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Analysis of Flavonoid Levels in Processed Moringa Leaf Products *(Moringa oleifera Lam)* as a Source of Chemistry Learning

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This study aims to determine the levels of flavonoids in processed products of Moringa leaves (*Moringga oleifera Lam*) by using them as a source of chemistry learning. The samples used in this study were Moringa leaf tea and Moringa leaf sticks. The levels of flavonoids in processed Moringa leaf products were analyzed using the maceration method with a concentration test using UV-Vis spectrophotometry at a wavelength of 436.0 nm. Test the feasibility of learning chemistry resources using a team of experts and small groups. The results showed that Moringa leaf tea samples were 1.15 ± 0.098 g/100 g, and Moringa leaf sticks were 0.11 ± 0.014 g/100 g. Based on the results of the study, researchers can draw the conclusion that the processed product of Moringa leaves that has the best flavonoid content is Moringa tea with a value of 1.15 ± 0.098 g/100 g so that repeated heating processing can affect flavonoid levels and the results of the feasibility test of learning resources. chemistry obtained a value of 88.25% which indicates that the results of this study are very suitable to be used as a source of chemistry learning in the form of a practicum guide.

Keywords: Flavonoids; moringa leaf processed products; UV-Vis spectrophotometry; chemistry learning resources

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Indonesia is a country rich in natural resources, especially plants. This can be seen in the diversity of plants that live in the form of vegetables, fruits, and others. This biodiversity needs to be researched, developed and utilized for the improvement of health and economic goals, while maintaining its sustainability. Indonesians have known and utilized medicinal plants to overcome health problems. One of the components contained in plants is antioxidant substances, such as tannins, alkaloids, flavonoids, saponins, and others [1].

Indonesia is a country rich in natural resources, both animals and plants can be used as a source of medicine or nutritious food. One of the plants that can be used as food and medicinal materials is *Moringa oleifera Lam* [2].

Moringa oleifera Lam is a versatile plant because almost all parts of the Moringa plant can be used as a food source because it contains many complete nutrients. Internationally, Moringa is known as the "Tree of Miracles" or "Tree of Life", and this is not because the super nutrient content of Moringa has been verified by various scientific research institutes and universities around the world for no reason. And, this information was later used in humanitarian campaigns to address malnutrition in impoverished African countries. Millions of people have been saved by consuming Moringa. *Moringa oleifera* plant parts such as leaves, roots, seeds, bark, fruits, and flowers serve as heart-stimulating and circulatory with antitumor, anti-hypertensive, cholesterol-lowering, antioxidant, antidiabetic, anti-bacterial, and antifungal properties [3].

Parts of this plant such as leaves, stems, bark, fruits, flowers, roots, and seeds contain secondary metabolites or chemical compounds that can be developed as medicines [4].

According to the results of research from Oluduro (2012) that the content of the Moringa plant (*Moringga oleifera Lam*) consists of phytochemical components, alkaloids 0.4 %, tannins 0.33 %, saponins 18.34 %, flavonoids 0.77 %, phenols 0.29%. The content of compound components in this plant has many benefits for the human body, one of which is flavonoids [5].

Moringa leaves are part of the *Moringa oleifera* plant and have been widely studied for its nutritional content and uses. Moringa leaves are rich in nutrients, including calcium, iron, protein, vitamin A, vitamin B, and vitamin C. Moringa leaves have a higher iron content than other vegetables, namely 17.2 mg / 100 g (Yameogo et al. 2011 in Aminah, Syarifah, et al., 2015). In addition, Moringa leaves also contain various amino acids, including aspartic acid, glutamic acid, alanine,

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valine, leucine, isoleucine, histidine, lysine, arginine, amino acids such as alanine, tryptophan, cysteine and methionine [6].

Moringa leaves are one part of the Moringa plant which is often consumed as an ingredient in food and drinks, Moringa leaves are very easy to find anywhere and the price is fairly economical. Moringa leaves can be processed in various ways, for example, they can be processed into processed vegetables, flour, tea and can also be used as Moringa sticks.

Food and beverages according to BPOM in 2003 are sources of energy and various nutrients to support human life. Food and drink can be a disruptive element for human health, entering through food in a certain way. Food is important in human life, food and beverages not only meet nutrition but must also be safe in the sense that it does not contain microorganisms and chemicals that can cause disease.

Processed food and beverage products such as sticks and teas have bioactivity because they are caused by high antioxidants such as phenolic compounds and flavonoids. Heating in the process of making food and beverage products can maintain the quality of food and beverages from microorganisms [7].

Flavanoids are antioxidant compounds that act as neutralizers of free radicals and cell regeneration (Khaira, 2010). Flavanoids are found in all parts of the Moringa plant, including Moringa leaves. Mulyo (2007) has proven it through the results of his research which shows the content of active secondary metabolites in Moringa leaves, namely flavanoids, alkanoids, tannins, and saponins [5].

Learning is a two-way communication process, teaching is carried out by the teacher as an educator and learning is carried out by students as students. Learning activities carried out by students are a process of effort made by a person to obtain a new change in behavior as a whole, as a result of his own experience in interaction with his environment (Slameto, 2003: 2). Learning according to E. Mulyasa (2006: 255) is essentially a process of interaction between students and their environment, so that there is a change in behavior for the better. Chemistry learning cannot be separated from the understanding of learning and understanding chemistry itself [8].

Chemistry is a science that seeks answers to the what, why, and how of natural symptoms related to the composition, structure and nature, changes, dynamics, and energetics of substances. Therefore, chemistry subjects in SMA / MA learn everything about substances which includes the composition, structure and properties, changes, dynamics, and energetics of substances involving skills and reasoning. There are two things related to chemistry that cannot be separated, namely chemistry as a product (chemical knowledge in the form of facts, concepts, principles, laws, and theories) and chemistry as a process, namely scientific work [9].

Chemistry learning is the process by which students interact with the environment to achieve chemistry learning goals. The quality of learning or the achievement of learning objectives is strongly influenced by several factors. For example, teaching strategies, learning methods and approaches, and learning resources in the form of books, modules, LKS, media, and others [10].

METHOD

This research is a type of laboratory experimental research with 2 processed moringa leaf products and 2 repetitions (duplo) on Moringa leaf sticks and Moringa leaf tea which are used to analyze flavonoid levels with the final results of a source of chemistry learning. This research was carried out at the FKIP chemistry laboratory and the FMIPA laboratory of Tadulako Palu University, Central Sulawesi. The samples used in this study were Moringa leaves which were processed by making Moringa leaf sticks and Moringa leaf tea.

Data Collection Techniques

The process of researching the content of flavonoid levels in processed Moringa leaf products begins with the manufacture of a standard solution of quercetin to determine the calibration curve. The procedure for making a standard solution of quercetin, starts with weighing the standard quercetin standard of 0.010 grams, then put it in a 10 mL measuring flask. Adding ethanol to the limit mark (Mother liquor 100 mg/L). A series of standard solutions of 10, 20, 40, 60, and 80 ppm is made. Then pipette each standard solution of quercetin as much as 1 mL into the test tube and then labeled, then add a 95% ethanol solution of 1.5 mL, aluminum chloride $AlCl_3$ 10% as much as 0.1 mL, Sodium acetate 1 M as much as 0.1 mL, aquades as much as 2.8 mL after that incubated for 30 minutes. Measure its uptake at the maximum wavelength obtained using a UV-Vis spectrophotometer. From the calculation of the curve regression equation obtained the equation of the line y = 0.0156x – 0.1279 with a regression coefficient (R^2) of 0.962.

The process of analyzing the flavonoid content begins with weighing each extract sample of 0.5 grams. Adding ethanol to the limit mark (Mother liquor 100 mg/L). Then pipettes of each extract sample as much as 1 mL into the test tube and then labeled, then add a 95% ethanol solution of 1.5 mL, aluminum chloride $AlCl_3$ 10% as much as 0.1 mL, 1 M acetic acid as much as 0.1 mL, aquades as much as 2.8 mL after that incubated for 30 minutes. Measure the absorption at the maximum wavelength obtained 436.0 nm using a UV-Vis spectrophotometer, after which it calculates the results of each sample so as to obtain results.

Creation and Validation of Chemistry Learning Resources are analyzed using the following steps:

1. Design learning resources. At this stage, the researcher designs learning resources in the form of guidelines by including the research results obtained.

2. Validate learning resources. Validation is carried out by a team of experts after the creation of the learning resource guide completed, with three experts namely design experts, content experts and learning resource media experts.

3. Revision of learning resources. Revision of learning resources is carried out to improve and reduce the weaknesses contained in these learning resources.

4. Trial and error. The trial was carried out to 30 students as respondents and several expert lecturers at the Chemistry Education Study Program, Faculty of Teacher Training and Education.

Data Analysis Techniques

The data analysis technique in this study is divided into two techniques, namely flavonoid content analysis and learning media analysis. Using the formula:

Flavonoid Content Analysis:

$$\textbf{Flavonoid Levels 100 g (F)} = \frac{C \times V}{g\ Extract} \textbf{x 100}$$

Description:

F = **Flavonoid Levels** (mg/100g)

C = Quercetin Equality (mg/L)

V = Volume (L)

g extract = Sample Weight of the Extract (g)

Learning Media Analysis:

$$\text{Average} = \frac{\text{The overall number of percentages}}{\text{Number of assessment aspect items}}$$

Table 1. Learning Media Eligibility Percentage Category.

Percentage	Feasibility
81% - 100%	Very Worthy
61% - 80%	Proper
41% - 60%	Decent enough
20% - 40%	Less viable
0% - 20%	Not worth it

[11].

RESULTS AND DISCUSSION

The results obtained from this study regarding the Analysis of Flavonoid Levels in Processed Moringa Leaf Products (*Moringga oleifera Lam*) using UV-VIS spectrophotometry and its use as a source of chemistry learning. Data on flavonoid levels from processed Moringa leaves (*Moringga oleifera Lam*) include products such as Moringa Leaf Tea and Moringa Leaf Sticks. Determination of flavonoid content is used raw quercetin. The use of quercetin as a standard standard because quercetin is one of the flavonoid glycoside groups that are found in many types of plants using a maximum wavelength of 400 nm. The standard curve obtained in the study has the equation of the line y = 0.0156x – 0.1279 with a regression value of 0.962 (Figure 1). Regression values close to 1 indicate that there is a relationship with high linearity between the concentration of quercetin and its absorbant value [12].

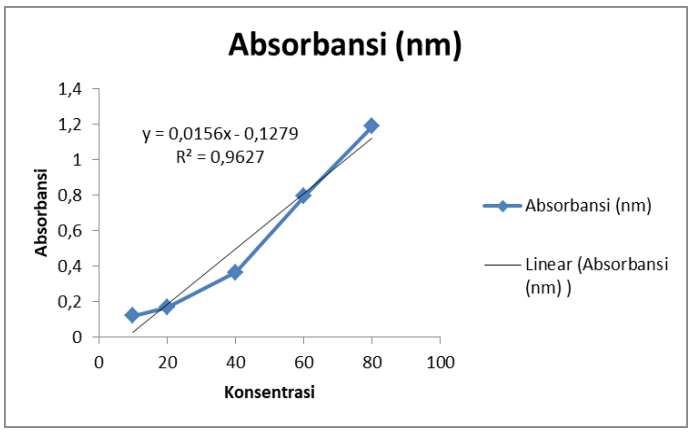

Figure 1. Quercetin Standard Solution Absorbance Graph.

Table 2. Flavonoid Level Test Results of Moringa Leaf Processed Products.

No	Sample	Flavonoid Levels (g/100g) (mean±SD)
1.	Moringa Leaf Powder	1,41 ± 0,014
2.	Moringa Leaf Tea	1,15 ± 0,098
3.	Moringa Leaf Sticks	0,11 ± 0,014

The results obtained from the test of flavonoid levels in Moringa Leaf Processed Products (*Moringga oleifera Lam*) can be seen in Table 2.

Based on the results of research, flavonoid levels in processed Moringa leaf products with their absorption results at a wavelength of 436.0 nm, namely for samples of Moringa leaf powder 1.41 ± 0.014 grams / 100 g, Moringa leaf tea 1.15 ± 0.098 grams / 100 g, and Moringa leaf sticks 0.11 ± 0.014 grams / 100 g. The results of the study can be concluded that the flavonoid content in Moringa tea has decreased flavonoid levels with a value of Moringa Leaf Tea of 1.15 ± 0.098 grams / 100 g with a sample comparison of Moringa Leaf Powder of 1.41 ± 0.014 grams / 100 g due to the process of processing Moringa tea through drying in direct sunlight. Meanwhile, Moringa sticks experienced a decrease in flavonoid levels with a moringa leaf stick value of 0.11 ± 0.014 grams / 100 g with a comparison of Moringa Leaf Powder samples of 1.41 ± 0.014 grams / 100 g due to the processing process through several stages of heating which results in reduced flavonoid levels in the sample. This is in accordance with research [13] The higher the filtering temperature the lower the flavonoid content. The use of high temperatures in the filtering process results in low levels of flavonoids in foodstuffs. The higher the temperature, the flavonoid compounds will be damaged.

This flavonoid level analysis study used UV-Vis spectrophotometry which was carried out with two repetitions to increase accuracy in conducting the analysis. based on this study, it shows the content of flavonoid levels in moringa stick samples and Moringa tea. From the research data obtained moringa sticks and Moringa tea can be recommended as functional foods and drinks with flavonoid levels that are beneficial to the body as secondary antioxidants that work to decide oxidation reactions and capture free radicals. According to [14] states that foods and drinks containing flavonoids can inhibit the occurrence of degenerative diseases such as cancer, heart disease, inflammation and premature aging.

The results of the calculation of the percentage of assessment of the feasibility of chemistry learning resources in the form of practicum guidance by a team of experts, then these results are obtained, can be seen in Table 3 as follows:

Table 3. Percentage Results of Assessment of Feasibility of Chemistry Learning Resources by a Team of Experts.

	Expert Team Percentage Results				
	Expert Team	Sum		Average	
		Grading scale	Percentage	Grading scale	Percentage
1.	Content expert	48	960	4,8	96
2.	Design expert	75	1480	4,93	98,67
3.	Media experts	52	1040	3,71	74,28

Table 4. Percentage Results of Assessment of Feasibility of Chemistry Learning Resources By student groups.

Respondent	Sum Respondent	Student group presentation results			
		Sum		Average	
		Grading scale	Percentage	Grading scale	Percentage
Student	30	33,63	672,6	4,20	84,08

The percentage of the percentage assessment of the feasibility of chemistry learning resources in the form of practicum guides after validation by a team of experts / lecturers which includes content experts, design experts and media experts. Furthermore, learning media in the form of practicum guides is assessed by a group of 30 students. The results can be seen in Table 4 as follows.

The feasibility level of practicum guidance as a source of chemistry learning can be known by validating by a team of experts, namely content experts, design experts and media experts. After validation by a team of experts, successive percentage values were obtained at 96%, 98.67% and 74.28% with an average value of 89.65%. Based on the average value obtained from the expert team then the guidance is declared "very feasible". The feasibility of this practicum guide, based on the assessment analysis according to [11]. So that it can be used as a source of chemistry learning. After the validation process was carried out by a team of experts (lecturers), the practicum guide was again tested for feasibility on students of the Chemistry Education Study Program, totaling 30 respondents. Based on the results of the feasibility test of 30 students, a grading scale was obtained that almost reached the maximum with a total score of 33.63 and an average of 4.2 and a percentage score of 84.08% this indicates a "very feasible" category. Thus, the average validation value from the expert team and students is 88.25%, this proves that the practicum guide for analyzing flavonoid levels in processed Moringa leaf products (*Moringga oleifera Lam*) based on assessment analysis according to [10] is very feasible to be used as a source of chemistry learning.

CONCLUSION

Based on the results of the study, the researchers can draw conclusions that the processed moringa leaf product that has the best flavonoid levels is Moringa leaf tea with a value of 1.15±0.098 grams / 100 g and the results of the feasibility test source Chemistry learning obtained a score of 88.25% which shows that the results of this study are very worthy of being used as a source of chemistry learning in the form of practicum guides.

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