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Project-Based Learning (PjBL) Worksheet on the Production of Whey Kefir Paper Soap

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Abstract

Students often ask about the practical application of concepts and knowledge gained from their coursework. Practicum worksheets provide an opportunity for students to engage in hands-on learning, identify their strengths, learn from their mistakes, and develop enhanced competence as learners. This study aims to develop an effective and valid worksheet on PjBL in whey kefir paper soap. Research and Development (R&D) is used as a method. Worksheet designs were produced using three formulas depending on production techniques. Based on Indonesia National Standard, Formula 1 (8% whey kefir) demonstrated the best qualities of the paper soap. The expert validation test of the worksheets showed a r_{count} value of 0.84 (valid). The percentage of worksheet answers was very good (88%). Student worksheet feasibility test results showed a r_{count} value of 0.84 (feasible). Practicum worksheets are categorized as very suitable for use as a learning media in an organic chemistry course.

Keywords*:* kefir whey, PjBL worksheet, paper soap

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1. Introduction

In Chemistry learning process, students' skills are needed for understanding, mastering concepts, and resolving questions or problems (Khaeruman et al., 2019). Besides, the experimental activities will give students a better understanding of the concept and make learning more meaningful. In order practicum could be carried out properly, woorksheet is one of media needed to help. Therefore, a good worksheet needs to be designed based on specifications and according to the topic being practiced (Rahmatullah & Fadilah, 2017).

Previous studies have shown that PjBL worksheets can improve students' creative thinking skills in molecular modeling material. The average score of students when completing worksheet reaches 85 which is categorized as very creative (Apipah et al., 2019). Meanwhile, other research proves that the steps in PjBL worksheets are able to develop scientific attitudes and real abstract concepts, especially in chemistry (Tazqiyah et al., 2021).

One of an abstract concept with a concrete example in chemistry learning is saponification reactions. It's one of the concepts studied in lipid material in organic chemistry course. Saponification is a reaction between an ester and base that converts into alcohol (glycerol) and soap as the final product. (Arniezca et al., 2017).

As we know, soap has many uses, including cleaning dirt and as an anti-bacterial. Soap has properties as an emulsifier to separate oil and

grease; therefore, soap can be adsorbed on dirt particles (Sari et al., 2010). Paper soap is a type of soap that is often used when doing outdoor activities (Aldiana et al., 2021). Paper soap has the characteristics of being flexible, easily soluble in water, and stable (Habibah et al., 2017).

There are three techniques for making paper soap: using plasticizers, film foaming agents, or paper membranes. The most commonly used plasticizer is glycerin (Wati et al., 2020). The process of making soap is divided into hot and cold processes. The temperature of the hot process to mix the base solution and oil or fat is 70°C. Whereas in the cold process, the mixing temperature is done at 32-35°C. This temperature has affected curing time (time to drying soap). The cold process has a longer curing time than the hot process, which is ± 2-3 weeks (Sastrawidana et al., 2020).

Nowadays, many people are more interested in using soap made from herbal ingredients because of its bioactivity properties, and natural ingredients in it has lower or even non-existent side effects for users (Sari et al., 2017); an example is whey kefir. Whey kefir is one part of the kefir product that has various benefits. Whey kefir contains 0.8-1% of protein, 65% of β-lactoglobulin, 25% of α-lactalbumin, 8% of bovine serum albumin, and immunoglobulin (Kurniati et al., 2016). In soap making, whey kefir works as skin lightener and inhibits melanin synthesis in it (Helsy et al., 2018).

Based on previous research, lemon peel contains a D-limonene compound that functions as aromatherapy and can improve the soap quality. In the pharmaceutical industry, essential oils of lemon peel have activity as anti-bacterial (Suryafly & Aziz, 2019). This research develops a PjBL worksheet for making soap with whey kefir as a natural ingredient based on a saponification reaction, with adding a plasticizer as glycerin to produce paper soap.

PjBL worksheet is student-centered worksheets to develop thinking skills. It contains questions that direct students to discover and construct concepts (Wirda et al., 2018). Also, the PjBL worksheet conducts questions with learning stages that lead to the final product production goal. In PjBL worksheets, discourses, tools, and materials guide students in designing and conducting experiments, also communicating the result of products/projects (Apipah et al., 2019). PjBL can motivate low-achieving students to be more interested in learning and reduce the achievement gap (Mutakinati 2018). Based on this description, PjBL worksheet is appropriate to be applied in chemistry learning, especially in abstract concepts with concrete examples. Therefore, developing PjBL worksheets is appropriate for the concept of saponification reactions in lipid material in an organic chemistry course.

2. Research Method

This research use R&D (Research and Development) method. According to Borg and Gall, it is divided into four stages which are preliminary studies, development model, validation, and revision (Hanafi, 2017).

Preliminary study was carried out through analysis of journals relevant to the technique of making paper soap and the benefits of using kefir whey. At the development stage, worksheets designs are made based on manufacturing techniques and materials that have been analyzed in the first stage. After developing the worksheet, validation is carried out to made a valid and effective worksheet.

Several expert lecturers validated worksheets. The aspects seen in validation test consist of display, content or language, and construct. The resulting data were analyzed by comparing the due diligence (r) results with the critical value. The worksheet categorizes as valid category if the value of $r_{count} \geq 0.3$ (Ernawati & Sukardiyono, 2017). The research procedure can be seen in Figure 1, and the procedure for making whey kefir soap can be seen in Figure 2.

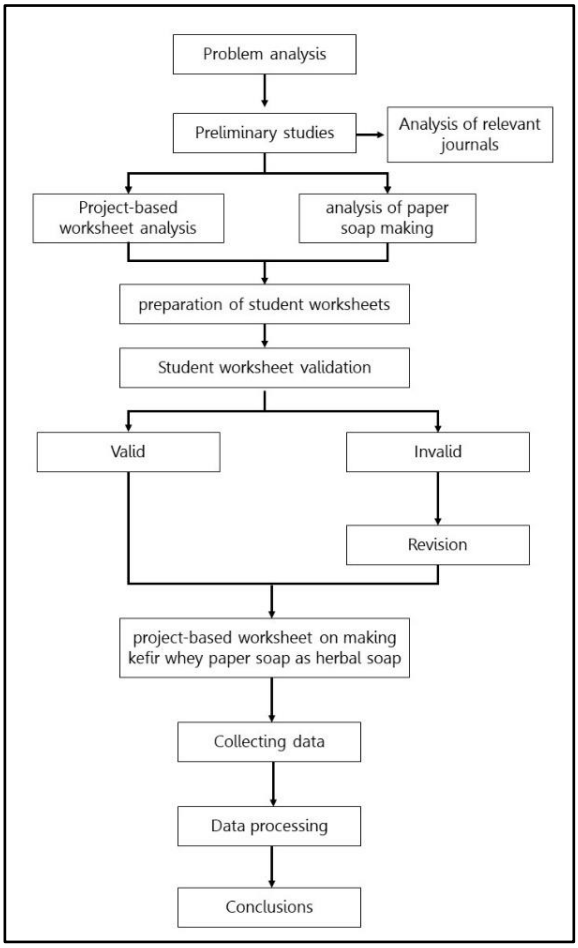

Figure 1. Research Procedure

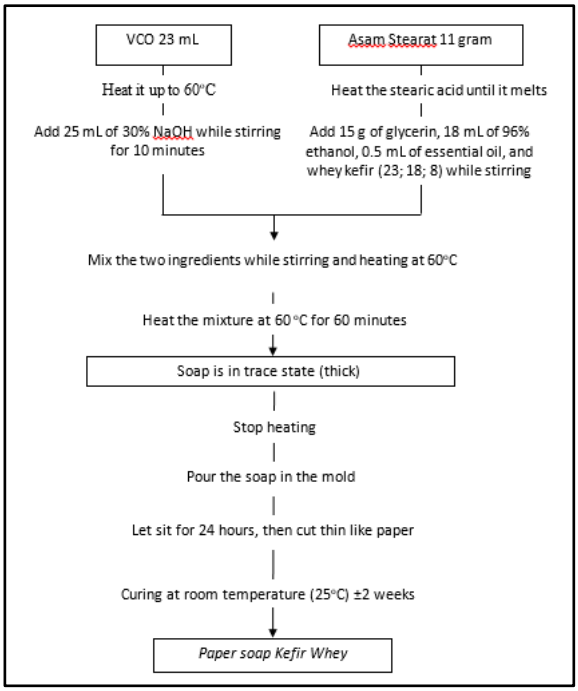

Figure 2. Procedure for Making Paper Soap Kefir Whey

3. Result and Discussion

The results are presented in two sections: the form of a worksheet design, and the worksheet validation results.

3.1. Worksheet Design

PjBL worksheet has six learning stages which are analyzing problems, making designs, carrying out research, compiling prototypes, evaluating products, and product finalization (Apipah et al., 2019). First page of the worksheets is provided a student identity format, activity objectives, and instructions for working on it. Then on the next page, a discourse is given. The discourse presented contains of explanation about advantage of paper soap, manufacturing process, materials used, as well as the quality testing techniques of the soap produced. At this early stage, questions were also given that directed students to formulate problems, hypothesize, and conduct experiments.

The second stage is to design. Students are directed to write down the tools and materials as well as procedures in making paper soap based on the pictures presented. Pictures of tools and materials are presented along with the stages of making kefir whey paper soap as shown in Figure 3 and 4.

Figure 3. Making Paper Soap using Hot Process

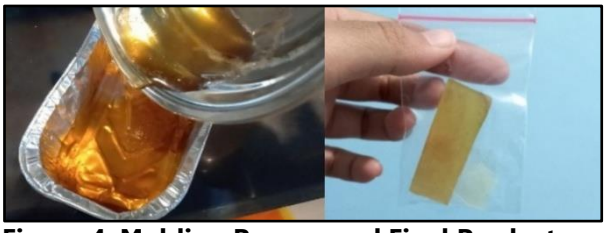

Figure 4. Molding Process and Final Product

The third stage is the implementation of research. Students carry out experiments

based on the designs that have been made. Student write down the results of their observations while carrying out the experiment in tabular form. After that, students are directed to analyze the results of observations obtained with theory from various sources (books, journals, etc.).

The fourth stage is compiling a product draft or prototype. At this stage, students test the product which are testing the pH, unsaponified fat, water content, and foam stability. The fifth stage is product assessment, students compare the paper soap produced with commercial paper soap based on SNI no. 3532-2016. Paper soap with the best characteristics is the paper soap with 8 mL whey kefir (F1) with a pH of 8, an unsaponifiable number of 0.39% and, foam stability of 83% in accordance with SNI. This stage as shown in Figure 5-8.

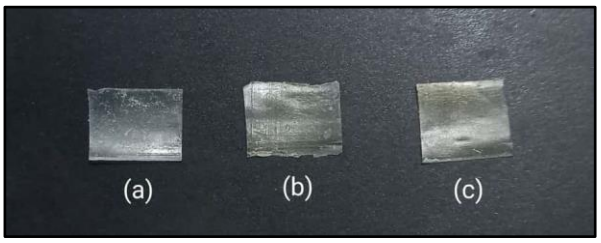

Figure 5. Paper Soap Display (a) Formula 1 (8% Kefir Whey), (b) Formula 2 (18% Kefir Whey), (c) Formula 3 (23% Kefir Whey)

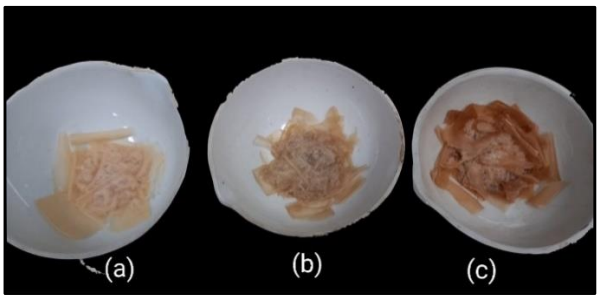

Figure 6. Water content in Paper Soap (a) Formula 1 (8% Kefir Whey), (b) Formula 2 (18% Kefir Whey), (c) Formula 3 (23% Kefir Whey)

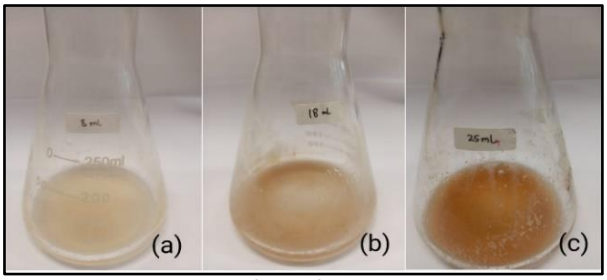

Figure 7. Unsaponified fat (a) Formula 1 (8% Kefir Whey), (b) Formula 2 (18% Kefir Whey), (c) Formula 3 (23% Kefir Whey)

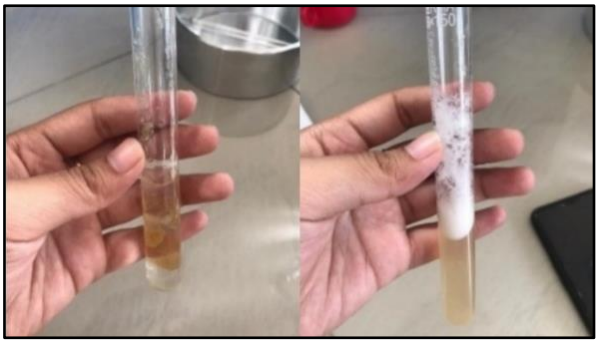

Figure 8. Foam Stability

The last stage was finalization and publication; students were directed to present the products that had been made. At this stage, students were instructed to publish the product by video, then upload it to the YouTube application and attach the video link to the worksheet.

3.2. Worksheet Validation Test Results

PjBL worksheets that have been prepared are then validated by three expert lecturers to ensure that the worksheets developed with categorized as valid or not. The results of validation test from the three validators can be seen in Table 1.

Table 1. Worksheet Validation Test Results

No.	Question	r_{count}	Category
1.	Concept confusion	0.83	Valid
2.	Regularity between practicum activities (procedures)	0.92	Valid
3.	Use sentences that are easy to understand	0.83	Valid
4.	Pictures are clear and in accordance with the material	0.83	Valid

No.	Question	r_{count}	Category
5.	The discourse displayed is accordance with the material	0.83	Valid
6.	Discourse can help design experiments	0.75	Valid
7.	Discourse can help answer questions	0.83	Valid
8.	Compatibility of pictures and illustrations with the material	0.83	Valid
9.	The tools used to make kefir paper soap are easy to get (available in the neighborhood)	0.92	Valid
10.	The materials used to make kefir paper soap are easy to obtain (available in the neighborhood)	0.75	Valid
11.	The procedure for making kefir paper soap is easy to do	0.92	Valid
12.	Encourage to seek more information	0.83	Valid
13.	Suitability of questions with material, indicators, and learning objectives	0.83	Valid
14.	Readability/language of statements	0.75	Valid
	Average	**0.84**	**Valid**

In addition, worksheets has function as supporting learning media that can optimize students' ability to understand the material and make students active during the practicum (Subarkah et al., 2015).

The validation carried out covers four important aspects, which are presentation, construct, content and questions. The presentation aspect is shown in questions one and two regarding the coherence of concepts and regularity between practicum activities (PjBL stage) which are said to be valid. Assessment of the construct aspect is shown in questions number three and four regarding the use of sentences that are easy to understand and pictures that are clear and according to the r_{count} value of 0.83 which is declared valid.

The content aspect is shown in questions number five to twelve and get valid results. The validation results of question number 11 show that the procedure for manufacturing kefir whey paper soap is easy to do according on the tools and materials that are easy to find in the surrounding environment. In the last aspect, the questions shown in numbers 13 and 14 regarding the suitability of the questions with the material, indicators, and learning objectives are declared valid.

According to Table 1, PjBL worksheet has a value of 0.84 r_{count} which are considered valid. This shows that the worksheet developed satisfies the requirements of a proper worksheet.

3.3. Feasibility Test Results

After being validated and categorized as a valid worksheet, the next step is to carry out a limited test on 15 students in fourth semester chemistry education that are divided into three groups. The percentage of answer value are show in Table 2.

Table 2. Percentage of Answer Value on Worksheet

No.	Stage	Maximum score	Average	Percentage (%)	Interpretation
1	Analyze the problem	20	14	70	Good
2	Designing Projects	10	10	100	Very good
3	Research	45	41	91	Very good
4	Developing draft or prototype	5	5	100	Very good

No.	Stage	Maximum score	Average	Percentage (%)	Interpretation
5	Product evaluation	5	4	80	Good
6	Finalization and publication	15	13	87	Very good
	Average			**88**	**Very good**

According to Table 3, the scores obtained by students in the limited test were presented. In the problem analysis stage, the percentage obtained was 70%. This stage contained questions regarding reaction equations, manufacturing techniques, and testing on manufacturing paper soap and questions regarding the formulation of the problem, hypothesis, and the purpose of the experiment. According to respondents, adding the size (amount) of materials used in making paper soap was necessary. At the project design stage, students wrote down the tools and materials used in making whey kefir paper soap, and a score of 100% was obtained.

After writing down the tools and materials needed, students conducted research by designing experiments (making procedures in flowcharts), writing down the results of observations in tabular form, and analyzing the observed data. At this stage, the percentage value was 91%. In the research conducted by Apipah (2019), an average value of 86% was obtained at the research stage with PjBL worksheets in molecular model material. This data showed an increase in the average value of worksheet based on manufacturing projects whey kefir paper soap as herbal soap.

In the fourth stage, namely compiling a draft/prototype, students test the paper soap they produce. Students only do simple tests, namely foam stability and pH value. At this stage, the percentage value is 100. Then in the fifth stage, the percentage value is 80. Students carry out a product assessment: comparing paper soap made with soap that followed the SNI. In the final stage, the percentage value was 87%. Students were directed to publish their project as a video uploaded to the YouTube application and attach the video link to the worksheet. The project display uploaded is presented in Figure 9.

Figure 9. Product Finalization and Publication

This worksheet development followed the stages of PjBL and made it easier to understand the concept. The average percentage obtained from filling out this worksheet was 88%, categorized as very feasible to apply (Ernawati et al., 2017). Hence, students were given a questionnaire containing the statements to determine the worksheet feasibility. It is shown in Table 3.

Table 3. Student Worksheet Feasibility Test Results

No.	Question	r_{count}	critical	Category
1.	The appearance of this worksheet is interesting.	0.83	0.30	Feasible
2.	This worksheet helps in studying saponification materials.	0.92	0.30	Feasible
3.	Figures on worksheets provide motivation to study the material.	0.83	0.30	Feasible
4.	Figures in the worksheet look clear and attractive.	0.83	0.30	Feasible
5.	The material presented on the worksheet is related to everyday life.	0.92	0.30	Feasible
6.	The discourse presented on the worksheet is clear, easy to understand, and assists students in formulating problems, writing hypotheses, experimental objectives, and experimental principles.	0.75	0.30	Feasible
7.	This worksheet helps student find concepts independently.	0.83	0.30	Feasible
8.	This worksheet helps student in discussion.	0.83	0.30	Feasible
9.	The sentences used on the worksheet are easy to understand.	0.83	0.30	Feasible
10.	The instructions in each question make it easier to work on the worksheet	0.83	0.30	Feasible
	Average	**0.84**	**0.30**	**Feasible**

Based on the data in Table 3, the lowest r_{count} value was 0.75 in statement number 6 regarding the discourse presented. The discourse explained the phenomenon of saponification and the ingredients used in soap making. According to the respondent, in the discourse, it was necessary to add the quantity of the ingredients used in making soap.

Moreover, statements 1, 3, 4, 7, 8, 9, and 10 got r_{count} of 0.83. This statement concerns the appearance of the worksheet, the images presented, and the language used in the worksheet. The appearance and images on the worksheet were made more colorful and clearer to increase interest in the work. The language used was clear and easy to understand. The largest r_{count} value was 0.92 in statements number 3 and 5. Based on these statements, the worksheet was effective and valid in helping students to study the saponification topic.

4. Conclusion

Natural ingredients used such as VCO, kefir whey, and essential oil from lemon peels are proven to improve the quality of paper soap. Based on Indonesia National Standard, the best paper soap was obtained from the addition of 8% whey kefir (F1 formulation) with a pH of 8 and the value of foam stability was 83%.

Meanwhile, the PjBL worksheet includes six stages: analyzing the problem, designing the project, conducting research, evaluating the product, and finalizing and publishing the product. The worksheet has discourse that can direct students to conduct experiments. The PjBL worksheet on making whey kefir paper soap as herbal soap was declared valid by obtaining the r_{count} of 0.84 and categorized as very suitable for use as a learning media in organic chemistry courses.

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