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RESEARCH ARTICLE

Analysis of the Bioactive Content of Kirinyu (Chromolaena Odorata) Extract through GC-MS Phytochemical Testing to Improve Laboratory Skills of Biology Students at Jabal Ghafur University

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ABSTRACT

Kirinyu (Chromolaena odorata) is a plant that the people of Aceh believe can cure several diseases. The results of the research that has been carried out show that the content of kirinyu extract has the potential to be antihypercholesterolemic, antibacterial, and accelerate wound healing. This research aims to determine the content of bioactive compounds contained in kirinyu leaves. The method used is the extraction of dried kirinyu leaf powder in 96% ethanol solvent, then dissolved in several reagents for phytochemical screening (alkaloids, tannins, flavonoids, steroids, terpenoids, and saponins) and analyzed using gas chromatography-mass spectrometry (GC-MS) to get polar content information. The results of the phytochemical screening showed it was positive for containing tannins, flavonoids, saponins, and alkaloids. GC-MS analysis of kirinyu leaf extract showed that there were 39 compound components extracted. The research results also showed that there were four polar bioactive compounds at the highest peak, namely 9,12-Octadecadienoic acid (Z, Z)-, delta.-Cadinene, trans (.beta).- caryophyllene and gamma.-Muurolene, obtain related laboratory skills Phytochemical screening and gas chromatography–mass spectrometry (GC-MS) analysis as authentic experiences to promote science to students.

INTRODUCTION

Kirinyu belongs to the Magnoliophyta division, class Magnoliopsida, order: Asterales, family Asteraceae, genus Chromolaena, and species Chromolaena odorata. Known as On Seurapoh among the people of Aceh-Indonesia. Kirinyu is classified as a weed in the form of a woody shrub and grows very quickly so it is difficult to control. Kirinyu plants spread widely on roadsides and empty gardens but have not been utilized optimally. This plant is very detrimental because it reduces the carrying capacity of pastures.

Kirinyu has an incomplete leaf structure. The veins reach the edge of the leaf and are curved. The central leaf vein is the largest and the others follow the edge of the leaf. Kirinyu stems are round with a hairy or hairy surface. The roots are branched taproots, large and deep. It has a long cone shape and grows straight down. The study of medicinal plants and their health potential is currently being widely developed, including kirinyu. Kirinyu's potential as a medicine is influenced by the active ingredients it contains, namely flavonoids, tannins, alkaloids, and saponins. There is currently a lot of research on medicinal plants, including the potential of the kirinyu plant. Several previous studies have proven that kirinyu is useful as an antihypercholesterolemic agent (Koban, 2019), antibacterial against Candida albicans, Pseudomonas aeruginosa (Ernawati & Jannah, 2021), Staphylococcus epidermidis, Staphylococcus aureus and Propionibacterium acnes, anti-

inflammatory (Ifora et al., 2017), accelerates wound healing (Putry et al., 2021) and treating diseases.

Currently, education in universities, including the Jabal Ghafur University Biology Education Study Program, not only produces graduates who are ready to work but also graduates who gastric are ready to face jobs that prioritize high-level thinking skills called scientific work skills (Fitriani, 2017). Scientific work skills are skills in discovering a scientific concept through scientific methods and developing it (Khoiriroh & Shofiyah, 2019). These skills are identified into 2 (two) groups, namely basic skills (observing, classifying, communicating, measuring, predicting, concluding) and integrated skills (recognizing variables, making data tables, making graphs, drawing relationships between variables, collecting data, analyzing data , formulating hypotheses, defining variables, designing research, experimenting) (Pujiastutik, 2017). Laboratory technique is a mandatory subject in the Jabal Ghafur University Biology Education Study Program which requires students to master basic laboratory techniques and be able to apply them using the equipment/materials needed to support each advanced laboratory-based course; Students can work together in groups and can carry out experiments (practicum) in the laboratory and in the field as well as analyze practicum data. However, so far learning has only focused on theory and practical introduction to simple laboratory equipment so the ability to practice and analyze experimental results is low. This series of research stages is devoted to improving the laboratory skills of students in the Biology Education study program at Jabal Ghafur University. Increasing laboratory skills is closely related to authentic knowledge and experience and connects learning with real-life according to developments in science to analyze relevant problems (Palermo et al., 2022). Therefore, this research was designed to improve the laboratory skills of Biology Education Study Program students at Jabal Ghafur University by analyzing the bioactive compound content of kirinyu (Chromolaena odorata) extract through a gas chromatography–mass spectrometry (GC-MS) phytochemical screening test.

MATERIALS AND METHODS

Place and Time of Research

This research was carried out from July to September 2023. Preparation of 96% kirinyu ethanol extract and phytochemical screening were carried out at the Pharmacy Laboratory, Faculty of Pharmacy, Faculty of Mathematics and Natural Sciences, Syiah Kuala University. Gas chromatography–mass spectrometry (GC-MS) analysis of the extract was carried out at the Environmental Quality Laboratory, Chemical Engineering Department, Faculty of Engineering, Syiah Kuala University.

Research Stages

This research is laboratory research which is divided into 3 sessions.

Session *1. Theoretical Explanation*

The background, problem formulation, and research objectives were explained to the group of students involved, namely 3 (three) students, by the instructor at the beginning of the meeting. Followed by a presentation of research procedures that had been previously prepared by the Lecturer in the Laboratory Engineering Course.

Session 2. Implementation

The implementation of bioactive content analysis activities begins with the preparation of kirinyu leaf Simplicia, extraction, phytochemical testing, and gas chromatography–mass spectrometry (GC-MS) analysis. The instructor explained how to detect bioactive ingredients through phytochemical screening and how to read GC-MS reports followed by analyzing chromatogram reports by students. The implementation stages are presented in Figure 1. Students carry out each stage of the activity according to the instructor's directions.

Session 3. Analysis of Results

The results of student research on content analysis are analyzed and discussed together. Research data is presented in a comprehensive written laboratory report.

Figure 1. Research Stages

Simplicia Kirinyu Setup

Kirinyu (Chromolaena odorata) leaves were collected from the Glee Gapui ecosystem area, Indrajaya District, Pidie Regency, Aceh Province, Indonesia. Kirinyu was chosen because of its high abundance in the area. Kirinyu leaves are washed and dried in the sun to dry. Drying is done by covering the entire surface of the leaves to avoid exposure to direct sunlight. Once dry, the sample is ground into powder and then soaked in a filter solution.

Simplicia Kirinyu Extraction

The kirinyu leaf extraction process refers to research by (Amfotis et al., 2022), namely 800 g of kirinyu leaf powder was macerated in 4 L of 96% ethanol for 72 hours. Next, it is filtered with filter paper. The resulting filtrate was evaporated using a rotary vacuum evaporator at a temperature of 40°C. And a thick extract is obtained.

Phytochemical Test

Consists of flavonoid, tannin, and alkaloid, steroid, and terpenoid tests. The testing steps are as follows:

Flavonoid Test

The flavonoid test uses the Wilstatter test, 1 g of extract is mixed with concentrated HCl and magnesium powder and shaken. A positive indicator for flavonoids is when a red-orange or yellow color forms (flavonoids from the flavonol and flavanone groups).

Alkaloid Test

2 grams of the extract was mixed with 5 mL of 2 N HCl, heated then cooled. Next, divide into 3 test tubes, 1 mL each. Each tube is added with each reagent. When Mayer's reagent is added, the indicator is positive for an alkaloid if it forms a white precipitate. or yellow. On the addition of Wagner's reagent, the alkaloid indicator is positive if a brown precipitate forms. When adding Dragendrof reagent, the indicator is positive for alkaloids if an orange precipitate forms.

Terpenoid and Steroid Test

2 grams of extract was mixed with 2 mL of ethyl acetate and shaken. The ethyl acetate layer was taken and then dripped onto a drop plate and left to dry. After drying, 2 drops of anhydrous acetic acid and 1 drop of concentrated sulfuric acid were added. A positive indicator for terpenoids is if a red or yellow color forms. And a positive indicator of steroids if a green color forms.

Table 1. Laboratory Report Assessment Rubric

Item	Proficient	Adequate	Substandard	Unacceptable (Fail)
Introduction:Objectives	Raises, exposes and explains synthetically and clearly all proposed objectives, recognising the potential and limitations of the work done.	Raises, exposes and explains adequately, but not always clearly, the proposed objectives. Recognises the potential and limitations of the work done.	Raises, exposes and explains only partially the objectives proposed, and without recognising the potential and limitations of the work done.	Raises and exposes only the objectives.
Introduction:Theory	Recognises and exposes in a clear and synthetic way the theoretical concepts on which the objectives based, and those on which the experiment is carried out.	Recognises and exposes adequately, but not always clearly, the theoretical concepts on which the objectives are based and those on which the experiment is carried out.	Recognises and exposes only some of the concepts, and reveals a lack of understanding of them.	Does not understand or know how to apply the concepts or theories in the work carried out.
Material and Methods: ExperimentalProcedure	The procedures to be followed in the lab practice are described and listed in a clear and precise way as being optimal for achieving the objectives of the topic analysed.	The procedures to be followed in the lab practice are reasonably well described and listed, and these are recognised as being consistent for achieving the objectives of the topic analysed.	The procedures to be followed in the lab practice are described and listed.	Does not identify, describe or list the procedures to be followed in the laboratory practice.
Material and Methods: Materials and Instrument Management	Describes all the elements to be used. Optimises and uses creatively the resources. Identifies that the material used is necessary to clearly address the problem analysed.	Describes the elements to be used, but these are not used optimally or creatively. Some missing materials impede an approach with clarity of the problem analysed.	There are deficiencies in the material presented and in its mode of use.	Describes but misuses or does not use optimally the items. Missing materials prevent an acceptable solution to the problem to be analysed.
Material and Methods: Experimental data handling	Presents the data obtained in an orderly way with tables, figures, diagrams, etc. All the data obtained have relevant indications and observations.	Presents the data obtained in orderly way with tables, figures, diagrams, etc. However, not all the data obtained has relevant indications.	Presents the data obtained in an unclear way. Not all the data is relevant.	Does not present data, or these are inaccurate and presented in an unclear way.
Material and Methods: Analysis of data	Uses and presents in a synthetic, clear, and critical way the equations, graphs, and diagrams or figures which relate to the problem analysed. Explains the possible data errors. An optimal processing of the data and information is achieved.	Uses and presents reasonably well the equations, graphs, and diagrams or figures which relate to the problem analysed. Explains the possible data errors. A consistent processing of the data and information is achieved.	Uses and presents in an incomplete, inaccurate, or unclear way the graphical equations, and diagrams or figures which relate to the problem analysed. Does not explain possible data errors. Only achieves a partial processing of data and information.	Does not present equations, graphs, or figures that are related to the problem analysed. Does not achieve processing of data or information.
Results:Connection observation - theory	Associates clearly and in a precise and relevant way the problem analysed with theories.	Associates reasonably well the problem analysed with theories.	The connection between the problem analysed and theory is imprecisely stated.	Fails to connect the observations obtained with the theory.
Conclusions	Draws consistent conclusions argued with the generation and synthesis of the new knowledge for the problem analysed with respect to the objectives and the case study carried out.	Draw partial conclusions argued with the generation and synthesis of the new knowledge. However, does not show coherence when connecting the problem analysed with the case study and the objectives.	Draws conclusions that do not explain the phenomenon analysed.	Unable to draw conclusions.
Critical thinking	Analyzes, evaluates, or combines relevant information to form an argument or reach a conclusion supported with evidence. Suggests improvements.	Partially analyzes, evaluates, or combines relevant information to form an argument or reach a conclusion, but with some errors.	Only minimally evaluates, or combines relevant information to form an argument or reach a conclusion, and with some errors.	Inaccurately evaluates or combines relevant information to form an argument or reach a conclusion.
Bibliography	Identifies the sources of information used	Uses the bibliography, but does not clearly identify the sources of information used.	Uses the bibliography, but does not identify the sources of information used.	Does not use the bibliography.
Team work	The group is seen to be bonding, and has a consistent idea of what was accomplished.	The group appears to be functioning well, but with not all the members having an equal understanding of what was accomplished.	The group does not appear to function well, with not all members having an equal understanding of what was accomplished.	There is very little evidence of teamwork.

Source: Tamara 2020 (Palermo et al., 2022).

Saponin Test

1 gram of extract is mixed with 10 mL of hot water, cooled, and then shaken for 10 seconds. A positive indicator of saponin is if foam forms 1-10 cm in no less than 10 minutes. And when adding 1 drop of 2 N HCl, the foam does not disappear.

Gas chromatography-mass spectrometry (GC-MS) analysis

GC-MS testing of 96% ethanol extract of kirinyu plant leaves was set for 60 minutes with an injector temperature of 270°C, detector 270°C, and column 300°C with a carrier gas, namely helium, as a carrier at a constant flow rate of 1 ml/minute. The process of identifying bioactive compounds using GC-MS is seen from the peak of the chromatogram as identification of chromatography and mass spectrometry (MS) data results seen from the mass spectrum with each molecular weight of the bioactive compound.

Measurement of Laboratory Skills and Student Responses

The results of measuring students' laboratory skills are measured after a series of activities are completed through assessing laboratory results reports. Assessment of student laboratory reports refers to the laboratory report assessment rubric (Table 1). At the end of the Laboratory Engineering course, students are asked to fill out a response questionnaire for the practical activity of analyzing the bioactive content of plant extracts through the GC-MS phytochemical test.

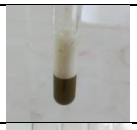
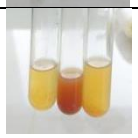
RESULTS

Phytochemical Screening

The results of the phytochemical test on the 96% ethanol extract of kirinyu (Chromolaena odorata) can be seen in Table 1 and the chemical compounds resulting from GC-MS analysis in Table 2. 96% ethanol is used as a filter because it is selective for fungal growth, has good absorbance, is neutral, and non-toxic. , requires a little heat for concentration. Apart from that, 96% of ethanol is semipolar

which is capable of dissolving active ingredients in plants, both polar, semipolar, and non-polar (Dewi, 2020).

Table 2. Phytochemical test results of Kirinyu Ethanol Extract

No	Phytochemical Test	Reactor	Observation result		Result
1	Tanin	H_2O + $FeCl_3$	The formation of a blackish green color		+
2	Flavonoid	Concentrated HCl + magnesium powder	Formation of yellow orange color		+
3	Saponin	H_2O + HCl 2N	Foam is formed that remains for no less than 1 minute		+
4	Alkaloid	Mayer's reagent Wagner's reagent, alkaloid if Dragendrof's reagent	A yellow precipitate is formed A brown precipitate forms Red Orange Precipitate		+
5	Steroid and Terpenoid	Liebermann-burchard reagent	No reddish-yellow color was formed for terpenoids Not formed. No green color for steroids		-

GC-MS Analysis

The results of GC-MS analysis show a chromatogram of 96% ethanol extract of kirinyu leaves (Figure 1). Identification of each peak in the chromatogram is done by matching the MS spectrum of each peak with the Wiley database to determine the type of compound. The analysis results show that 39 compound components were successfully extracted from the ethanol extract with different Similarity Index (SI) (Table 2) with the 5 compounds at the highest peak being 9.12-Octadecadienoic acid (Z,Z)- (7.85%), followed by .delta.-Cadinene (6.12%), trans(.beta.)-caryophyllene (5.73%), gamma.-Muurolene (5.43%) and 2-Naphthalenemethanol, decahedron-.alpha (5.29%) (Table 3).

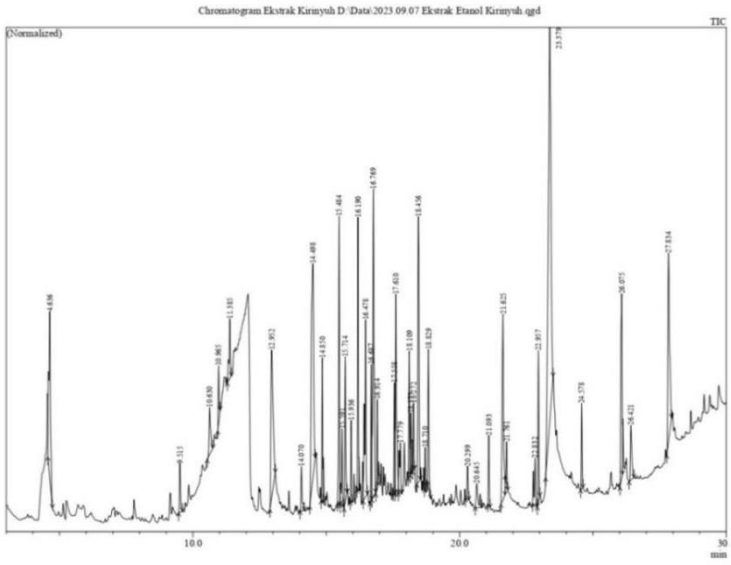


Figure 2. Chromatogram of 96% ethanol extract of kirinyu leaves (*Chromolaena odorata*)

Table 3. Chromatography Results of Kirinyu Ethanol Extract

Peak	R.Time	Area	Area%	Height	Height%	A/H	Name
1	4,636	48486380	4,34	11224118	3,32	4,32	2-Propanone, 1-hydroxy-
2	9,515	8226396	0,74	3293313	0,98	2,50	Tetrahydrocyclopenta[1,3]dioxin-4-one
3	10,630	11981259	1,07	3176797	0,94	3,77	1,4-Cyclohexanedione
4	10,965	7837710	0,70	3873580	1,15	2,02	1,2-Cyclopentanedione, 3,3,5,5-tetramethyl
5	11,385	11759300	1,05	4004964	1,19	2,94	GEYRENE
6	12,952	54837054	4,91	9927511	2,94	5,52	2,3-DIHYDRO-BENZOFURAN
7	14,070	8180330	0,73	3013594	0,89	2,71	Phenol, 4-ethenyl-2-methoxy-
8	14,498	88594664	7,93	14449419	4,28	6,13	1,2,4-Cyclohexanetriol, (1.alpha.,2.alpha.,4
9	14,850	18589432	1,66	9663641	2,86	1,92	Copaene
10	15,484	39849044	3,57	19344918	5,73	2,06	TRANS(.BETA.)-CARYOPHYLLENE
11	15,591	13153256	1,18	5153076	1,53	2,55	GERMACRENE-D
12	15,714	23359370	2,09	9748073	2,89	2,40	3,9-Dimethyltricyclo[4.2.1.1(2,5)]dec-3-en-
13	15,936	9761157	0,87	5492892	1,63	1,78	.alpha.-Humulene
14	16,190	34835351	3,12	18333339	5,43	1,90	.gamma.-Muurolene
15	16,478	40624702	3,64	11889734	3,52	3,42	.alpha.-Amorphene
16	16,687	18466381	1,65	9147406	2,71	2,02	.gamma.-Cadinene
17	16,769	65389498	5,85	20655762	6,12	3,17	.delta.-Cadinene
18	16,914	10749311	0,96	5974874	1,77	1,80	4-epi-cubedol
19	17,558	16342444	1,46	7405618	2,19	2,21	(-)-Spathulenol
20	17,610	38925349	3,48	13348130	3,95	2,92	Caryophyllene oxide
21	17,779	14307835	1,28	3388397	1,00	4,22	Benzene acetic acid, 4-methoxy-.alpha.-oxo
22	18,109	17787611	1,59	8430723	2,50	2,11	Murolan-3,9(11)-diene-10-peroxy
23	18,173	9800053	0,88	4095493	1,21	2,39	Guaiol
24	18,272	9411517	0,84	4510208	1,34	2,09	1-Naphthalenol, 1,2,3,4,4a,7,8,8a-octahydro
25	18,456	56183851	5,03	17848430	5,29	3,15	2-Naphthalenemethanol, decahydro-.alpha.,
26	18,710	4954194	0,44	2898820	0,86	1,71	(-)-Spathulenol
27	18,829	21799271	1,95	9216855	2,73	2,37	Andrographolide

28	20,299	5455161	0,49	2224553	0,66	2,45	2-Methyl-5-(2,6,6-trimethyl-cyclohex-1-en
29	20,645	9071033	0,81	1622819	0,48	5,59	Caffeine
30	21,093	8786582	0,79	4704442	1,39	1,87	Hexadecanoic acid, methyl ester
31	21,625	45027225	4,03	12476723	3,69	3,61	n-Hexadecanoic acid
32	21,761	4687282	0,42	2819221	0,83	1,66	Hexadecanoic acid, ethyl ester (CAS) Ethyl
33	22,832	11603695	1,04	3185274	0,94	3,64	9,12,15-Octadecatrienoic acid, methyl ester
34	22,957	20088610	1,80	10153649	3,01	1,98	Phytol
35	23,379	186447766	16,69	26497612	7,85	7,04	9,12-Octadecadienoic acid (Z,Z)-
36	24,578	11579286	1,04	5732283	1,70	2,02	Hexadecanoic acid, 2-hydroxy-1,3-propane
37	26,075	41493251	3,71	12424686	3,68	3,34	9-Octadecenoic acid, 1,2,3-propanetriyl est
38	26,421	13321557	1,19	3682518	1,09	3,62	Hexadecanoic acid, 2-hydroxy-1-(hydroxym
39	27,834	55416394	4,96	12682763	3,76	4,37	Propyleneglycol monoleate
		1117170562	100,00	337716228	100,00		

DISCUSSION

Phytochemical Screening

The results of phytochemical screening of the 96% ethanol extract of kirinyu leaves contain tannins, flavonoids, saponins, and alkaloids so they have potential as medicine (Table 1). Tannin is a secondary metabolite that can precipitate proteins and combine with these proteins. Tannin functions as an astringent so it is used as an antidiarrhea, stops bleeding, and prevents inflammation (Pratama et al., 2019). Tannins trigger wound tissue regeneration and re-epithelialization by precipitating complex protein lipids (Palumpun et al., 2017).

Flavonoids are the largest group of phytochemicals in plants, including hydroxy phenols (polyphenols) which have high antioxidant activity with various bioactivities, namely antioxidant (Ningsih & Advinda, 2023), antibacterial, anticancer, anti-inflammatory (Maharani & Fernandes, 2021). Phenolic compounds belong to the largest group of secondary metabolites in plants. Flavonoids found in kirinyu leaf extract include 9,12-Octadecadienoic acid (Z, Z)- and phenol, 4-ethenyl-2-methoxy-. Saponins are compounds in the form of glycosides that are widely distributed in higher plants (Putri et al., 2023). Saponin acts as an antibacterial, antifungal (Primayani, 2018), an antioxidant with a mechanism to reduce free radical activity so that it can prevent biomolecular damage (Hasan et al., 2022) so that it can heal wounds. Alkaloids are secondary plant metabolites that contain nitrogen atoms (Roy, 2017). Alkaloids function as antibacterial, antiviral, analgesic, hypotensive, and antidiabetic (Aba & Asuzu, 2018).

GC-MS Analysis

9,12-Octadecadienoic acid (Z, Z)- is a phenolic compound in the flavonoid group with the most methyl ester found in the 96% ethanol extract of kirinyu leaves. The results of GCMS analysis, 9,12-Octadecadienoic acid (Z, Z)- was found at peak 35 (thirty-fifth) with a retention time of 23,379 minutes at 7.85%. 9,12-Octadecadienoic acid (Z, Z)- functions as an antioxidant (Maharani & Fernandes, 2021), analgesic, anti-inflammatory, and ulcer genic. Phenol, 4-ethenyl-2-methoxy- belongs to the phenolic group. GC-MS test results, Phenol, 4-ethenyl-2-methoxy- was detected at peak 7 with a retention time of 14,070 minutes, as much as 0.89%.

GC-MS analysis can detect terpenoid compounds even though they are not detected through phytochemical screening. Gas chromatography is capable of detecting compounds at very low concentrations so that secondary metabolites in plants can be completely identified in the chromatography article. Terpenoids are compounds with a main group of multiples of five carbon atoms and have an aroma. Terpenoids function as antioxidants, anti-microorganisms, aromatherapy (Bergman et al., 2019), anti-diabetic (Lyu et al., 2016), wound healing, anti-inflammatory (A. Ludwiczuk, K.Skalicka-wozniak, 2017), and anti-malarial (Maharani & Fernandes, 2021). Trans(.beta.)-caryophyllene is the most abundant terpenoid in Kirinyu leaves, found in the 10th (tenth) peak with a retention time of 10,484 at 5.73%. trans(.beta.)-caryophyllene functions in reducing pro-inflammatory mediators, repairing cell damage, and curing various metabolic diseases (Scandiffio et al., 2020).

Phytol belongs to the diterpenoid group. From the GCMS test results, phytol was detected at the 34th (thirty-fourth) peak, with a retention time of 22,957 minutes, as much as 3.01%. Phytol acts as an antioxidant, anti-inflammatory, and antimicrobial, and improves the immune system. In the body, Phytol can activate peroxisome proliferator-activated receptors (PPARs) so that it functions as an antidiabetic (Lyu et al., 2016).

Gamma-Cadinene, Delta.-Cadinene, gamma.-Muurolene and 2-Naphthalenemethanol, decahydro-.alpha are sesquiterpenoids. The results of GC-MS analysis, Gamma-Cadinene was found in the 16th (sixteenth) peak with a retention time of 16,687 of 2.71% and Delta.-Cadinene was found in the 17th (seventeenth) peak with a retention time of 16,769 of 6.12%. Gamma-Muurolene was found at the 14th (fourteenth) peak with a retention time of 16,190 minutes, amounting to 5.43%. 2-Naphthalenemethanol, decahydro-.alpha was found at the 25th (twenty-fifth) peak with a retention time of 18,456 minutes, amounting to 5.29%.

Laboratory Skills

The use of the laboratory for analyzing the Bioactive Content of Plant Extracts through the GC-MS Phytochemical Test for students of the Jabal Ghafur University Biology Education study program has only been applied for the first time in the Laboratory Engineering course, where in 2023, kirinyu (Chromolaena odorata) was chosen as the sample. Kirinyu was chosen because of its abundance in the Jabal Ghafur University campus area with a variety of medicinal properties. Evaluation of students' laboratory skills is carried out based on laboratory results reports. Laboratory result reports are evaluated based on a rubric (Table 1), and the success rate qualifications are descriptive (proficient, adequate, below standard, unacceptable).

In this laboratory activity, students gain new and better knowledge and learning experiences about laboratory techniques including extraction methods, phytochemical tests, how gas chromatography works, and how to analyze the results. Rubrics are very useful in research and learning. Rubrics are used to assess concept mastery of the material, skill development, and scientific attitudes (Mullinix, 2014). For instructors, rubrics help in coordinating instruction and assessment so they must be structured according to the criteria to be measured. For students, rubrics help them obtain results that are on target, transparent, and fair (Reynders et al., 2020).

Laboratory training for analyzing the Bioactive Content of Plant Extracts through GC-MS Phytochemical Testing has a positive impact on students' understanding and learning practices. There has been a significant increase in skills, both oral and written communication skills as well as extraction skills, phytochemical testing, how gas chromatography works, and how to analyze GC reports.

CONCLUSION

Based on the research results, it is concluded that Phytochemical screening of 96% ethanol extract of kirinyu (Chromolaena odorata) containing tannins, flavonoids, saponins, and alkaloids which have potential as traditional medicine. The results of GC-MS analysis show that 39 compound components were successfully extracted from the ethanol extract with different Similarity Index (SI) with 5 compounds at the highest peak being 9.12-Octadecadienoic acid (Z, Z)- (7.85%), followed by .delta.-Cadinene (6.12%), trans(.beta.)-caryophyllene (5.73%), gamma.-Muurolene (5.43%) and 2-Naphthalenemethanol, decahedron-.alpha (5.29%). Realization of laboratory practicum activities to improve student laboratory and communication skills.

Author Contributions

ED conceptualized the study and supervised the research project, performed data analysis and interpretation, wrote the manuscripts. WS and A conducted the experiments and collected data. RA wrote the manuscript and prepared the figures. All authors reviewed and approved the final manuscript.

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