CHEESA: Chemical Engineering Research Articles
ISSN **2614-8757 (Print)**, ISSN **2615-2347 (Online)**
Available online at: http://e-journal.unipma.ac.id/index.php/cheesa
Copyright © 2023

Research Article

Identification of Flavonoid Compounds in Ethanol Extract of Majapahit plant (*Crescentia cujete*) Leaves and their Potential as Anticancer

Identifikasi Senyawa Flavonoid Ekstrak Etanol Daun Tanaman Majapahit (Crescentia cujete) dan Potensinya sebagai Antikanker

Rahma Diyan Martha[1*)], Fatimah[2)], Danar[3)], Hesty Parbuntari[4)]

[1)]*STIKes Karya Putra Bangsa, Department of Pharmacy, Indonesia*
[2)]*STIKes Karya Putra Bangsa, Department of Health Analyst, Indonesia*
[3)]*Universitas Negeri Malang, Department of Chemistry, Indonesia*
[4)]*Universitas Negeri Padang, Department of Chemistry, Indonesia*

Article History
Received: 05th October 2022; Revised: 08th June 2023; Accepted: 15th June 2023;
Available online: 25th June 2023; Published Regularly: June 2023

doi: 10.25273/cheesa.v6i1.14056.34-48

*Corresponding Author.
Email:
rahmadiyan@stikes-kartrasa.ac.id

Abstract

The Majapahit plant is commonly found in Indonesia but is rarely used due to a lack of information about its potential. One of the secondary metabolites commonly found in this plant are flavonoids. Therefore, this study aims to determine the distribution of flavonoid compounds in the Majapahit plant, particularly their potential as anticancer activty. Leaf material from Majapahit plants was extracted using the maceration technique, while the flavonoid compounds in the extract were identified using LCMS (Shimadzu LCMS-8040 LC/MS). The identification results showed that about 97 compounds were detected, including 14 flavonoids. The flavonoid compounds found include Quercetin, Chlorogenic acid, Kaempferol 3-O rhamnoside, Acacetin 7-rutinoside, Fortunellin, Kaempferol 3-[6”-(3-hydroxy-3-methyl glutarl) glucoside], Didymin, Diosmin, Hesperidin, Rutin, Citrusoside C, Citrusoside D, Narirutin 4'-glucoside, and Kaempferol 3-[6”-(3-hydroxy-3-methylglutaryl)glucoside] -7-glucoside. The highest composition of the identified flavonoid compounds was found in Kaempferol 3-O rhamnoside, with a 3.90%

Keywords: ethanol extract; flavonoids; Majapahit plant leaves; LCMS

Abstrak

Tanaman Majapahit banyak ditemukan di Indonesia, tetapi kurang dapat dimanfaatkan oleh masyarakat Indonesia, karena kurangnya informasi mengenai potensi tanaman tersebut. Senyawa metabolit sekunder yang ditemukan salah satunya yaitu flavonoid. Tujuan penelitian ini adalah untuk mengetahui sebaran senyawa flavonoid ekstrak etanol daun tanaman majapahit yang berpotensi sebagai antikanker. Metode yang digunakan untuk ekstraksi daun tanaman majapahit yaitu maserasi, sedangkan identifikasi senyawa flavonoid pada ekstrak daun tanaman majapahit menggunakan LCMS (Shimadzu LCMS-8040 LC/MS). Identifikasi menggunakan LCMS (Shimadzu LCMS-8040 LC/MS) diketahui sekitar 97 senyawa yang terdeteksi, termasuk didalamnya 14 senyawa flavonoid. Senyawa flavonoid yang ditemukan, yaitu; Quercetin, Chlorogenic acid, Kaempferol 3-O rhamnoside, Acacetin 7-rutinoside, Fortunellin, Kaempferol 3-[6”-(3-hydroxy-3-methyl glutaryl) glucoside], Didymin, Diosmin, Hesperidin, Rutin, Citrusoside C, Citrusoside D, Narirutin 4’-glucoside, dan Kaempferol 3-[6”-(3-hydroxy-3-methylglutaryl)glucoside] -7-glucoside. Salah satu senyawa golongan flavonoid yang terdeteksi, senyawa Kaempferol 3-O rhamnoside yang memiliki komposisi tertinggi yaitu 3,90%.

***Kata kunci**: daun tanaman majapahit; ekstrak etanol; flavonoid; LCMS*

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

1. Introduction

Indonesia is renowned for its abundant natural resources, including a biodiversity of animal and plant species. This biodiversity produces numerous types and quantities of chemical compounds that play a crucial role in supporting life, particularly for humans, such as medicines and antibiotics. One of the chemical compounds that can serve this purpose is a group of secondary metabolites commonly found in plants, including Majapahit.

Majapahit is a native plant to South America [1] but it can also be found in Indonesia. It is a member of the citrus family and is distinguished by enormous, bitter-tasting green fruits, which contributes to its underutilization by Indonesian people. Majapahit receives little attention and is mostly regarded as an ornamental plant. Therefore, it is crucial to conduct a study on the benefits of the plant, with a specific focus on the leaves and constituent compounds, such as flavonoids.

Flavonoids are secondary metabolites abundantly produced in natural subtances. These compounds are concentrated in the leaves, particularly in full exposure sunlight area [2] because they function as UV radiation filters [3]. Flavonoids can be found in the lower and upper epidermis cells as well as the stomata of leaves.

Within plants, flavonoids have various roles, including serving as secondary antioxidants in tissue defense against abiotic and biotic stressors [4], promoting growth, such as auxins [1], and providing color to plants, which can indicate their stress level [5].

The maceration method (soaking) was used to extract Majapahit plant leaves because it requires relatively simple equipment and is a straightforward process. Compounds in the extract were identified using LCMS (Shimadzu LCMS-8040 LC/MS), which provided information about their structure [6]. Previous studies have been conducted on various parts of the Majapahit plant, including toxicity analysis and anticancer potential of the leaves using maceration with methanol solvent of BSLT [7], identification of potential anticancer compounds and in silico prediction on the stem bark [8], as well as detection and identification of flavonoid compounds in the ethanol extract of the bark using LCMS [9]. The novelty of this study is predicated on the identification and classification of flavonoid compounds, which are secondary metabolites in the ethanol extract of Majapahit plant leaves. Furthermore, it aimed to examine the fragmentation patterns of the flavonoid compounds with the highest composition.

2. Research Methods

2.1 Tools and Materials

The main materials used were Majapahit plant leaves, 96% ethanol, methanol, and water, while the materials for the phytochemical test included an alkaline reagent.

The tools used included a maceration tube, a Buchi brand rotary evaporator, and an LCMS (Liquid Chromatography Mass Spectrometry) device, specifically the Shimadzu LCMS-8040 LC/MS model, which was conducted at the Muhammadiyah University of Malang.

2.2 Extraction of Majapahit Plant Leaves

Fresh Majapahit plant leaves were washed thoroughly with running water and then dried. Drying was carried out without direct exposure to sunlight. Subsequently,

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

The leaves were then sieved through an 80-mesh sieve after being coarsely crushed in a blender. Around 100 grams. sieved material was then macerated with 600 ml of 96% ethanol. This process was carried out in a maceration tube and left for 3 days. The extraction process result was filtered using filter paper and yielded the extract of Majapahit plant leaves. The extract was concentrated using a rotary evaporator.

2.3 Qualitative Test for the Extract of Majapahit Plant Leaves

About 1 mL of the ethanol extract from Majapahit plant leaves was taken and placed into a test tube. Furthermore, 3-5 drops of the alkaline reagent were added and the result was observed. A positive result would produce a yellow color in the sample.

2.4 Identification of Compounds with LCMS

The concentrated extract obtained from the extraction process was dissolved in methanol at a concentration of 20 ppm with a ratio of 2 mg concentrated extract to 10 mL of methanol. Furthermore, 1 µL of the sample was taken and injected into the LCMS-8040 instrument equipped with a binary pump. The eluents used in this process were water and 90% methanol. The LC (Liquid Chromatography) eluent connected to the Quadrupole Time-of-Flight (QTOF) mass spectrometer was set at a total flow rate of 0.5 mL/minute. The mass spectrometry (MS) used was the QTOF system with positive ionization mode.

3. Results and Discussion

3.1 Extraction of Majapahit Plant Leaves

The extraction process of Majapahit plant leaves was conducted using the soaking or maceration method. This extraction employed a semi-polar solvent of 96% ethanol to extract both non-polar and polar compounds. The 96% ethanol was used to inhibit the growth of yeast and mold during the maceration process due to its lower toxicity compared to other organic solvents [10].

In the maceration method, re-maceration was carried out to obtain a higher yield of the extract, ensuring that the compounds present in the simplicia were fully extracted. The obtained extract shown in Figure 1 was then concentrated using a rotary evaporator. This process aimed to reduce direct contact between the extract and continuous heat, preventing the degradation or alteration of the constituent compounds.

Figure 1. Concentrated Extract of Majapahit Plant Leaves

3.2 Qualitative Test for the Extract of Majapahit Plant Leaves

The phytochemical analysis was conducted to determine the presence or absence of secondary metabolites in the Majapahit plant, particularly in their leaves. An alkaline reagent was implemented in the procedure to establish the presence of flavonoid compounds.

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

Samples containing flavonoids were identified by the appearance of a yellow color as shown in Figure 2.

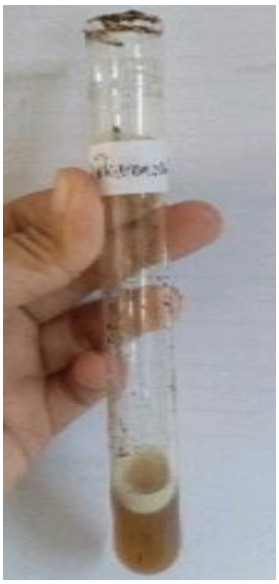


Figure 2. Phytochemical Test of Flavonoid Compounds

3.3 Identification of Compounds with LCMS

The extract of Majapahit plant leaves was discovered to contain 14 chemicals that were thought to be flavonoids based on the identification by LCMS. The compounds included quercetin, chlorogenic acid, kaempferol 3-O rhamnoside, acacetin 7-rutinoside, fortunelin, kaempferol 3-[6”-(3-hydroxy-3-methyl glutaryl) glucoside], didymin, diosmin, hesperidin, rutin, citrusoside C, citrusoside D, narirutin 4’-glucoside, and kaempferol 3-[6”-(3-hydroxy-3-methylglutaryl)glucoside]-7-glucoside (Table 1).

As shown in Table 1, the mass spectrum of chlorogenic acid, kaempferol 3-O rhamnoside, kaempferol 3-[6”-(3-hydroxy-3-methyl glutaryl) glucoside], hesperidin, and rutin have the highest content with values of 3.06%, 3.90%, 3.19%, 3.77%, and 3.43% respectively, compared to other flavonoid compounds. Therefore, the fragmentation patterns of these compounds were determined and the results are presented in Table 2.

The mass spectrum of chlorogenic acid showed peaks at m/z 306, 305, and 304. The molecular ion (M+) at m/z 306 released an H radical, resulting in 2 consecutive fragments at m/z 305 and 304. The molecular ion (M+), as well as the base peak, was observed at m/z 304, corresponding to the molecular weight of the target compound, Chlorogenic acid.

Similarly, the mass spectrum of kaempferol 3-O rhamnoside exhibited peaks at m/z 433, 432, and 431. The molecular ion (M+) at m/z 433 released an H radical, culminating in the generation of 2 consecutive fragments at m/z 432 and 431. The molecular ion (M+), as well as the base peak, was observed at m/z 431, corresponding to the molecular weight of the target compound, kaempferol 3-O rhamnoside.

In the case of kaempferol 3-[6”-(3-hydroxy-3-methyl glutaryl) glucoside], the mass spectrum showed other peaks such as m/z 594, 593, and 592. The molecular ion (M+) at m/z 594 released an H radical, resulting in 2 consecutive fragments at m/z 593 and 592. The molecular ion (M+), as well as the base peak, was observed at m/z 592, representing the molecular weight of the target compound, kaempferol 3-[6”-(3-hydroxy-3-methyl glutaryl) glucoside].

The mass spectrum of hesperidin exhibited peaks at m/z 612, 611, and 610. The molecular ion (M+) at m/z 612 released an H radical, leading to the generation of 2 consecutive fragments at m/z 611 and 610. The molecular ion (M+), as well as the base peak, was observed at m/z 610, corresponding to the molecular weight of the target compound, hesperidin.

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

For rutin, the mass spectrum showed peaks at m/z 612, 611, and 610. The molecular ion (M+) at m/z 612 released an H radical, resulting in 2 consecutive fragments at m/z 611 and 610. The molecular ion (M+), as well as the base peak, was observed at m/z 610, corresponding to the molecular weight of the target compound, rutin.

The presence of flavonoid compounds in Majapahit plant leaves as shown in Table 1, confirmed its potential as an anti-cancer agent. Kaempferol 3-O rhamnoside was detected at a retention time of 21.429 minutes in the LCMS instrument. A previous study showed that kaempferol 3-O rhamnoside extracted from Schima wallichii Kort leaves can inhibit MCF-7 breast cancer cells [11].

Acacetin 7-rutinoside has been found to induce apoptosis in cancer cells [12], while quercetin has chemopreventive effects on prostate cancer [13]. Quercetin can also act as an anti-metastatic agent in gastrointestinal cancer [14]. In a previous study, hesperidin induced apoptosis in MSTO-211H pleural mesothelioma cells [15]. Another study also showed that hesperidin can induce colon, breast, lung, and liver cancer [16].

In lung cancer cells, rutin has been shown to reduce cell migration and adhesion, leading to inhibited proliferation and decreased ROS production [17]. Acacetin 7-rutinoside, also known as linarin, has the ability to induce apoptosis in human prostate cancer cells, indicating its potential as an anti-cancer agent [12]. Meanwhile, narirutin 4'-glucoside can inhibit the proliferation of HL-60 leukemia cells [1].

Kaempferol 3-[6"-(3-hydroxy-3-methylglutaryl) glucoside]-7-glucoside and kaempferol 3-[6'-(3-hydroxy-3-methylglutaryl)glucoside] are known to be anti-cancer agents and are derivatives of kaempferol [18]. Kaempferol reportedly inhibited the growth of breast cancer cells [19]. Moreover, diosmin demonstrated great potential against prostate cancer cells and exhibited genotoxic effects, suppressing the proliferation and viability of HepG2 hepatocarcinoma cell cultures [20]. Didymin has potential against neuroblastoma cells as it can kill both p-53 wild-type and drug-resistant p-53 mutant cells [21].

4. Conclusion

In conclusion, LCMS analysis of Majapahit plant leaves revealed the presence of 14 different flavonoid chemicals. 12 of these were discovered to have remarkable anticancer potential. Kaempferol 3-O rhamnoside had the highest concentration compared to other flavonoid compounds.

References

[1] Agati, G., Azzarello, E., Pollastri, S., & Tattini, M. (2012). Flavonoids as antioxidants in plants: Location and functional significance. *Plant Science*, 196(November), 67–76. doi: 10.1016/j.plantsci.2012.07.014

[2] Tattini, M., Gravano, E., Pinelli, P., Mulinacci, N., Romani, A. (2000). Flavonoids Accumulate in Leaves and Glandular Trichomes of Phillyrea latifolia Exposed to Excess Solar Radiation. *Phytol*, 148, 69–77.

[3] Wollenweber E, D. V. (1981). *Occurrence and distribution of free flavonoid aglycones in plants*.

[4] Kumar, S., & Pandey, A. K. (2013). Chemistry and biological activities of flavonoids: An overview. *The Scientific World Journal*, 2013. doi: 10.1155/2013/162750

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

[5] Peixoto, H., Roxo, M., Krstin, S., Rohrig, T., Richling, E., Wink, M. (2016). An anthocyanin-rich extract of acai (Euterpe precatoria Mart.) increases stress resistance and retards aging-related markers in Caenorhabditis elegans. *J. Agric.Food Chem*, 64, 1283–1290.

[6] Saibaba, S. V., Kumar, M. S., & Shanmuga, P. (2016). Mini Review on LC/MS Techniques. *Journal of Pharmacy and Pharmaceutical Science*, 5(4), 2381–2395.

[7] Fatimah, F., Martha, R. D., & Danar, D. (2022). Analisis toksisitas dan potensi antikanker ekstrak metanol daun Majapahit (Crescentia cujete) dengan metode Brine Shrimp Lethality Test. *Jurnal Penelitian Saintek* .

[8] Fatimah, F., Martha, R. D., Danar, D., Zummah, A., Anggraini, I. M. D., & Kusumawati, A. (2023). Identification of Anticancer Potential Compounds and its In Silico Prediction of The Cytotoxic Activity in Majapahit (Crescentia cujete L.) Stem Bark. In *AIP Conference Proceedings*. doi: 10.1063/5.0112833

[9] Fatimah, F., Martha, R. D., & Kusumawati, A. (2020). Deteksi dan Identifikasi Senyawa Flavonoid Ekstrak Etanol Kulit Batang Tanaman Majapahit (Crescentia cujete) dengan LCMS. *CHEESA: Chemical Engineering Research Articles*, 3(2), 88. doi: 10.25273/cheesa.v3i2.7688.88-98

[10] Saifudin, F & Rahayu, V. (2011). *Standarisasi Bahan Obat Bahan Alam*.

[11] Lewinska, A., Siwak, J., Rzeszutek, I. & Wnuk, M. (2015). Diosmin Induces Genotoxicity and Apoptosis in DU145 Prostate Cancer Cell Line. *Toxicology in Vitro*, 29(3), 417–425.

[12] Singh, R. P., Agrawal, P., Yim, D., Agarwal, C. & Agarwal, R. (2005). Acacetin Inhibits Cell Growth and Cell Progression, and Induces Apoptosis in Human Prostate Cancer Cells: Structure-Activity Relationship with Linarin and Linarin Acetate. *Carcinogenesis*, 26(4), 845–854.

[13] Kim, W. K., Bang, M. H., Kim, E. S., Kang, N. E., Jung, K. C., Cho, H. J., & Park, J. H. Y. (2005). Quercetin decreases the expression of ErbB2 and ErbB3 proteins in HT-29 human colon cancer cells. *Journal of Nutritional Biochemistry*, 16(3), 155–162. doi: 10.1016/j.jnutbio.2004.10.010

[14] Araújo, J. R., Gonçalves, P., & Martel, F. (2011). Chemopreventive effect of dietary polyphenols in colorectal cancer cell lines. *Nutrition Research*, 31(2), 77–87. doi: 10.1016/j.nutres.2011.01.006

[15] Lee, K. A., Lee, S. H., Lee, Y. J., Baeg, S. M., & Shim, J. H. (2012). Hesperidin induces apoptosis by inhibiting Sp1 and its regulatory protein in MSTO-211H cells. *Biomolecules and Therapeutics*, 20(3), 273–279. doi: 10.4062/biomolther.2012.20.3.273

[16] Devi, K. P., Rajavel, T., Nabavi, S. F., Setzer, W. N., Ahmadi, A., Mansouri, K., & Nabavi, S. M. (2015). Hesperidin: A promising anticancer agent from nature. *Industrial Crops and Products*, 76, 582–589. doi: 10.1016/j.indcrop.2015.07.051

[17] Sghaier, M. B., Pagano, A., Mousslim, M., Ammari, Y., Kovacic, H. & Luis, J. (2016). Rutin Inhibits Proliferation, Attenuates Superoxide Production, and Decreases Adhesion and Migration of Human Cancerous Cells. *Biomedicine & Pharmacotherapy*, 84, 1972–1978.

[18] Imran, M., Salehi, B., Sharifi-Rad, J., Gondal, T. A., Saeed, F., Imran, A., … Estevinho, L. M. (2019). Kaempferol: A key emphasis to its anticancer potential. *Molecules*, 24(12), 1–16. doi: 10.3390/molecules24122277

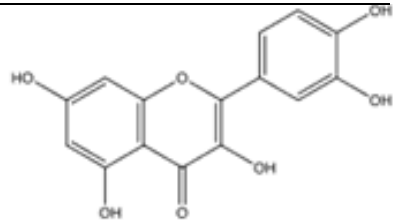
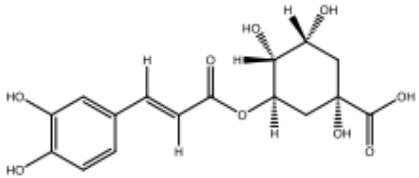
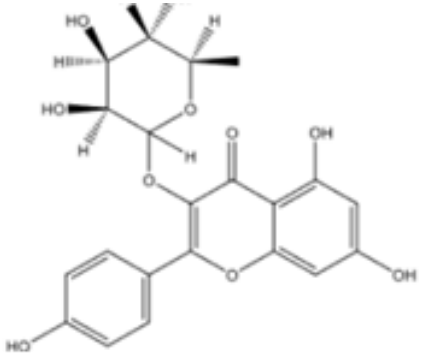
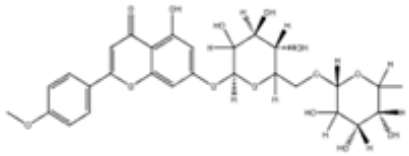
[19] ben Sghaier, M., Pagano, A., Mousslim, M., Ammari, Y., Kovacic, H., & Luis, J. (2016). Rutin inhibits proliferation, attenuates superoxide production and decreases adhesion and migration of human cancerous cells. *Biomedicine and Pharmacotherapy*, 84, 1972–1978. doi: 10.1016/j.biopha.2016.11.001

[20] Perumal, S., & Langeswaran, K. (2019). Diosmin anti-tumor efficacy against hepatocellular carcinoma ., 1–10.

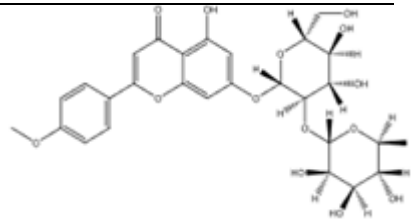
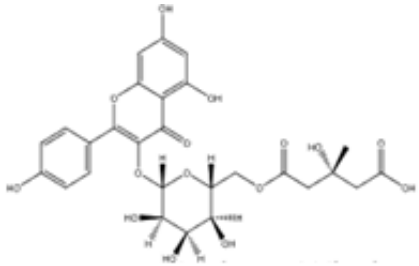
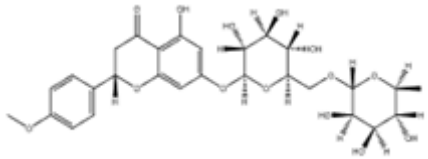
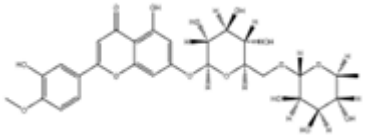
[21] Singhal, S. S., Singhal, S., Singhal, P., Singhal, J., Horne, D., & Awasthi, S. (2017). Didymin: An orally active citrus flavonoid for targeting neuroblastoma. *Oncotarget*, 8(17), 29428–29441. doi: 10.18632/oncotarget.15204

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

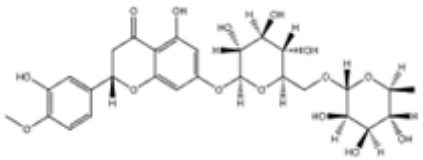
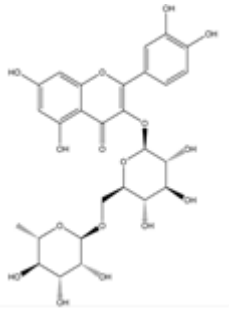
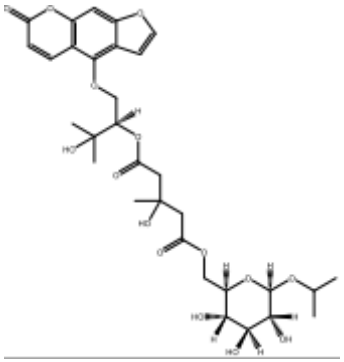
Table 1. LCMS Results of Flavonoid Compounds from the Extract of Majapahit Plant Leaves

No	Compounds	Retention Time (min)	Composition (%)	Analysis	Structure
1	*Quercetin*	11.427	1.96925	Chemical formula: $C_{15}H_{10}O_7$ Molecular weight: 302.0427 m/z : 302.0427 (100%)	
2	*Chlorogenic acid*	12.421	3.06210	Chemical formula: $C_{16}H_{18}O_9$ Molecular weight: 354.0951 m/z : 354.0951 (100%)	
3	*Kaempferol 3-O rhamnoside*	21.429	3.90389	Chemical formula: $C_{21}H_{20}O_{10}$ Molecular weight: 431.0984 m/z : 431.0984 (100%)	
4	*Acacetin 7-rutinosid*	33.702	2.69590	Chemical formula: $C_{28}H_{32}O_{14}$ Molecular weight: 592.5500 m/z : 592.1792 (100%)	

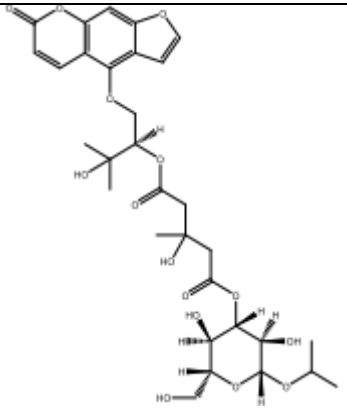
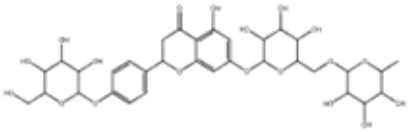
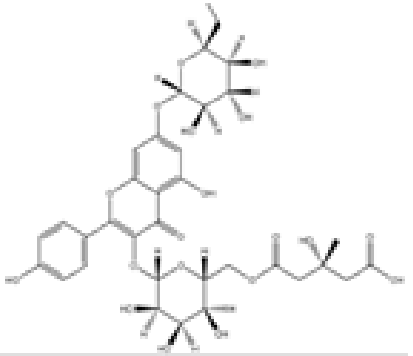
This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

No	Compounds	Retention Time (min)	Composition (%)	Analysis	Structure
5	*Fortunelin*	33.722	1.69004	Chemical formula: $C_{28}H_{32}O_{14}$ Molecular weight: 592.1792 m/z : 592.1792 (100%)	
6	*Kaempferol 3-[6''-(3-hydroxy-3-methyl glutaryl) glucoside]*	33.729	3.19042	Chemical formula: $C_{27}H_{28}O_{15}$ Molecular weight: 592.5060 m/z : 592.1428(100%)	
7	*Didymin*	34.004	1.70507	Chemical formula: $C_{28}H_{34}O_{14}$ Molecular weight: 594.5060 m/z : 594.1428(100%)	
8	*Diosmin*	35.504	1.84236	Chemical formula: $C_{28}H_{32}O_{15}$ Molecular weight: 608.5490 m/z : 608.5490 (100%)	

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

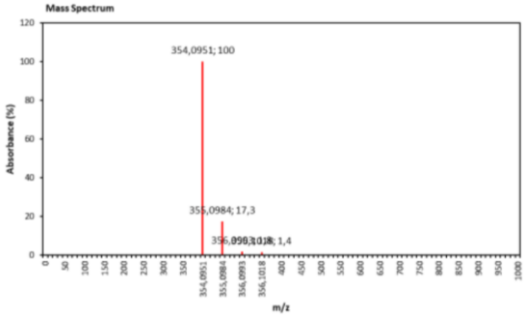
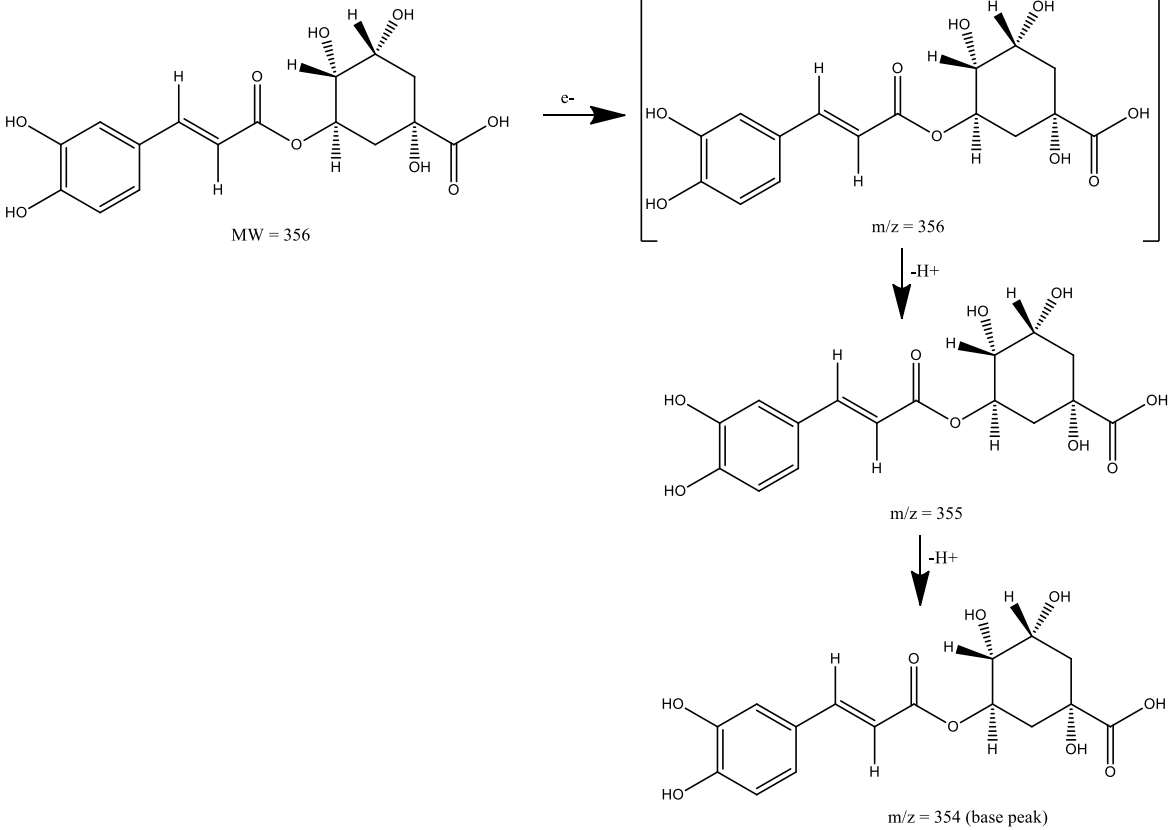
No	Compounds	Retention Time (min)	Composition (%)	Analysis	Structure
9	*Hesperidin*	35.507	3.77466	Chemical formula: $C_{28}H_{34}O_{15}$ Molecular weight: 610.5650 m/z : 610.1741 (100%)	
10	*Rutin*	35.517	3.43252	Chemical formula: $C_{27}H_{30}O_{16}$ Molecular weight: 610.1534 m/z : 610.1534 (100%)	
11	*Citrusoside C*	39.064	1.25323	Chemical formula: $C_{31}H_{40}O_{15}$ Molecular weight: 652.2367 m/z : 654.2367 (100%)	

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

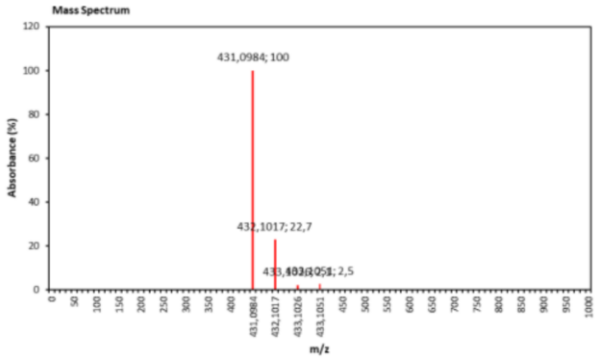
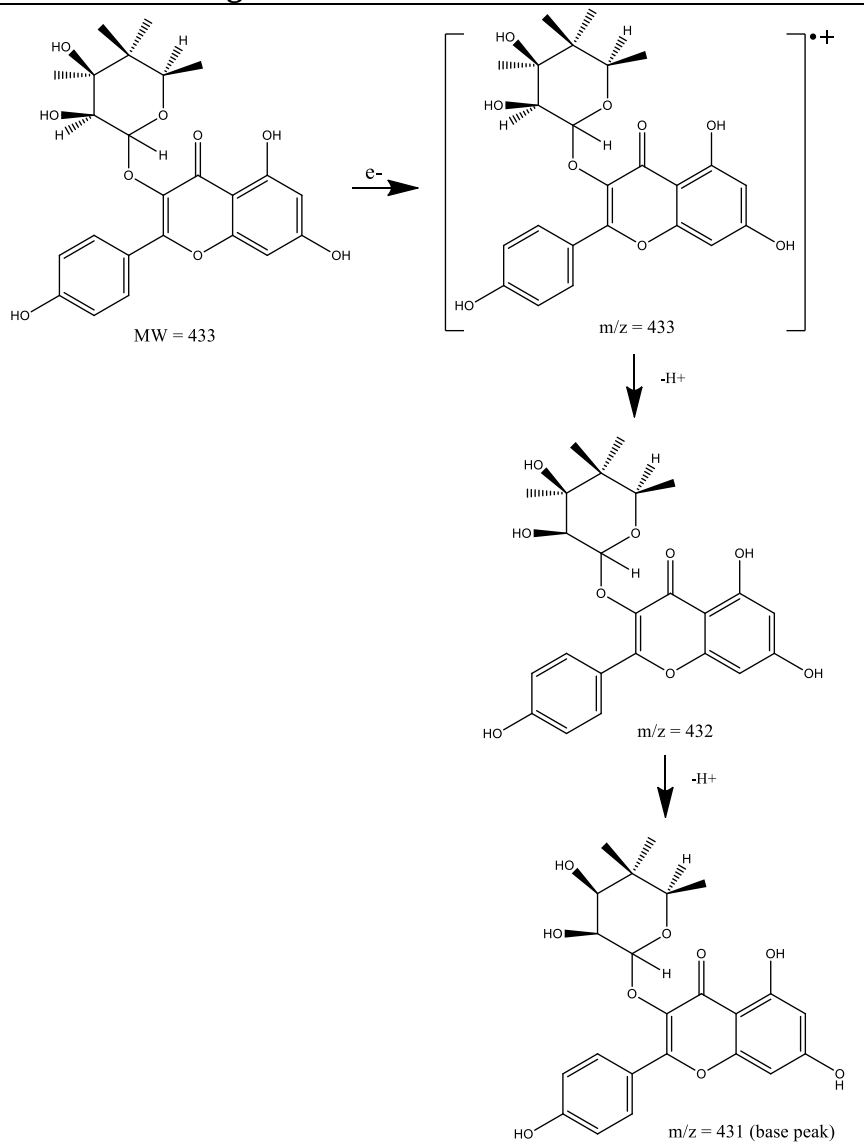
No	Compounds	Retention Time (min)	Composition (%)	Analysis	Structure
12	*Citrusosid D*	39.067	1.48975	Chemical formula: $C_{31}H_{40}O_{15}$ Molecular weight: 652.6460 m/z : 654.2434 (100%)	
13	*Narirutin 4'-glucosid*	46.301	2.21045	Chemical formula: $C_{33}H_{42}O_{19}$ Molecular weight: 742.2320 m/z : 742.2320 (100%)	
14	*Kaempferol 3-[6"-(3-hydroxy-3-methylglutaryl)glucosid] -7-glucoside*	46.564	2.60072	Chemical formula: $C_{33}H_{38}O_{20}$ Molecular weight: 754.6470 m/z : 754.1956 (100%)	

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

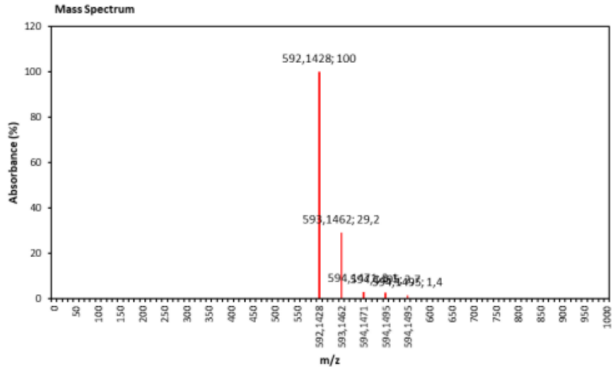
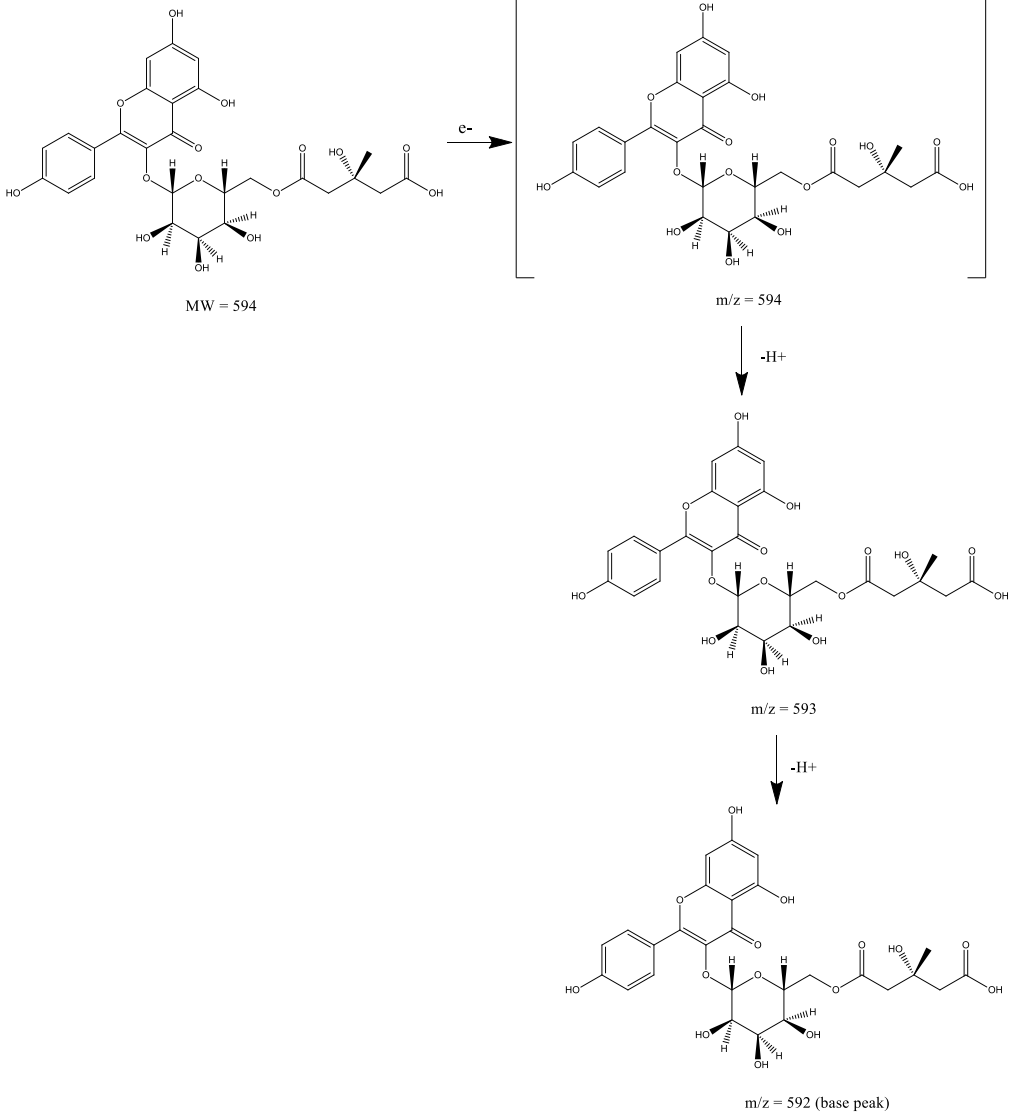
Table 2. Mass Spectrum and Fragmentation of Compounds with the Highest Composition

Name	Mass Spectrum	Fragmentation
Chlorogenic acid		

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

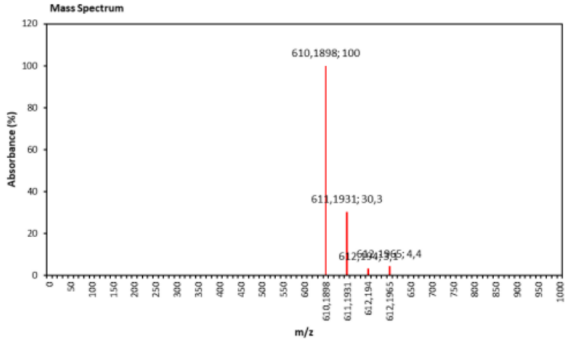
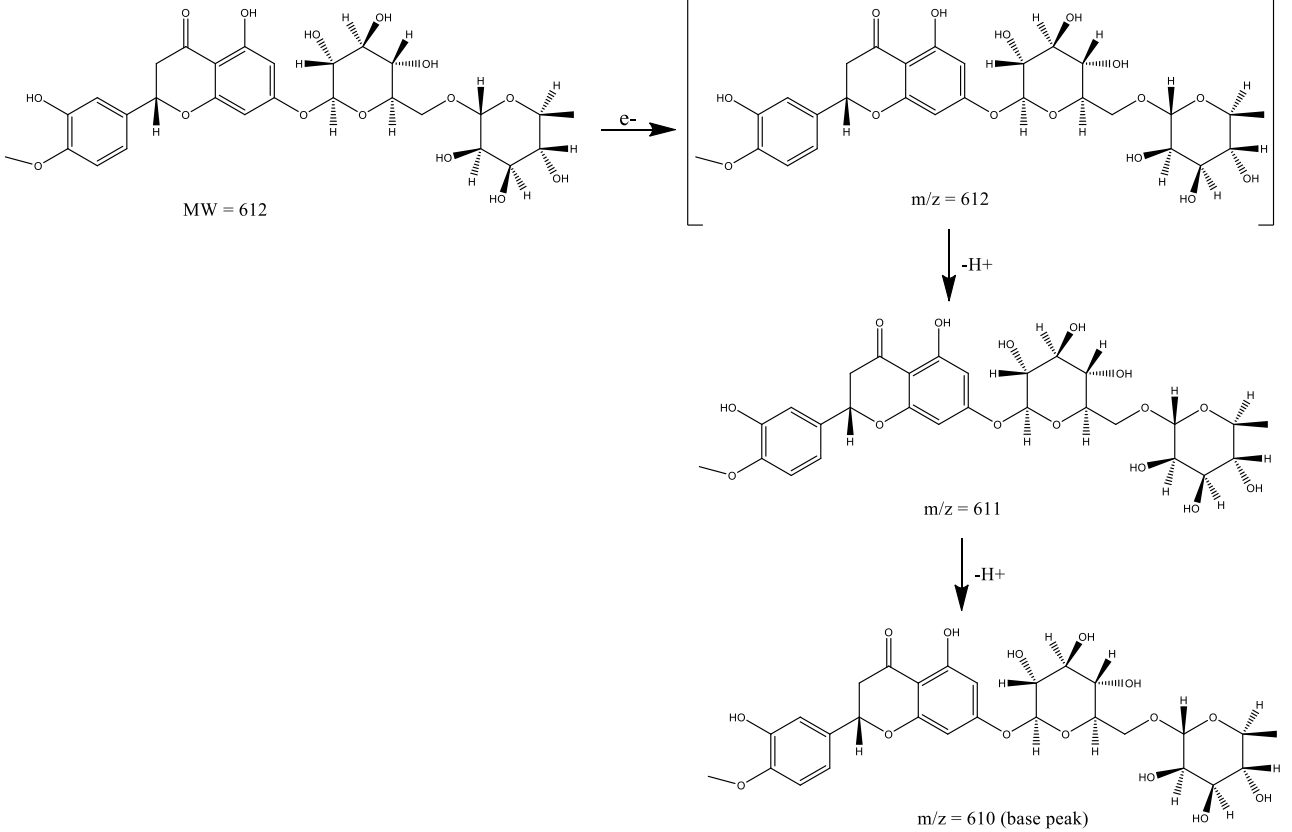
Name	Mass Spectrum	Fragmentation
Kaempferol 3-O rhamnosid		

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

Name	Mass Spectrum	Fragmentation
Kaempferol 3-[6''-(3-hydroxy-3-methyl glutaryl) glucoside]		

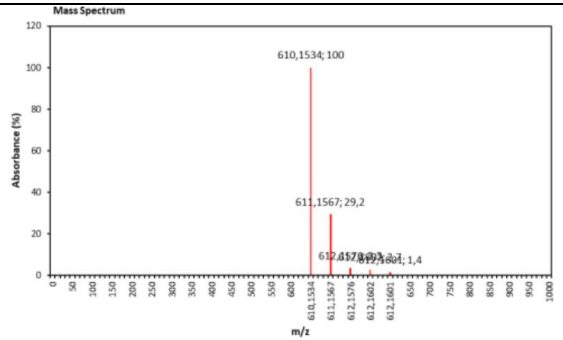
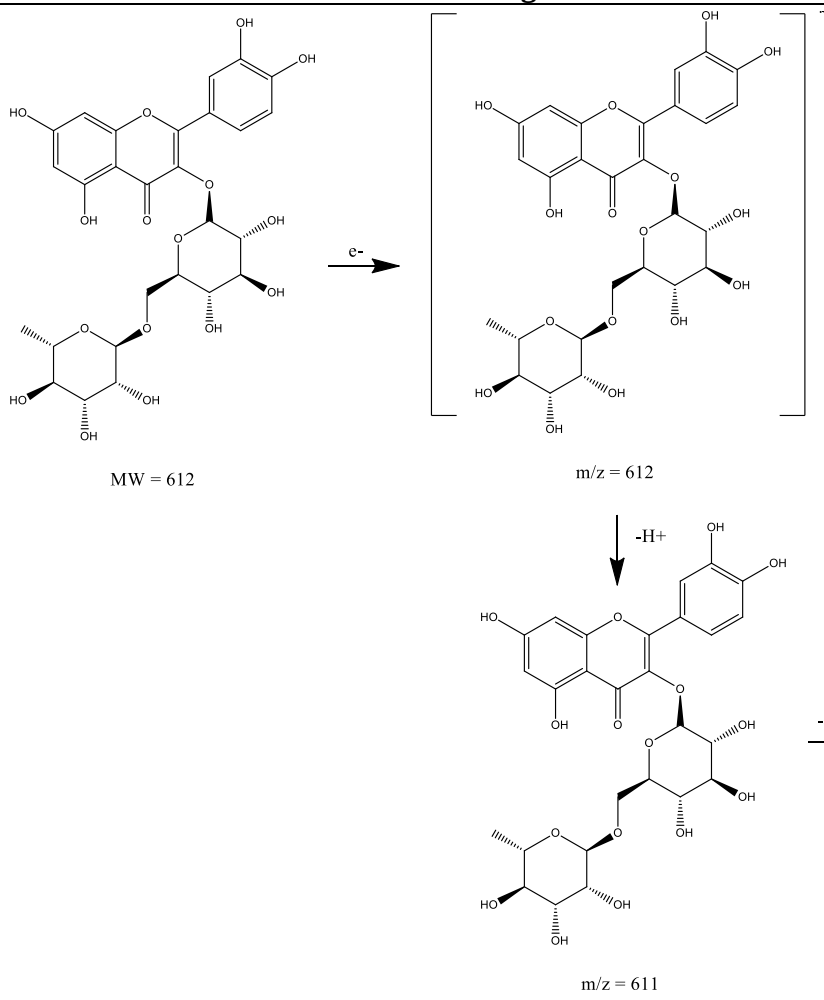
This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

Identification of Flavonoid Compounds in Ethanol Extract of Majapahit plant (*Crescentia cujete*) Leaves and their Potential as Anticancer

Name	Mass Spectrum	Fragmentation
Hesperidin		

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)

Identification of Flavonoid Compounds in Ethanol Extract of Majapahit plant (*Crescentia cujete*) Leaves and their Potential as Anticancer

Name	Mass Spectrum	Fragmentation
Rutin		

This work is licensed under the CC BY-NC-SA
(http://creativecommons.org/licenses/by-nc-sa/4.0/)