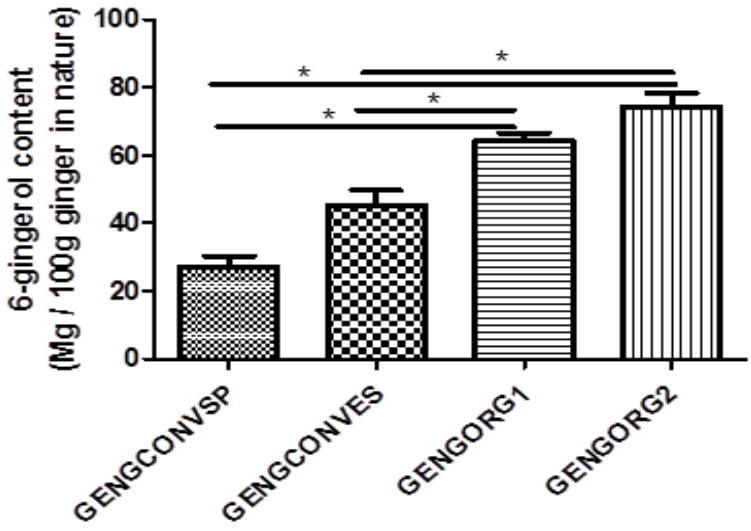
Recovery data in two levels of addition of analyte studied (level 1 and level 2) were subjected to the Grubbs test, which indicated the absence of outliers ($p > 0.05$). The average recovery also observed that levels 1 and 2 were 88.15% and 91.5%, respectively. These results are in the range of 80% to 110% accessibility established by the European Commission (2002), indicating appropriate concentration levels of veracity.

3.4 Content of 6-gingerol

The content of 6-gingerol was 27.0; 45.1; 64.3; 74.4 mg of 6-gingerol /100g of ginger *in natura* from conventional cultivation were obtained from São Paulo, Espírito Santo, organic agriculture from Minas Gerais sample 1 and 2 respectively.

Ginger samples of organic farming showed significantly higher levels of 6-gingerol when compared to conventional farming samples; there is no difference between samples within the same culture.

Figure 2. 6-gingerol content in ginger samples (mg of gingerol / 100g of fresh ginger).

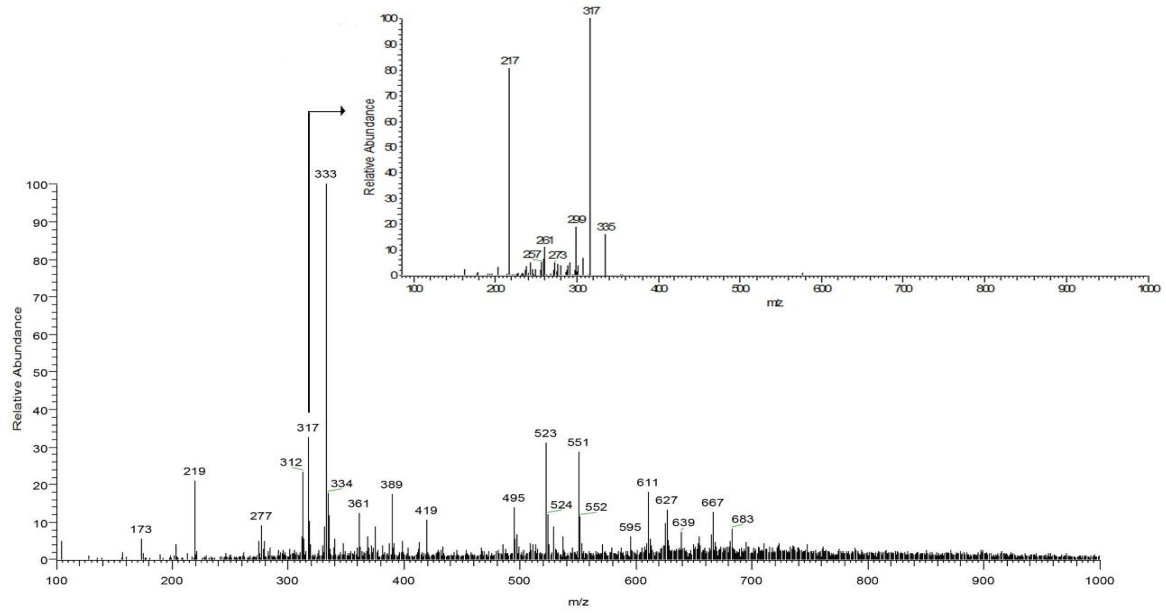


Mean values ± standard deviation (n = 6) with equal subscripts * in the same row did not differ significantly ($p \leq 5$; Tukey's test). Source: Author.

3.5 Chemical constituents identified in ginger by PS-MS

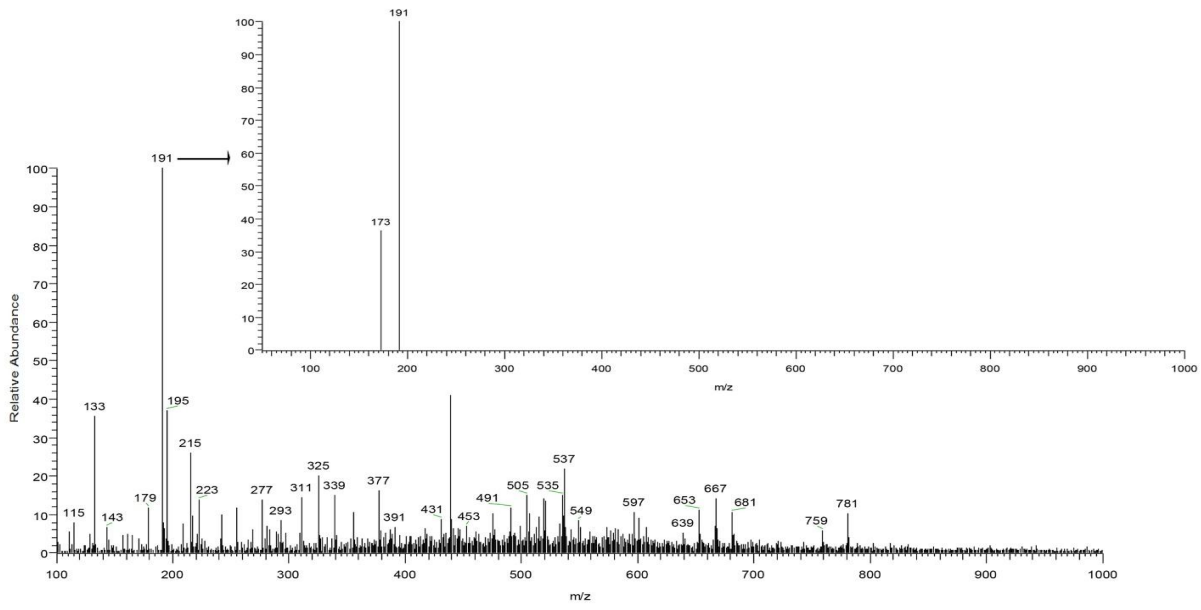
Mass spectra and fragmentation profile of some characteristic ginger ions are shown in Figure 3 ((+) PS-MS) and Figure 4 ((-) PS-MS).

Figure 3. Full-Scan and fragmentation profile of isorhamnetin identified in ginger by (+) PS-MS.



Source: Author

Figure 4. Full-Scan and fragmentation spectrum of citric acid identified in ginger by (-) PS-MS.



Source: Author

Table 3 presents the proposed identification for signals found in ginger in positive ionization mode and the profile of compounds identified in negative ionization mode is presented in Table 4.

Table 3. Proposed identification for ions found in ginger by (+) PS-MS.

N°	Identification attempt	m/z	MS^2	Reference	Classification	Ginger organic	Ginger Commercial
1	Glucose	219	-	(A. S. Ramos et al., 2015)	carbohydrate	X	X
2	Trans-N-feruloyl-3-hydroxytyramine	312	177, 145, 117	(Basaiyye et al., 2018)	phenylpropanoid	X	X
3	Isorhamnetin-O-hexoside	317	-	(Martucci, 2016)	flavonoid	X	X
4	Cyanidin-3-O-xyloside	419	-	(Gouvêa et al., 2015)	flavonoid		X
5	Kaempferol-3-O-rutinoside	595	179, 253, 308, 331, 471, 512	(Jia et al., 2017)	flavonoid		X
6	*p*-cumárico acid	611	-	(Batista et al., 2017)	phenylpropanoid	X	X
7	Delphinidin-3,5-O-diglucoside	627	303, 465	(Faria et al., 2011)	flavonoid	X	X
8	Malvidin-3-rutinoside	639	-	(Bochi et al., 2015)	flavonoid	X	X
9	Malvidin-3,5-O-diglucoside	655	331, 493	(Faria et al., 2011)	flavonoid	X	
10	[8]-gingerol	667	-	(Krüger et al., 2018)	phenylpropanoid	X	X
11	17-Descarboxy-amaranthine	683	345, 507	(Roriz et al., 2014)	-	X	X

Source: Author

Table 4. Assignments for analytes found in ginger (-) PS-MS.

N°	Identification attempt	*m/z*	MS/MS	Reference	Classification	Ginger organic	Ginger Commercial
1	malic acid	133	-	(Guo et al., 2017)	carboxylic acid	X	X
2	cafeic acid	179	-	(Mikulic-Petkovsek et al., 2015)	carboxylic acid	X	X
3	citric acid	191	173	(Alberti-Dér, 2013)	carboxylic acid	X	X
4	Glucose	215	-	(Guo et al., 2017)	carbohydrate	X	X
5	Palmitic acid	255	-	(Amorim et al., 2009)	carboxylic acid	X	X
6	[6]-gingerol	293	-	(Krüger et al., 2018)	phenylpropanoid	X	
7	caftaric acid	311	-	(M. Silva et al., 2019)	phenylpropanoid	X	X
8	Coumaroyl hexoside	325	163, 119	(Alberti-Dér, 2013)	phenylpropanoid	X	X
9	Oleuropein aglycon	377	362, 334, 297, 282, 252	(Berto et al., 2015)	phenylpropanoid	X	X
10	Kaempferol-3-O-desoxyhexoside	431	285, 284, 257, 227	(Alberti-Dér, 2013)	flavonoid	X	
11	Sulphated rosmarinic acid	439	439, 359, 179, 161, 135	(Barros et al., 2013)	phenylpropanoid		X
12	Chrysoeriol-7-O-glycuronyl	475	405, 367, 301, 286, 224, 145	(El Sayed et al., 2016)	flavonoid	X	
13	Caffeoyl-coumaric-quinic acid	499	377, 273, 163, 119	(Benayad et al., 2014)	phenylpropanoid		
14	Quercetin-3-malonylglucoside	505	301, 271, 255,179	(Borges, 2008)	flavonoid		X
15	3,4-di-O-(E)-caffeoylquinic acid	515	464, 382,301	(El Sayed et al., 2016)	phenylpropanoid	X	
16	9-cis-β-carotene	535	295, 269	(Mariutti et al., 2012)	carotenoid	X	X
17	Lithospermic acid A (isomer)	537	493, 359, 313, 295, 269, 197, 179	(Barros et al., 2013)	phenylpropanoid	X	X

Source: Author.

It can be seen from this table that analysis by (+) PS-MS (Table 3) allowed the identification of 11 compounds belonging to various classes, such as sugar, phenylpropanoids and flavonoids. Moreover, most of the identified substances are present in both types of ginger. The differences between them are related to the signal with m/z 655 (malvidin-3,5-O-diglucoside), which was found only in organic ginger. On the other hand, signals with m/z 419 (cyanidin-3-O-xyloside) and 595 (kaempferol-3-O-rutinoside) are present only in commercial ginger.

As shown in Table 4, a total of 17 compounds were found in ginger belonging to the chemical classes sugars, fatty acids, phenylpropanoids and flavonoids. The differentiation of organic from commercial ginger was due to ions with m/z 293 ([6] -gingerol), 431 (kaempferol-3-O-desoxyhexoside), 475 (chrysoeriol-7-O-glycuronyl) and 515 (3,4-di-O- (E) -caffeoylquinic acid).

It is noteworthy that no studies were found in the literature evaluating the differences between the chemical profile of organic and commercial ginger.

4. Final Considerations

This work presents several contributions for the advancement of research in the area of chemical analysis of foods, mainly for the characterization of ginger, in addition to contributing to the advancement and incentive to the cultivation of organic foods, since it brings a vast comparison of components present in ginger of traditional and organic crops. It also presents several methods of quantifying the antioxidant capacity of ginger, presenting positive and negative points of each method. Still in this article, after extensive analyzes of mass spectrometry with paper spray ionization, about 28 components of different classes were identified in ginger as sugars, fatty acids, phenylpropanoids, flavonoids, in addition to the identification and quantification of gingerol, a component with high anti-inflammatory capacity, thus contributing to a better characterization of this rhizome.

Organic ginger samples showed lower moisture content when compared with the conventional samples and increased amounts of protein and fiber with a prevalence of insoluble fiber.

It is necessary to intake 21 to 43 g of fresh ginger, to achieve the proper amount of gingerols, biologically active substances, responsible for the anti-inflammatory activity of ginger.

Preference must be given to organic ginger intake, since, besides the absence of pesticides, it also presented superior levels of 6-gingerol, dietary fiber and protein when compared with conventionally grown ginger.

PS-MS proved to be an efficient method for determining the chemical constituents of ginger, allowing the identification of 28 compounds belonging to different classes such as sugars, fatty acids, phenylpropanoids and flavonoids.

Moreover, through this method it was possible to verify some differences between the types of ginger. Malvidin-3,5-O-diglucoside, cyanidin-3-O-xyloside, and kaempferol-3-O-rutinoside were found only in organic ginger and cyanidin-3-O-xyloside and kaempferol-3-O -rutinoside was identified only in commercial ginger. This work opens up new possibilities in the use of ambient ionization techniques by PS / MS, since it has allowed fingerprints of several complex matrices to be obtained through ultra-fast analysis, low analytical cost and without generating chemical residues.

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