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Development of Practicum Instructions for Junior High School Students: Formalin Test Using Natural Indicators

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Abstract. The purpose of this study was to develop a formaldehyde test practicum instructions using natural indicators for the first high school students. This research method refers to the development procedure developed by Borg and Galls. The trial of 104 leaf and flower crown samples which were estimated to have potential as a natural indicator for formalin testing was carried out. Only 3 natural indicators can be used for drops and filter paper, namely flower: ribosa ruellia, hibiscus rosa-sinensis L and balsamina Impatiens L purpel. Based on the results of the expert assessment and the teacher showed that the practicum instructions were suitable for use by junior high school students to test formalin.

1. Intruduction

Formalin is the trade name of formaldehyde solution in water with levels of 10-40%. In the market, formalin can be obtained in a diluted form, with levels of formaldehyde 40, 30, 20 and 10% and in the form of tablets weighing about 5 grams each. Formalin is a solution that is colorless and smells very piercing. In formaldehyde, about 37% of formaldehyde is contained in water. Methanol is usually added to 15% as a preservative [1]. Formalin has a pH of 2.8-4.0 [2]. In the last few years, there is still an abuse of formalin for food ingredients. Formalin is often misused as a supplementary snack [3].

Pure formalin is a formaldehyde solution saturated in water (37% by weight) [4]. It is unstable in water because it blends in a few hours by sunlight or by bacteria. However, when digested by the body with concentrations above 2.6 mg / L through contaminated food or water, formaldehyde has been shown to cause vomiting, abdominal pain, dizziness, and in extreme cases can cause death. The use of formalin can cause irritation, genotoxicity and cancer [5].

There have been various studies in formalin identification that have been carried out, the development of fluorophotometric methods for the determination of formaldehyde in environmental waters, based on the reaction of formaldehyde with acetoace-tanilide and ammonia [6]. Determination of formaldehyde levels in human saliva. Formaldehyde was determined as an addition to dimedone (formaldemethone) using OPLC [7]. Determination of total formaldehyde in drinking water samples in 1 liter of water was derivatized with 2,4-dinitrophenylhydrazine in acidic medium and then extracted with chloroform. After separation by solvent extraction, the product was confirmed using reverse phase liquid chromatography [8]. In 2010 proposed a simple and fast catalytic kinetic method (based on the

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catalytic effect of formaldehyde on cresylviolet oxidation by bromate in the presence of sulfuric acid) for the determination of the amount of formaldehyde in water samples [9]. The method of identifying the most widely used formalin for aqueous samples is high performance liquid chromatography (HPLC). Other methods that can be used are colorimetry, fluorimetry, polarography, gas chromatography (GC), infrared detection, injection flow analysis and gas detector tubes [10]. HPLC or GC combined with mass spectrometers (MS) are the most sensitive techniques, but require very expensive costs.

Some of the methods described to test formalin are very expensive and very difficult to implement for junior high school students. various methods must be carried out in the laboratory using complete tools and materials. This study aims to develop practicum instructions for formalin testing so that junior high school students can carry out these activities. Formalin test method developed in this study uses natural indicators derived from plants in Indonesia. Test methods are carried out in a simple, inexpensive, and fast way for qualitative testing. The practicum tools developed in this study are practicum instructions and formaldehyde test materials.

2. Method

2.1. Method Reseach

The development procedure used in this research and development is procedural development where the steps are explained in a concrete and detailed manner. The development procedure carried out refers to the procedure developed by Borg and Galls [11]. Borg and Gall found that the development research procedure basically consisted of two main objectives, namely developing products and validating the products produced. The description of this development model is explained in **Figure 1**.

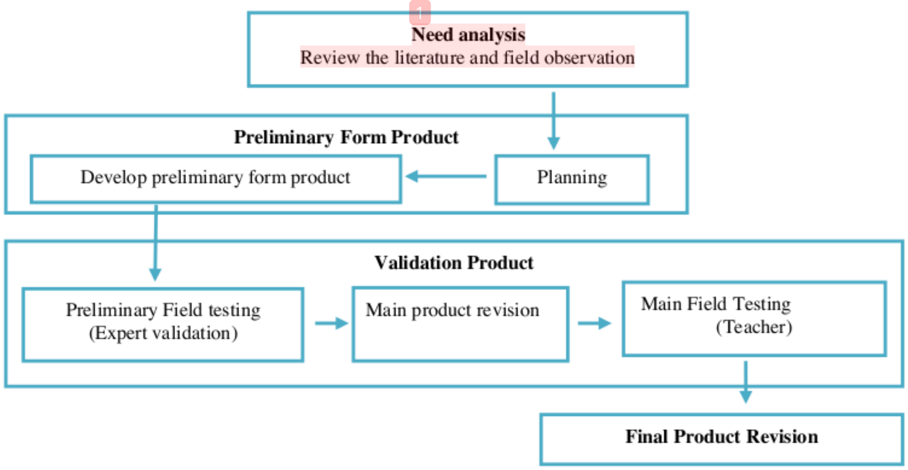

Figure 1. Model development practicum instructions

Details of the research procedures that have been carried out are as follows:

- Library study activities by looking for literature relevant to research. Literature study was conducted to gather information, including studying the curriculum of integrated science subjects for junior high schools, reviewing the literature on the physical and chemical properties of formalin
- Field observations are carried out to see firsthand the state of the school environment, the potential of natural resources that can be used as a natural indicator. Field observations were carried out in West Nusa Tenggara Province.

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- Planning experiments on formalin experiments with natural indicators. The draft Practicum Directive begins with a laboratory experiment using pure ingredients of formalin compounds by using various types of natural materials that exist around the environment. At this stage also began to be designed simple materials for formalin test indicators. Formalin test practicum method with natural indicators as follows:
  - Weigh 2 grams of natural indicator material, then cut into small pieces
  - Grind natural indicators by using mortal
  - Add 5 ml of distilled water to the crushed indicator
  - Separate filtrate with indicator residues
  - Take 5 drops of the filtrate indicator then add 5 drops of formalin solution
  - Observe the color changes that occur
- Develop preliminary product form using filter paper for a simple formalin test tool. How to make indicator paper as follows:
  - Cut the filter paper with a length of 7 cm and a width of 0.5 cm
  - Dip filter paper into the filtrate indicator
  - Dry for 4 hours until indicator paper can be used
  - The step of the formalin test practicum with natural indicators is then compiled in practical instructions that can be used by junior high school students.
- Preliminary Field testing by validating by 1 chemist and 1 expert in science education
- Play product revision based on input from expert validation
- Playing Field Testing was conducted to 8 teachers in several schools in West Nusa Tenggara Province

2.2. Data Research Tools
The instrument used in this study is a questionnaire on the feasibility of products that have been developed. Preliminary Field testing is given a questionnaire to chemists and science education experts. Main field testing was given a questionnaire to 8 teachers in several schools in the province of West Nusa Tenggara. The questionnaire used contains 3 aspects of assessment: disability, graphics and practicality of use. Readability aspect: the instructions for using the formalin test practicum book with natural indicators are easy to understand, the statements and sentences in the formalin test instruction with natural indicators are easy to understand, the size and model of the letters used in the formalin test instruction are clearly visible and easy to use. Graphical aspect: the drawings on the formalin test instruction with natural indicators look attractive and clear, the cover in the formalin instruction with natural indicators looks attractive. Practical aspects of use: the use of formalin test practicum instructions with natural indicators is easy to use, the use of time is more effective when practicum with practical instructions formalin test with natural indicators, the information provided in the formalin practicum instructions with natural indicators makes practicum more active, creative, and fun, the procedures and work steps are presented in a clear and easy to use.

2.3. Data Analysis
Feasibility questionnaire for device products formalin test is provided to experts and teachers. The data obtained from the questionnaire were changed to interval data. The questionnaire provided contains five choices to provide feedback about the practicum instruction products that have been developed, namely: very good (5), good (4), good enough (3), not good (2) and very poor (1). If the respondent gives a "very good" response then the statement item is given the number "5" and so does the other. The score obtained is then converted to a value on a scale of 5 with a table reference quoted from Saifuddin Azwar [12], as given in Table 1:

Table 1. Conversion of Actual Scores to Five-Scale Values

Score Interval	Value	Categori

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$X > x_i + 1{,}5\ SB_i$	A	Very good
$x_i + 0{,}5\ SB_i < X \leq x_i + 1{,}5\ SB_i$	B	Good
$x_i - 0{,}5\ SB_i < X \leq x_i + 0{,}5\ SB_i$	C	Good enough
$x_i - 1{,}5\ SB_i < X \leq x_i - 0{,}5\ SB_i$	D	Not good
$X \leq x_i - 1{,}5\ SB_i$	E	Very poor

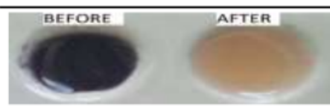
Information:
xi = Average ideal score = 1/2 (ideal maximum score + ideal minimum score)
SBi = Ideal standard deviation = 1/6 (ideal maximum score - ideal minimum score)
X = Actual score (score achieved)
Ideal maximum score = Σ item criterion x highest score
Ideal lowest score = Σ item criterion x lowest score

3. Result and Discussion

Early identification of plants that are used as a natural indicator to test formalin is that which has a bright color other than white, because the color of the formalin solution is clear white. There are two parts of the plant that are used as the test material, namely leaves and flower crowns. Based on the results of field observations that have been carried out on plants in the West Nusa Tenggara Province, 104 leaf and flower crown samples were taken which are thought to have potential as natural indicators for formalin testing.

Based on the results of the trial of 15% formalin solution using various ingredients that have been identified, 3 samples of indicators can be used, namely: *ruellla ribosa*, *hibiscus rosa-sinensis* L and *impatiens balsamina L* purple. The following are the results of the 15% formalin trial with these 3 types of indicators given in Table 2.

Table 2. Test results of natural indicators

Natural indicator	Drop test results	Results with indicator paper
Ruellla Ribosa		
Article I. Hibiscus Rosa-Sinensis L.		
Article II. Impatiens Balsamina L.		

After finding natural indicators that can be used for formalin testing, a practical guide will be developed that be used by junior high school students. Cover and contents of the practicum instructions that have been developed is given in Figure 2.

Figure 2. Cover dan conten practicum instruction

The practicum instruction that have been developed are validated by experts and request responses from teachers with questionnaire instruments. The results of the expert validation questionnaire and teacher tagging are given in Table 3 as the following.

Table 3. Average results of expert validation and assessment of 8 teachers

Assesment aspect	Average rating		
	Expert	Teacher	Average
Readability	12,00	12,80	12,40
Graphics	7,50	7,50	7,50
Practicality of use	23,50	23,60	23,55

Based on the results of questionnaires that have been given to experts and teachers there are several inputs related to the practicum instructions that have been developed:

- The image of the flower for the indicator is made clearer in color
- Larger image size to make it clear
- Indicator paper is made smaller in size to make it easier to use

In general, the color of flowers is caused by flavonoid and carotenoid pigments which can attract attention to help pollination [13]. Flavonoids are the most common flower color pigment, and the dominant flavonoid pigment is anthocyanins. Anthocyanins are composed of anthocyanidin and sugar groups. They are the basis for most of the colors orange, pink, red, magenta, purple, blue, and blue-black. Common anthocyanidins are pelargonidin, cyanidin, peonidin, delphinidin, petunidin, and malvinidin, named after the genera from which they were first isolated. Most anthocyanins come from only the following three basic anthocyanidins: pelargonidin, cyanidin, and delphinidin [14].

The first natural indicator that can be used as a substance to identify formalin is *ribose ruellia.* The dyestuffs contained in ribose with purple color ruellia are anthocyanins [15]). Anthocyanins are a biocative component of the flavanoid group found in flowers, leaves, yams, fruits and vegetables clinging to the pH of the environment in which they are located [16][17]. The structure of anthocyanins changes at pH 1, pH 4.5 and pH 7 [18]. Changes in pH cause changes in the structure of the quinonoidal anhydrobase (A) pH of 6.5-8 to Karbinol (B) pH <6 [19]. Formalin solution which has a pH of about 2.8-4.0 when mixed with the extract of ribosa ruellia with purple color will experience a blue-green color change due to structural changes. Structure changes that cause complement color changes that can be observed as an indicator to determine the presence of formalin in a sample.

The second natural indicator that can be used is *hibiscus rosa-sinensis l.* Hibiscus anthocyanins are phenolic natural pigments extracted from the dried flowers of Hibiscus that have been used effectively in folk medicines against hypertension, pyrexia and liver disorders. The pigments are contained in the owers of Hibiscus species are anthocyanins such as cyanidin-3-glucoside and delphinidin-3-glucoside [20][21]. pH has a major effect on the color of anthocyanins. They are redder and more intense in color at low (acid) pH and bluer and less intense in color at a higher pH. A change in the structure of anhydrobase which has a pH of 6-7 is bluish-colored to a colorless structure of carbinol pseudabase pH <4 and flavylium cation which has a pH> 3 of reddish color [22]. Based on the results of the research that has been done it is known that *hibiscus rosa-sinensis L* flower can be used as an indicator of formalin test because it can experience a change in color from bluish to pink.

The third indicator that can be used to identify the presence of formalin is the flower of *impatiens balsamina l.* wait. The color of *impatiens balsamina l* flower is caused by anthocyanins. Changes in the structure of anthocyanins occur from the structure of the quinonoidal anhydrobase (A) pH 6.5 to 8 to Karbinol (B) pH <6 [19]. This change is almost the same as the changes that occur in the flower *ruellia ribose*. With these changes, the *impatiens balsamina* L flower can be used as an indicator of formalin.

Based on the conversion score instruction in table 1. The validation results and the teacher's response to the practicum instructions are then converted to a five scale and given in Table 4.

Table 4. The results of the conversion of scores to a scale of five

Aspect	Interval	Value	Category
Readability	X > 12,0	A	Very good
	10,0 < X ≤ 12,0	B	Good
	8,0 < X ≤ 10,0	C	Good enough
	6,0 < X ≤ 8,0	D	Not good
	X ≤ 6,0	E	Very poor
Graphics	X > 8,0	A	Very good
	6,6 < X ≤ 8,0	B	Good
	5,4 < X ≤ 6,6	C	Good enough
	4,0 < X ≤ 5,4	D	Not good
	X ≤ 4,0	E	Very poor

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Aspect	Interval	Value	Category
Practicality of use	X > 20,0	A	Very good
	16,6 < X ≤ 20,0	B	Good
	13,3< X ≤ 16,6	C	Good enough
	10,0 < X ≤ 13,3	D	Not good
	X ≤ 10,0	E	Very poor

The results of expert validation and teacher assessment in Table 3 compared with Table 4, about the quality of formalin test practice guidelines using indicators of *Ruellla Ribosa*, *Hibiscus rosa-sinensis L* and *Impatiens balsamina L*. Conclusion of the results of the assessment of practicum instructions is given in Table 5.

Table 5. Conclusions on the results of assessment of practicum instructions

Assesment aspect	Average rating		
	Average value	Interval	Category
Readability	12.40	X > 12,0	Very good
Graphics	7.50	6,6 < X ≤ 8,0	Good
Practicality of use	23.55	X > 20,0	Very good

Based on the results of the assessment carried out by experts and teachers, it was concluded that the aspects of readability were very good, aspects of graphic good categories and aspects of practicality of use in the category were very good, so it could be concluded that the practicum developed was feasible to use.

4. Conclusion

The results of this study indicate that the qualitative determination of formaldehyde practicum for junior high school students can be done using the natural indicator drop flower method Ruellla Ribosa, Hibiscus rosa-sinensis L and Impatiens balsamina Lunggu. Identification using filter paper that has contained natural indicator plant extracts can also be used for formalin testing. Based on expert judgment and the teacher shows that practicum instructions that have been developed are suitable for use. Subsequent research can be done using other natural indicators to test formalin. Further research is needed to determine the mechanism of the reaction that occurs with the mixing of indicators and formalin

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