Experimental Design on Electrolyte and Non-Electrolyte Materials Based on Natural Materials in High Schools

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ABSTRACT. Limited laboratory facilities are often an obstacle in the implementation of practical activities in schools. One of them is the lack of chemical substances in the laboratory. Therefore, new innovations are needed in finding other materials and tools that can be used so that practical activities can still be carried out. This study seeks to develop innovations in the form of experiments on electrolyte and non-electrolyte materials using materials that are easily found in everyday life so that the implementation of the practicum does not depend on laboratory facilities. This study is a Research and Development (R & D) study, the research model used is according to Borg and Gall which is limited to the 5th stage, namely: the initial data collection stage to the initial product revision stage. The products of this research were validated by learning media experts, material experts, tested for practicality by chemistry subject teachers, and tested for student responses at Madrasah Aliyah Negeri 1 Pekanbaru. This study produces materials that exist in everyday life that can be utilized properly to support electrolyte and non-electrolyte experiments in high schools. The feasibility of chemical learning media in the form of experiments on electrolyte and non-electrolyte materials using natural materials and materials in everyday life is based on: (a) the material expert validator reached a percentage of 91.4% with very valid criteria, the media expert validator reached a percentage of 88% with very valid criteria; (b) The response of the chemistry teacher's assessment through the practicality test obtained a percentage of 89.4% with very practical criteria; (c) The response of class X students of Madrasah Aliyah Negeri 1 Pekanbaru to the entire experiment on electrolyte and non-electrolyte materials based on natural materials and materials in everyday life, 80% stated that it was very good. Further research is needed to test the effectiveness of the product.

Keywords: *Experiments, Electrolytes, Non-electrolytes, Natural Materials.*

INTRODUCTION

In the implementation of chemistry learning, chemistry material is generally combined with chemical experiment activities carried out in the form of chemistry practicals.(Muna, 2022; Sinaga & Silaban, 2020). In carrying out practical work, good laboratory management is required as well as the availability of adequate tools and materials (Anggraeni & Hidayah, 2019). However, limited laboratory facilities can be an obstacle to the implementation of practical activities in schools. Thus, the implementation of practical activities does not depend on laboratory facilities in schools, but uses tools and materials that are easily found in everyday life. As we know, our world is a world of chemistry, meaning that everything around us is inseparable from the chemical aspect (Inayah et al., 2022; Mitarlis et al., 2018).

This shows that the surrounding environment is a means for learning chemistry. Therefore, researchers want to create a simple experimental design using materials available in the surrounding environment (Supriatni, 2022). In addition, it also uses natural materials as alternatives or supports that can be used in practical activities in the laboratory, especially for electrolyte and non-electrolyte materials (Berlian et al., 2020).

In carrying out electrolyte and non-electrolyte practical activities in the laboratory, the substances or materials used require relatively expensive costs. So you can use materials that are in nature, for example star fruit, lime, banana, tomato, and potato. While materials that are in the surrounding environment, for example table salt, Epsom salt, promag, vinegar, vitacimin, soap and caustic soda (Hasan & Ningsih, 2024)(Sundari et al., 2021). Based on the existing problems, researchers tried to analyze the materials in the surrounding environment to support electrolyte and non-electrolyte experiments (Jurusan et al., 2015)(Fardilla et al., 2017)(Susanty et al., 2023).

METHOD

This research was conducted at Madrasah Aliyah Negeri 1 Pekanbaru. The population in this study were students of class X MIA 2. The sampling technique used was purposive sampling technique. This research is included in the type of development research with the Borg and Gall research model (Waruwu, 2024)(Rustamana et al., 2024).This model consists of ten stages of development, namely: (1) research and information gathering; (2) planning; (3) development of initial product forms; (4) initial field tests; (5) revision of initial products; (6) main field tests; (7) revision of operational products; (8) operational field tests; (9) revision of final products; (10) dissemination and implementation. However, this research was only carried out up to stage five revision of initial products (Apriyani et al., 2021).

Data collection techniques in the study were first, through interviews conducted with chemistry teachers at Madrasah Aliyah Negeri 1 Pekanbaru, information was obtained that students carried out practical activities with several chemical substances in the laboratory such as HCl, NaOH, CH_3COOH, salt and alcohol. Second, using a questionnaire, in this study there were 4 types, namely a validity test questionnaire by learning material experts, a validity test questionnaire by learning media experts, a practicality test questionnaire by teachers, and a limited trial questionnaire by students. Third, documentation for researchers is clear and reliable (Nuraini, 2019).

Next, the data analysis techniques used are: first, qualitative descriptive data analysis can be in the form of qualitative data (Octarya & Fadhillah, 2023)such as input, criticism and suggestions for improvement of the products that have been made, then the results of the electrolyte and non-electrolyte experimental design assessment are processed and then analyzed descriptively. Second, quantitative descriptive, namely from the analysis of data from the validity test results of the electrolyte and non-electrolyte experimental design, as well as the analysis of the practicality of the electrolyte and non-electrolyte experimental design (Yani & Yerimadesi, 2023)(Adelia & Haetami, 2023).

RESULTS AND DISCUSSION

The results of this study are in the form of an electrolyte and non-electrolyte experiment design from natural materials and materials found in everyday life. This product is designed with the aim that the implementation of electrolyte and non-electrolyte material practical activities continues without relying on tools and materials in the laboratory. This is the basis that the characteristics of electrolyte and non-electrolyte materials require practical activities. Practical activities are very necessary for students to better understand the material on electrolyte and non-electrolyte solutions.

The electrolyte and non-electrolyte experimental design was designed and developed using the development steps according to Borg and Gall which were simplified according to research needs into five stages. The data results of each stage carried out are as follows.

Information Collection Stage

At this stage of data collection is a very important step to find out the needs of students for the product to be developed. This stage of data collection is carried out in two ways, namely field studies and library studies.

Field Study

The results obtained from the analysis of this field study are thatElectrolyte and non-electrolyte materials require activities in the form of practicums, so that students can better understand and differentiate the electrical conductivity of electrolyte and non-electrolyte solutions. In addition, based on the results of the interview, information was obtained that in learning electrolyte and non-electrolyte materials, practicum activities were carried out with several limited chemicals, namely HCl, NaOH, alcohol, sugar, table salt and acetic acid.

Literature review

Literature study aims to study concepts or theories related to experimental design on electrolyte and non-electrolyte materials which can be carried out without relying on tools and chemicals in the laboratory. Some of the results of the literature study are obtained in Table 1.

Table 1. Results of Literature Study from Journal References

No	Reference List	Main Content
	Shinta Marito Siregar. 2017. The effect of electrode materials on the electricity of starfruit (averrhoa Blimbi) as an environmentally friendly alternative energy solution. Shinta MIPA educational research journal.	Starfruit has electrical properties.
	Atina. 2015. Voltage and electric current strength from the acidic properties of fruit. Scientific journal of mathematics and natural sciences. 12 (2).	Acidic fruits can conduct electricity.
	Firly putri fardila. et al., 2017. Molecular identification of rajalawe banana plants based on internal transcribed spacer (ITS) genes.	Banana peels have electrical conducting properties.

Table 1 explains the results of a literature study from several journal sources taken in the development of designs for electrolyte and non-electrolyte materials based on natural materials.

Planning Stage

At this planning stage, an electrolyte and non-electrolyte experiment design was produced. The product design thatwill be developed to include: (a) electrolyte tester tools used as experimental designs; (b) natural materials used as experimental designs; (c) materials found in the surrounding environment used as experimental designs.

Early Product Development

After the product planning is carried out, the next step is to develop the initial product in the form of an electrolyte and non-electrolyte experimental design. For the experimental design with natural material samples, namely with variations of whole fruit, unfiltered fruit juice and filtered fruit juice. Parts of the development of the experimental design for electrolyte and non-electrolyte materials based on natural materials can be seen in the following tables.

Natural ingredients tomato fruit

Table 2. Results of initial product development in the experimental design with tomato fruit samples.

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
Whole fruit treatment					
1.	Tomato fruit	Small 0.06 watt	Coins (Cu) and nails (Fe)	On	There isn't any
		Bulb 0.075 Watt	Coins (Cu) and nails (Fe)	Doesn't turn on	There isn't any
		3 watt	Coins (Cu) and nails (Fe)	Doesn't turn on	There isn't any
Treat fruit juice without filtering					
1.	Tomato fruit	Small 0.06 watts	Carbon rod	Bright light	A little gas bubble
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble
Treat fruit juice by filtering					
1.	Tomato fruit	Small 0.06 watts	Carbon rod	Dim light	A little gas bubble
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble

Table 2 explains that based on several experimental treatments, the treatment of fruit juice filtered on a small 0.06 watt lamp is the best sample, producing a dim light and few gas bubbles, so it is included in weak electrolytes.

Table 3. Results of initial product development in the experimental design with potato samples

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
Whole fruit treatment					
1.	Potato	Small 0.06 watt	Coins (Cu) and nails (Fe)	On	There isn't any
		Bulb 0.075 watt	Coins (Cu) and nails (Fe)	Not On	There isn't any
		3 watt	Coins (Cu) and nails (Fe)	Not On	There isn't any
Treat fruit juice without filtering					
1.	Potato	Small 0.06 watt	Carbon rod	Bright Light	A little gas bubble
		0.075 watt bulb	Carbon rod	Not On	Lots of gas bubbles
		3 watt	Carbon rod	Not On	A little gas bubble
Treat fruit juice by filtering					
1.	Potato	Small	Carbon rod	Dim light	A little gas

		0.06 watt			bubble
		0.075watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble

Table 3 explains that based on several experimental treatments, the treatment of fruit juice filtered on a 0.06 watt small lamp is the best sample by producing a lamp with a dim flame and few gas bubbles, so it is included in the weak electrolyte.

Table 4. Results of initial product development in the experimental design with lime fruit samples.

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
Whole fruit treatment					
1.	Lime fruit	Small 0.06 watt	Coins (Cu) and nails (Fe)	On	There isn't any
		Bulb 0.075 watt	Coins (Cu) and nails (Fe)	Not On	There isn't any
		3 watt	Coins (Cu) and nails (Fe)	Not On	There isn't any
Treat fruit juice without filtering					
1.	Lime fruit	Small 0.06 watt	Carbon rod	Bright Light	A little gas bubble
		0.075 watt bulb	Carbon rod	Not On	Lots of gas bubbles
		3 watt	Carbon rod	Not On	A little gas bubble
Treat fruit juice by filtering					
1.	Lime fruit	Small 0.06 watt	Carbon rod	Dim light	A little gas bubble
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble

Table 4 explains that based on several experimental treatments, the treatment of fruit juice filtered on a small 0.06 watt lamp is the best sample by producing a dim light and few gas bubbles, so it is included in the weak electrolyte.

Table 5. Results of initial product development in the experimental design with starfruit samples

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
Whole fruit treatment					
1.	Star fruit	Small 0.06 watt	Coins (Cu) and nails (Fe)	On	There isn't any
		Bulb 0.075 watt	Coins (Cu) and nails (Fe)	Not On	There isn't any
		3 watt	Coins (Cu) and nails (Fe)	Not On	There isn't any
Treat fruit juice without filtering					
1.	Star fruit	Small 0.06 watt	Carbon rod	Bright Light	A little gas bubble

		0.075 watt bulb	Carbon rod	Not On	Lots of gas bubbles
		3 watt	Carbon rod	Not On	A little gas bubble
Treat fruit juice by filtering					
1.	Star fruit	Small 0.06 watt	Carbon rod	Dim light	A little gas bubble
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble

Table 5 explains that based on several experimental treatments, the treatment of fruit juice filtered on a small 0.06 watt lamp is the best sample by producing a dim light and few gas bubbles, so it is included in weak electrolytes.

Table 6. Results of initial product development in the experimental design with banana peel samples

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
Treat fruit skin juice without filtering					
1.	Banana peel	Small 0.06 watt	Coins (Cu) and nails (Fe)	Bright light	A little gas bubble
		Bulb 0.075 watt	Coins (Cu) and nails (Fe)	Not On	Lots of gas bubbles
		3 watt	Coins (Cu) and nails (Fe)	Not On	A little gas bubble
Process the fruit skin juice by filtering it					
1.	Lime fruit	Small 0.06 watt	Carbon rod	Dim light	A little gas bubble
		0.075 watt bulb	Carbon rod	Not On	Lots of gas bubbles
No.	**Sample**	**Lamp (watt)**	**Electrode**	**Lights on**	**Gas bubbles**
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble

Table 6 explains that based on several experimental treatments, the treatment of fruit juice filtered on a small 0.06 watt lamp is the best sample by producing a dim light with a few gas bubbles, so it is included in the weak electrolyte. Materials found in the surrounding environment

Table 7. Results of initial product development in the experimental design with samples of materials found in the surrounding environment.

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
1.	promag	Small 0.06 watt	Carbom rod	Dim light	A little gas bubble
		Bulb 0.075 watt	Carbon rod	Not On	Lots of gas bubbles
		3 watt	Carbon rod	Not On	A little gas bubble
2.	vitamin c	Small 0.06 watt	Carbon rod	Dim light	A little gas bubble
		0.075 watt	Carbon rod	Not On	Lots of gas

No.	Sample	Lamp (watt)	Electrode	Lights on	Gas bubbles
		bulb			bubbles
		3 watt	Carbon rod	Not On	A little gas bubble
3.	Vinegar	Small 0.06 watt	Carbon rod	Dim light	A little gas bubble
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble
4.	Soap	Small 0.06 watt	Carbon rod	Dim light	A little gas bubble
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	A little gas bubble
5.	Baking soda	Small 0.06 watt	Carbon rod	On	Lots of gas bubbles
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	Lots of gas bubbles
6.	Epsom salt	Small 0.06 watt	Carbon rod	On	Lots of gas bubbles
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	Lots of gas bubbles
7.	Table salt	Small 0.06 watt	Carbon rod	On	Lots of gas bubbles
		0.075 watt bulb	Carbon rod	Doesn't turn on	Lots of gas bubbles
		3 watt	Carbon rod	Doesn't turn on	Lots of gas bubbles

Table 7 explains based on the experiment, the sample of baking soda, table salt, and Epsom salt on a small 0.06 watt lamp is the best sample by producing a bright light and lots of gas bubbles, so it is included in strong electrolytes. In the initial product development stage, the research produced a product in the form of an experimental design on electrolyte and non-electrolyte materials based on natural materials and those in the surrounding environment. To determine the feasibility of a designed product, several things must be considered, namely: product validation by media experts, the results can be seen in the following diagram.

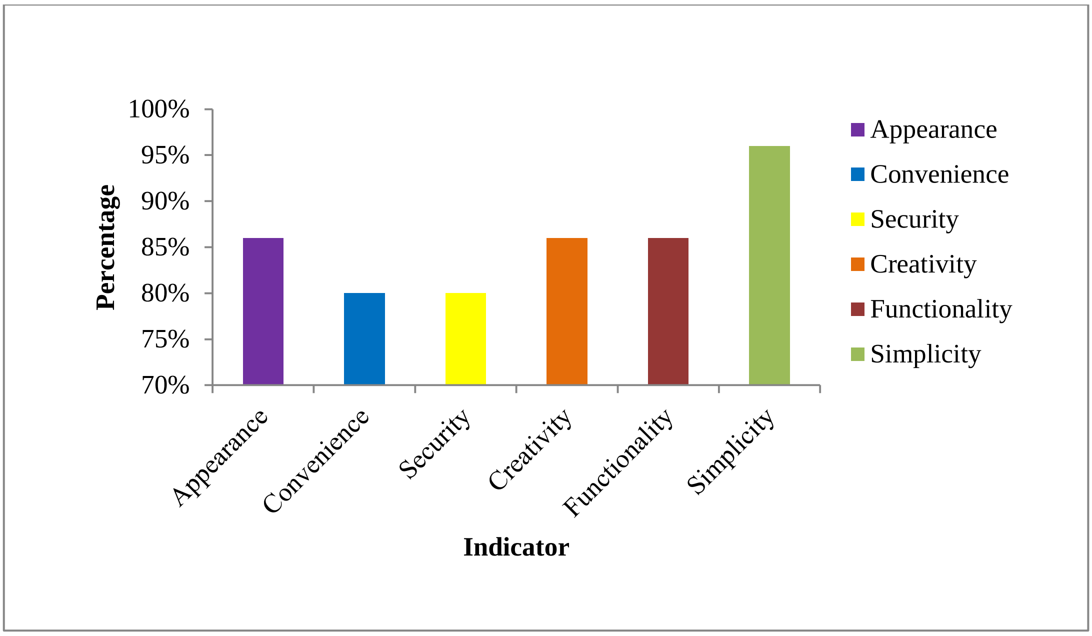

Figure 1. Percentage of media experts

As seen in Figure 1, the aspect of the experimental design process received the highest score, namely 96%, while in the aspects of appearance, ease, safety, creativity and functionalityget a score of 80%.

Product validation by material experts, the results can be seen in the following diagram.

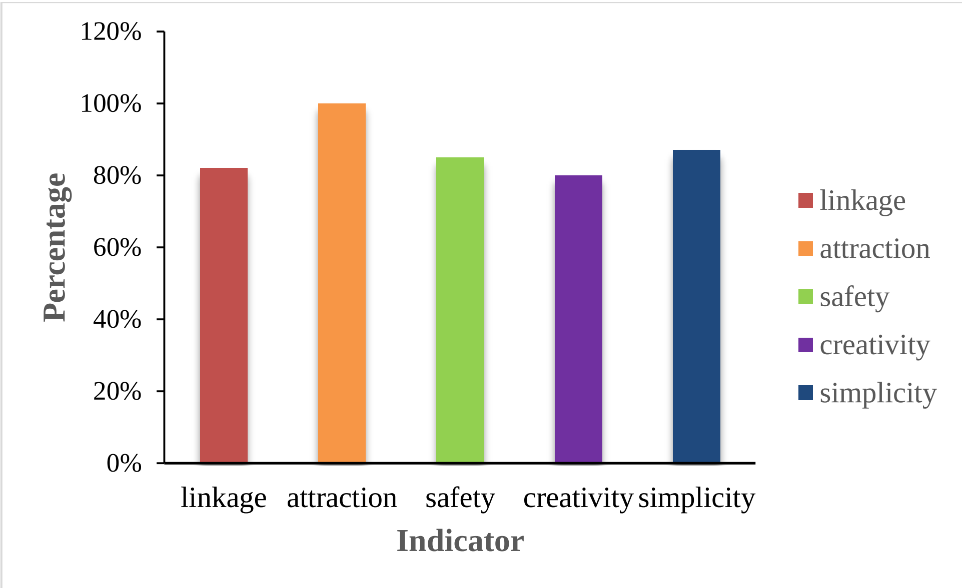

Figure 2. Percentage of material experts

As seen in Figure 2, the validation results on the experimental design interest aspect got the highest score, which is 100% with very valid criteria. While the creativity aspect got the lowest score, which is 80% with valid criteria.

Next, initial product field testing was carried out as follows. The practicality of the experimental design by chemistry teachers, the results are as follows.

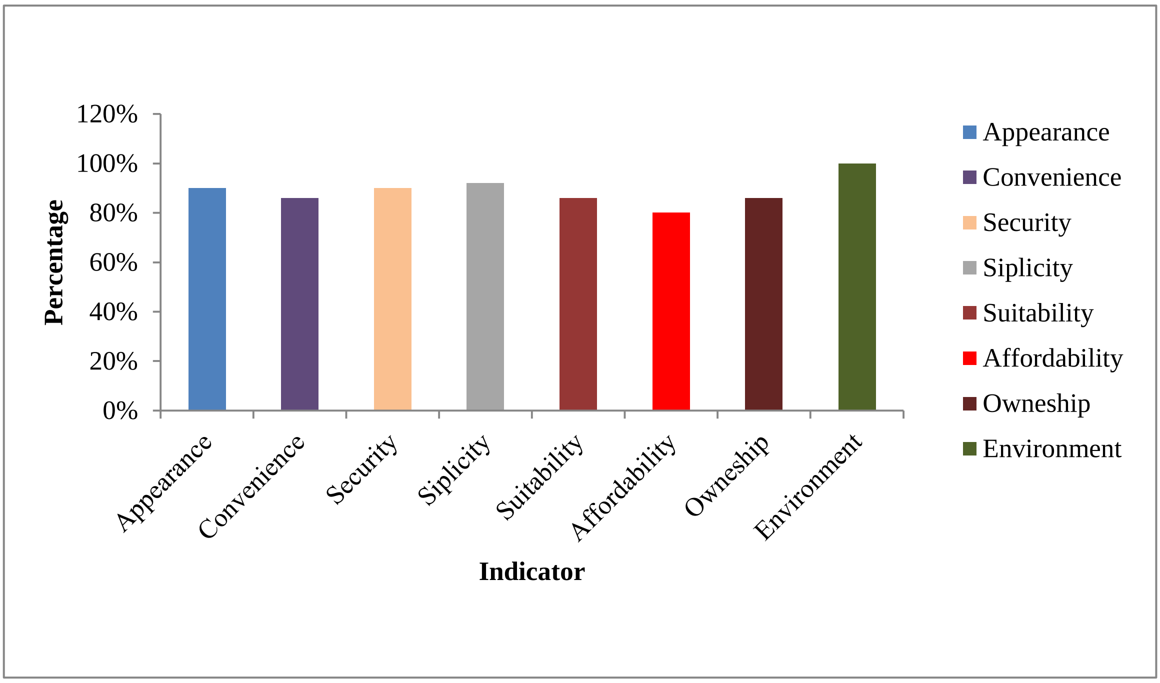

Figure 3. Percentage of practicality test

Figure 3 shows that the environmental aspect received the highest score, while the affordability aspect of manufacturing costs and ownership of the equipment received the lowest score.

The results of the student response test can be seen in the following diagram.

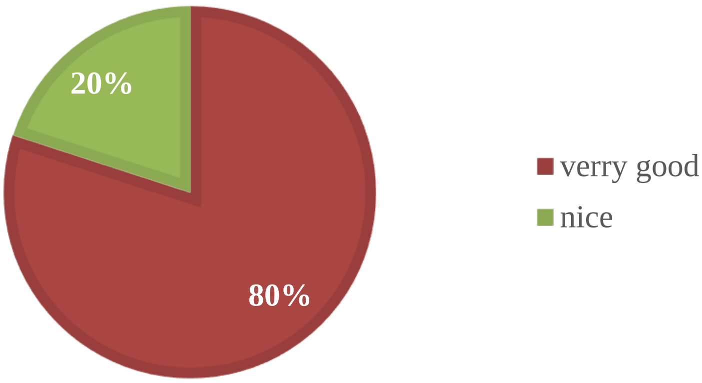

Figure 4. Student responses

In Figure 4, it shows that 80% of students gave a very good response to the overall experimental design, and 20% of students gave a good response to the overall experimental design. This shows that the experimental design on electrolyte and non-electrolyte materials based on natural materials can be used as a supporting learning media in chemistry learning.

The experimental design product on electrolyte and non-electrolyte material based on natural materials has been tested for its practicality by chemistry teachers and also to see the responses of students at MAN 1 Pekanbaru, and improvements were made based on the suggestions obtained, namely to add a solution name label to each container.

DISCUSSION

The experimental design for electrolytes and non-electrolytes based on natural materials is: tomato fruit, using whole tomatoes. For 4 tomatoes can light a small 0.06 watt green lamp but dim and on the LED bulb lamp and 3 watt LED lamp can not light up. If the fruit is juiced without filtering shows a few bubbles on both carbon rods and on the small 0.06 lamp the lamp can light up brightly. And for the bulb lamp and 3 watt lamp there are few bubbles and the lamp does not light up. If the fruit juice is filtered, on the small 0.06 watt lamp there are few gas bubbles and the lamp lights up but dim, but for the bulb lamp and 3 watt LED there are few bubbles and the lamp does not light up. So it is included in weak electrolytes.

Potatoes, use whole potatoes. For 4 potatoes you can turn on a small 0.06 watt green lamp but it is dim and the LED bulb and 3 watt LED lamp cannot turn on. If the fruit is juiced without filtering it will show a few bubbles on the two carbon rods and a small 0.06 lamp will light up brightly. And for 3 watt bulbs and lamps there are a few bubbles and the lamp does not turn on. If the fruit juice is filtered, in the small 0.06 watt lamp there are a few gas bubbles and the light lights up dimly, but for the 3 watt light bulb and LED there are a few bubbles and the light doesn't light up. So it is a weak electrolyte.

Lime fruit, use whole lime fruit. For 4 limes you can light a small 0.06 watt green lamp but it is dim and the LED bulb and 3 watt LED lamp cannot turn on. If the fruit is juiced without filtering it will show a few bubbles on the two carbon rods and a small 0.06 lamp will light up brightly. And for 3 watt bulbs and lamps there are a few bubbles and the lamp does not turn on. If the fruit juice is filtered, in the small 0.06 watt lamp there are a few gas bubbles and the lamp lights up but dimly, but for the 3 watt bulb and LED lamp there are a few bubbles and the lamp does not turn on. So limes are also a weak electrolyte.

Star fruit, using whole star fruit. For 4 star fruit can light a small 0.06 watt green lamp but dim, on the LED bulb lamp can light up but dim and the 3 watt LED lamp can not light up. If the fruit is juiced without being filtered shows a few bubbles on both carbon rods and on the small 0.06 lamp the lamp can light up brightly. And for the bulb lamp and 3 watt lamp there are few bubbles and the lamp does not light up. If the fruit juice is filtered there are few gas bubbles and the lamp lights up but dim. So star fruit is included in weak electrolytes.

Banana peel, If the peel is juiced without being filtered, it shows a few bubbles on both carbon rods and on a small lamp 0.06 the lamp can light up brightly. And for the light bulb and 3 watt lamp there are a few bubbles and the lamp does not light up. If the fruit juice is filtered, there are a few gas bubbles and the lamp lights up but dimly. So bananas are also weak electrolytes.

The materials found in the surrounding environment can be explained as follows:

Vinegar, for small 0.06 lamps there are a few gas bubbles and the lamp lights up, whereas for light bulbs and 3 watt lamps there are only a few bubbles and the lamp doesn't light up. So vinegar is a weak electrolyte. Soap, for small lamps, light bulbs and 3 watt lamps there are only a few bubbles and the lamp does not turn on. So soap is also an electrolyte even though it is basic, because it is an alkali salt.

Vitacimin, for small lamps 0.06 there are a few gas bubbles and the lamp lights up while on the bulb and 3 watt lamp there are only a few bubbles and the lamp does not light up. Vitacimin contains vitamin C or ascorbic acid, so vinegar is included in weak electrolytes. Promag, for small lamps 0.06 there are a few gas bubbles and the lamp lights up while on the bulb and 3 watt lamp there are only a few bubbles and the lamp does not light up. This shows that promag is an electrolyte.

Baking soda, for small 0.06 lamps, there are a few gas bubbles and the light lights up, whereas for light bulbs and 3 watt lamps there are only a few bubbles and the light doesn't light up. So that includes electrolytes. For table salt and English salt, for small 0.06 lamps there are a few gas bubbles and the lamp lights up, whereas for light bulbs and 3 watt lamps there are only a few bubbles and the lamp does not light up. So it is a weak electrolyte.

Furthermore, for validation tests from experts, practicality by teachers and student responses have been categorized as valid experimental design products although there are some suggestions that require further research to be carried out. Such as suggestions to add sample variations, vary the lights, vary the treatments in the experiment and add the number of fruits.

CONCLUSION

This study resulted in an experimental design on electrolyte and non-electrolyte materials based on natural materials, namely potatoes, starfruit, banana peels, limes and tomatoes as well as materials in the surrounding environment, namely vinegar, baking soda, soap, promag, vitacimin, table salt and Epsom salt which have been validated. And the feasibility of chemistry learning media in the form of experimental designs on electrolyte and non-electrolyte materials based on natural materials in the surrounding environment is based on: The results of the validation of material; the response of chemistry teacher assessments through practicality tests; the response of class X MIA 2 students at Madrasah Aiyah Negeri 1 Pekanbaru to the overall experimental design on electrolyte and non-electrolyte materials based on natural materials.

REFERENCES

Adelia, A.K., & Haetami, A. (2023). Efektivitas Metode Praktikum Larutan Elektrolit Dan Non Elektrolit Berbasis Inkuiri Terbimbig Terhadap Hasil Belajar Siswa. *Jurnal Pendidikan Kimia FKIP Universitas Halu Oleo*, *8*(1), 35–46.

Anggraeni, L., & Hidayah, R. (2019). Validitas Lembar Kegiatan Siswa Praktikum Kimia Berbasis Inkuiri Terbimbing Untuk Melatihkan Keterampilan Proses Sains Pada Materi Laju Reaksi Validity of Student Activity Sheet Practicum Chemistry Oriented By Guided Inquiry To Train Science Process Skills in Reaction Rate Materials. *Unesa Journal of Chemical Education*, *8*(1), 82–87.

Apriyani, A., Masriani, M., & Melati, H. A. (2021). Pengembangan Lkpd Berbasis Proyek Pada Materi Larutan Elektrolit Dan Nonelektrolit Di Sma Muhammadiyah 1 Pontianak. *EduChem*, *1*(2), 24–37.

Berlian, M., Cahyani Elvira, & Rian Vebrianto. (2020). Pembuatan Alat Uji Larutan Elektorlit dan Non Elektrolit SMA/MA. *Milenial: Journal for Teachers and Learning*, *1*(1), 6–11.

Fardilla, F. P., Kusumaningrum, H. P., & Wijanarka. (2017). Banana is one type of horticultural commodities in a group of fruits that have a socio-economic value is high enough for the people of Indonesia . Bananas have different varieties , one banana type Rajalawe found in Central Java . Rajalawe molecular ident. *Jurnal Biologi*, *6*(1), 21–28.

Hasan, M., & Ningsih, T. W. (2024). *Journal of Education in Science , Technology , Mathematics , and Disaster Management Development of Discovery Learning-Based Module on Electrolyte and Non-Electrolyte Solution to Increase Self-directed Learning*. *1*(2), 85–94.

Inayah, S., Dasna, I. W., & Habiddin, H. (2022). Implementasi Green Chemistry Dalam Pembelajaran Kimia: Literatur Review. *Hydrogen: Jurnal Kependidikan Kimia*, *10*(1), 42.

Jurusan, D., Fakultas, F., Universitas, M., & Palembang, P. (2015). *Tegangan Dan Kuat Arus Listrik Dari Sifat Asam*. *12*(2), 28–42.

Mitarlis, M., Azizah, U., & Yonatha, B. (2018). Pemanfaatan Indikator Alam Dalam Mewujudkan

Pembelajaran Kimia Berwawasan Green Chemistry. *Jurnal Penelitian Pendidikan IPA*, *3*(1), 1.

Muna, L. (2022). Analisis Pembelajaran Kontekstual berbasis Bahan Alam Pada Penentuan Kadar Vitamin C Daun Katuk (Sauropus Androgynus) sebagai Alternatif Sumber Belajar Kimia. *Journal of Tropical Chemistry Research and Education*, *4*(2), 64–74.

Nuraini, F. (2019). Peningkatan hasil belajar menganalisis sifat larutan elektrolit dan non elekttrolit pada mata pelajaran kimia melalui pembelajaran improve siswa kelas X TPTU SMK Negeri 3 Buduran. *Jurnal Ilmiah Pengembangan Pendidikan*, *6*(3), 26–34.

Octarya, Z., & Fadhillah, F. (2023). Desain dan Uji Coba Media Pembelajaran Interaktif Menggunakan Articulate Storyline 3 Pada Materi Larutan Elektrolit dan Non Elektrolit. *Konfigurasi : Jurnal Pendidikan Kimia Dan Terapan*, *7*(1), 31.

Rustamana, A., Hasna Sahl, K., Ardianti, D., Hisyam, A., Solihin, S., Sultan, U., Tirtayasa, A., Raya, J., No, C., & Banten, S. (2024). Penelitian dan Pengembangan (Research & Development) dalam Pendidikan. *Jurnal Bima: Pusat Publikasi Ilmu Pendidikan Bahasa Dan Sastra*, *2*(3), 60–69.

Sinaga, M., & Silaban, S. (2020). Implementasi Pembelajaran Kontekstual untuk Aktivitas dan Hasil Belajar Kimia Siswa. *Gagasan Pendidikan Indonesia*, *1*(1), 33.

Yani, S.H & Yerimadesi. (2023). Validitas dan Praktikalitas Modul Reaksi Kimia Berbasis Guided Discovery Learning Terintegrasi Etnosains untuk Fase E SMA. *Jurnal Pendidikan Mipa*, *13*(2), 436–444.

Sundari, I. D., Nurdiyanti, D., Yullina, I. K., & Gusman, T. I. (2021). the Design of Electrolyte and Non Electrolyte Solution Teaching Materials With Multi Representation. *Jurnal Penelitian Pendidikan IPA*, *6*(2), 75–80.

Supriatni, E. A. (2022). Penggunaan Alat Dan Bahan Dari Lingkungan Rumah Pada Praktikum Larutan Elektrolit Dan Non-Elektrolit. *SCIENCE : Jurnal Inovasi Pendidikan Matematika Dan IPA*, *2*(1), 32–36.

Susanty, S., Redjeki, A. S., Yustinah, Y., & Yudistirani, S. A. (2023). Metode Demonstrasi dan Praktek Uji Daya Hantar Larutan Elektrolit dan Non Elektrolit Guna Meningkatkan Minat Belajar Kimia Pada Siswa-siswi MtsN 42 Jakarta. *Prosiding Seminar Nasional Pengabdian Masyarakat LPPM UMJ; PROSIDING SEMNASKAT LPPM UMJ 2023*.

Waruwu, M. (2024). Metode Penelitian dan Pengembangan (R&D): Konsep, Jenis, Tahapan dan Kelebihan. *Jurnal Ilmiah Profesi Pendidikan*, *9*(2), 1220–1230.