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Enhancing From Healthy Eating to Green Energy: A Dual Approach to Student Education on Nutrition and Biodiesel (Renewable Energy)

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KEYWORDS
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Adolescent Health
Biodiesel Production
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ABSTRACT – Adolescence represents a critical stage of physical and cognitive development, requiring balanced nutrition to support growth, concentration, and academic performance. However, many students still lack awareness of healthy dietary practices and continue to consume nutrient-poor foods, leading to increased risks of metabolic and cognitive disorders. To address this issue, a dual-focus educational program was implemented at SMA Negeri 6 Penajam Paser Utara, combining balanced nutrition education with the introduction of simple renewable energy technology through biodiesel production from waste cooking oil. The program, conducted in collaboration with the Kalimantan Institute of Technology (ITK), employed interactive lectures, demonstrations, and hands-on sessions to enhance student understanding. A pre-test and post-test evaluation involving 40 students demonstrated a substantial improvement in knowledge, increasing from 45% to 96% after the intervention. Participants also expressed strong positive responses to the integration of nutritional awareness and eco-friendly technology, recognizing its relevance to daily life and environmental sustainability. The results show that this dual educational approach effectively strengthens students' understanding of healthy eating habits while promoting environmental responsibility through waste-to-energy concepts. Overall, the program highlights the potential of combining nutrition education and renewable energy literacy as a strategic model for school-based community outreach aimed at fostering healthier, more environmentally conscious future generations.

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INTRODUCTION

Adolescence is a crucial transitional period in human life, during which individuals experience significant physical, emotional, and cognitive changes. During this stage, physical growth occurs rapidly, marked by an increase in height, the development of body organs, and changes in the reproductive system. Cognitively, adolescents begin to demonstrate more complex and mature thinking abilities. Therefore, ensuring a balanced diet during this period is crucial to support optimal physical growth and brain development [1]. Good nutritional intake has been shown to improve concentration, enhance mood, and promote academic achievement. Several studies have demonstrated that a balanced diet, including adequate amounts of carbohydrates, protein, healthy fats, vitamins, and minerals, plays a crucial role in enhancing memory, concentration, and learning ability. Micronutrients such as vitamin D, iron, and folic acid even play a vital role in supporting brain function, enabling it to process information more effectively [2], [3].

Therefore, a healthy and balanced diet not only impacts physical health but also significantly influences the development of intelligence and academic achievement in adolescents. However, many adolescents still do not understand the importance of a balanced diet for their health and academic performance. The consumption of fast food and sugary drinks, which are high in calories but low in nutrients, still dominates the daily lives of adolescents. This condition increases the risk of various diseases, such as obesity, diabetes, and metabolic disorders [4]. Nutritional deficiencies can also lead to anemia, growth disorders, and cognitive decline, ultimately impairing students' academic achievement [5]. In other words, adolescents' low awareness of healthy eating habits can directly impact their quality of life and future. Given the important role of nutrition in adolescent growth and development, balanced nutrition education needs to be systematically provided in schools. This education aims to increase students' knowledge of healthy eating patterns while instilling sustainable healthy habits.

Schools, as formal educational institutions, have a strategic role in shaping students' understanding of nutrition, as unhealthy eating habits often develop during adolescence. An integrated nutrition education program can help students make healthy food choices, reduce the consumption of risky foods, and equip them with the skills to manage their diet wisely [6]. In addition to nutritional aspects, introducing appropriate technology to students is also important. One relevant example is the use of household waste cooking oil to produce biodiesel. Repeated use of used cooking oil can

pose health risks, while its improper disposal has the potential to pollute the environment. Using simple technology, used cooking oil can be processed into biodiesel, an environmentally friendly alternative fuel [7], [8][9]. The introduction of this technology not only raises students' awareness of environmental issues but also introduces the concept of a circular economy that can be applied in everyday life.

SMA Negeri 6 Penajam Paser Utara (PPU), located at Jalan Negara Km. 7 RT. 17, Sotek Village, Penajam District, East Kalimantan, is one of the schools playing a vital role in developing a healthy, intelligent, and competitive young generation. The school's proximity to the Indonesian Capital City (IKN) makes it strategic, as the development of the IKN demands an increase in the quality of superior human resources in health, education, and technology. However, initial observations indicate that many students still have a limited understanding of the importance of balanced nutrition and the use of appropriate technology, necessitating more intensive educational interventions [10], [11]. The Kalimantan Institute of Technology (ITK), as a higher education institution in East Kalimantan, has a strong commitment to community service. Through outreach activities on balanced nutrition and appropriate technology, ITK strives to make a real contribution to improving the quality of student knowledge. These activities also serve as a means of introducing ITK to the younger generation as an option for pursuing higher education, while also raising awareness of the important role of science and technology in maintaining health and environmental sustainability [12]. Thus, educational activities on balanced nutrition and the processing of used cooking oil into biodiesel, held at SMA Negeri 6 PPU, are expected to improve student understanding and foster awareness of a healthy and environmentally friendly lifestyle. SMA Negeri 6 PPU, as a partner, plays a role in providing.

METHOD

A. Method of Conducting the Training Program

The implementation of this community service program was carried out at SMA Negeri 6 Penajam Paser Utara (PPU), involving a total of 40 students as participants. The methodology consisted of four main stages: preliminary assessment, program preparation, implementation, and evaluation.

1. **Preliminary Assessment.** At this stage, an initial observation and discussion were conducted with the school to identify the level of students' understanding regarding balanced nutrition and environmentally friendly technologies. A **pre-test** was administered to measure baseline knowledge, showing that only **45% of students** had adequate understanding of the topics.

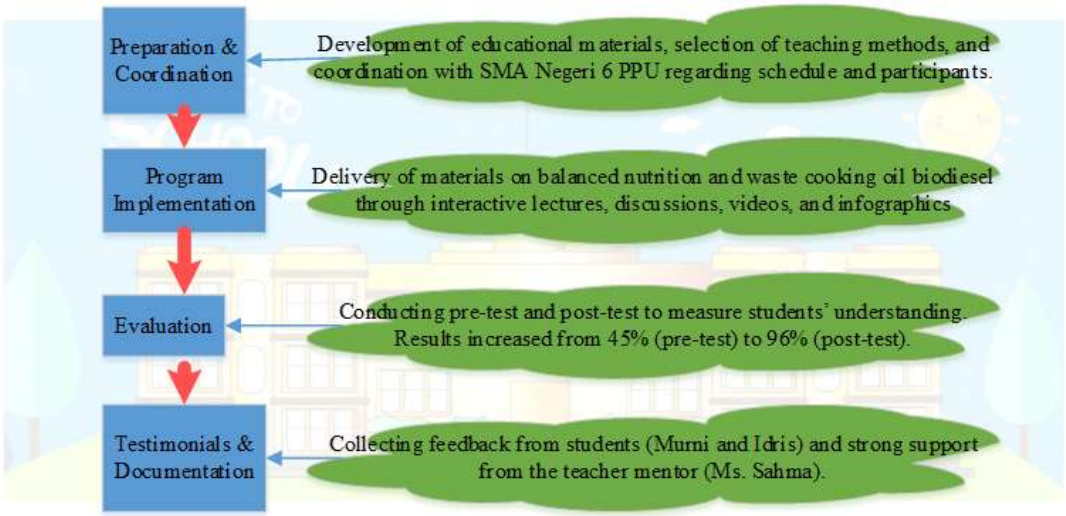

Figure 1. Guidance and Education Activity Flow

2. **Program Preparation.** The preparation phase included designing educational materials and interactive modules on balanced nutrition, as well as the introduction of appropriate technology for converting waste cooking oil into biodiesel. Visual aids, presentations, and demonstration equipment were arranged to support effective learning delivery.

3. **Program Implementation.** The implementation stage involved two major sessions:
   - **Nutrition Education Session**: Delivered through lectures, discussions, and visual presentations on the importance of balanced nutrition for physical and cognitive development in adolescence.
   - **Biodiesel Training Session**: Conducted through demonstrations and step-by-step explanation of the process of converting waste cooking oil into biodiesel. This session aimed to promote environmental awareness and the concept of circular economy.

   The school, represented by teachers, provided logistical support and encouraged active participation, while facilitators from Institut Teknologi Kalimantan (ITK) served as resource persons.

4. **Evaluation and Feedback.** To measure the effectiveness of the program, a **post-test** was administered after the sessions. The results indicated a significant improvement, with **96% of students** demonstrating enhanced knowledge and understanding. In addition, student testimonials (e.g., from Murni and Idris) reflected positive feedback regarding the relevance and benefits of the program. Teachers, represented by Mrs. Sahma, also expressed strong support for continuing such initiatives.

B. INTRODUCTION OF APPROPRIATE TECHNOLOGY

As part of the methodology, students were introduced to the potential of converting waste cooking oil (WCO) into biodiesel as an example of appropriate technology [9], [13], [14]. The session highlighted the environmental impacts of WCO disposal and demonstrated, through simplified explanations and visual aids, the basic process of transesterification [15][16]. This activity aimed to increase awareness of renewable energy, promote sustainable waste management, and encourage students to view WCO to biodiesel conversion as both an environmental solution and a potential community-based innovation.

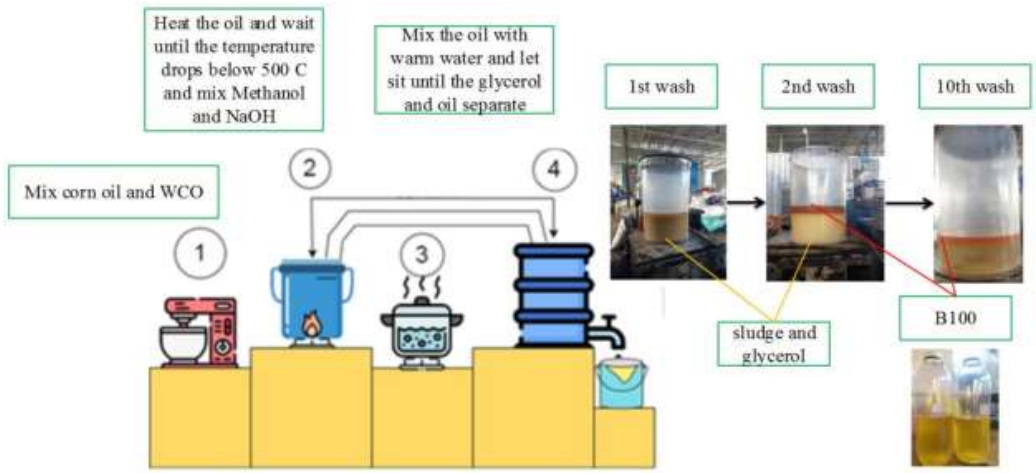

Figure 2. Appropriate Technology Design in the Form of A Biodiesel Production Process from Waste [16]

C. RESULTS AND DISCUSSION

The balanced nutrition and biodiesel introduction program conducted at SMA Negeri 6 Penajam Paser Utara yielded significant and positive outcomes. The primary objective of this program was to improve students' knowledge of balanced nutrition for health and academic achievement, while also introducing simple appropriate technology for processing used cooking oil into biodiesel. Prior to the program, most students had limited understanding of the principles of balanced nutrition and the negative impact of unhealthy eating habits. Post-program evaluations indicated a substantial improvement in their knowledge. Students were able to identify essential nutrients such as carbohydrates, proteins, vitamins, and minerals, and understood their roles in physical growth, cognitive development, and academic performance. During the practical session on appropriate technology, students were introduced to the process of converting used cooking oil into biodiesel through simple steps such as filtration and purification. They actively engaged in the discussion, asked questions regarding its benefits, and demonstrated strong interest in applying this knowledge to reduce household waste and promote environmental sustainability. Evaluations conducted through quizzes and group discussions revealed that students not only gained a better understanding of balanced nutrition but also showed increased awareness of the potential of waste-to-energy conversion. This hands-on experience was crucial in strengthening their knowledge and inspiring them to adopt healthier lifestyles while also considering environmentally friendly innovations.

Table 1 below shows the number of respondents (40) students of SMAN 6 PPU who completed the questionnaire related to balanced nutrition education and appropriate biodiesel technology.

Table 1. Respondents (40) Students of SMAN 6 PPU who Filled Out the Questionnaire

No	Name	Pre-Test Questionnaire Questions																			
		Nutritious Food for School Children (Yes/No)										Waste Cooking Oil Processing (Yes/No)									
		1		2		3		4		5		6		7		8		9		10	
		Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
1	Susi Pratiwi	1			1	1		1		1			1	1			1		1	1	
2	Chelsea	1		1		1		1		1			1	1		1		1		1	
3	Reviana Mariska	1			1	1		1		1			1	1		1		1		1	
4	Claudya Cinta Syari	1			1	1		1		1			1	-	1		1	1		1	
5	Qirana Anggita	1		1			1		1	1			1		1		1	1		1	
6	Selbia Nurtitria. A.W		1		1	1		1			1		1		1		1		1		1
7	Astari	1		1		1			1	1		1			1		1		1	1	
8	Nor Fatimah	1		1		1			1	1		1			1		1	1		1	
9	Arya Dinda	1		1		1		1		1			1	1		1			1	1	
10	Ocay Sankar	1		1			1	1		1		1		1			1	1		1	
11	Siti Cahaya	1		1		1			1	1		1		1		1		1		1	
12	Sitti Fatimah	1			1		1		1	1		1		1			1	1		1	
13	Septia Ramadhani	1		1		1			1	1			1	1			1	1		1	
14	Kholif Fatul Sa`adah	1		1			1	1		1		1		1			1	1		1	
15	Adinda Safitri	1		1			1	1		1		1		1			1	1		1	
16	Murniati	1		1		1			1	1		1			1		1	1			1
17	Fauziat Aulia Fitri	1			1		1		1	1			1		1	1		1		1	
18	Mutmainnah S.R	1		1			1		1	1			1	1		1		1		1	
19	Sulistiawati	1			1		1		1	1			1		1	1			1	1	
20	Angelica Pranata	1		1		1		1		1			1	1			1		1	1	
21	Azis Aryawijaya	1		1		1		1		1		1			1	1		1		1	
22	Selfia Nur Fitria Anugrah Wati		1		1	1		1			1		1		1		1		1		1
23	Fitri Nur Suci	1			1	1			1	1			1	1		1		1			1
24	Irfan Harahap	1		1			1	1			1		1	1			1		1		1
25	M. Wawan Maulana	1		1			1	1		1		1			1		1	1		1	
26	Muhammad Idris	1		1			1		1	1		1			1		1		1	1	
27	Nur Azizah	1		1			1	1		1			1	1		1			1	1	
28	Muhammad Adkram Fauzan	1		1		1		1			1	1		1		1		1		1	
29	Dean Astrianur	1		1		1		1			1		1	1			1		1	1	
30	Ridho Ferry	1		1			1	1		1		1			1		1	1		1	
31	Muhammad Mario	1		1			1		1	1		1		1		1		1		1	
32	Fryta Purnama Sari	1			1		1		1		1		1	1		1		1			1
33	Fitri Nur Suci	1		1		1		1		1		1			1	1		1		1	
34	M. Rafly Kurniawan	1		1			1		1	1		1		1		1		1		1	
35	Rahmat Israq	1		1			1	1		1		1			1		1	1		1	
36	M. Rizal	1		1			1	1		1		1			1		1	1		1	
37	Ahmad Taslim	1		1			1	1		1		1			1		1	1		1	
38	Syahrul Wijaya	1		1			1		1	1			1		1		1	1		1	
39	Indra Setiawan	1		1		1			1	1		1		1			1		1	1	
40	Susi Pratiwi	1			1	1		1		1			1	1			1		1	1	
	Total	38	2	29	11	20	20	23	17	34	6	20	20	22	18	15	25	27	13	34	6
	Total %	95 %	5 %	73 %	28 %	50 %	50 %	58 %	43 %	85 %	15 %	50 %	50 %	55 %	45 %	38 %	63 %	68 %	33 %	85 %	15 %

Figure 2 shows respondents (students) who stated an increased level of understanding after participating in educational activities. Previously, many were still confused and did not know, but after the training, almost the majority of respondents stated "yes", which indicates that they now understand the importance of balanced nutrition for school children and better understand how to process used cooking oil waste into environmentally friendly energy in the form of biodiesel.

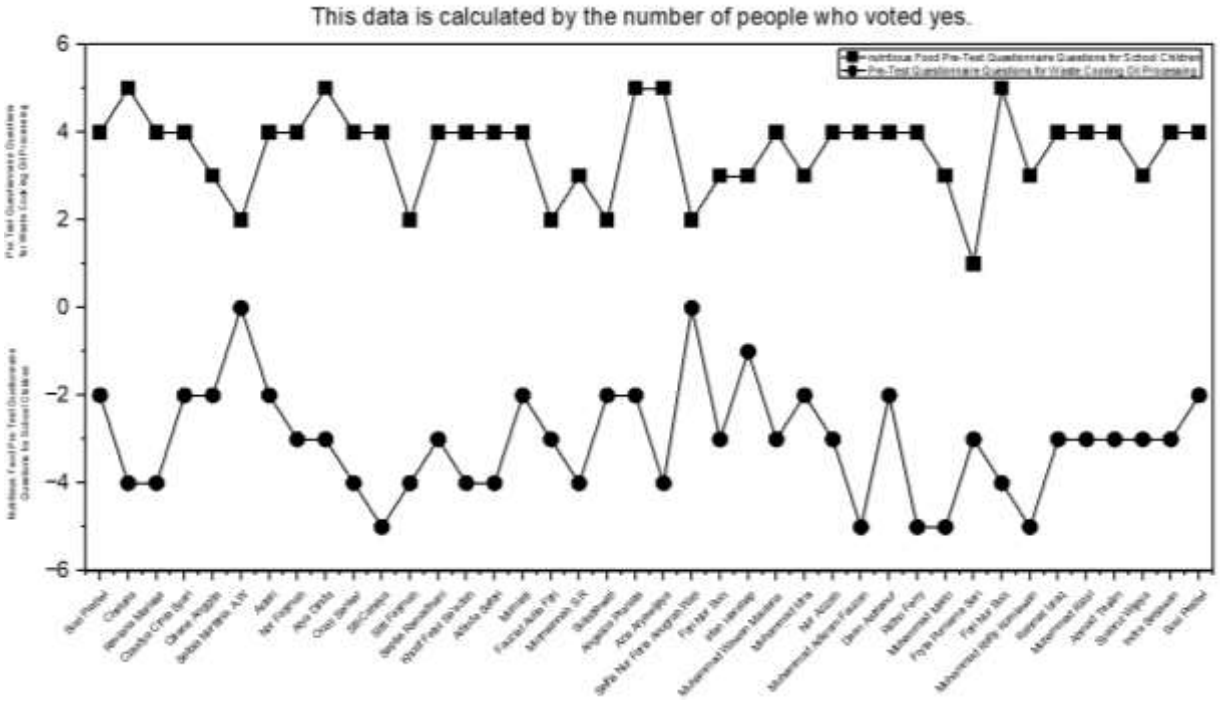

Figure 2. Post-Test Results Graph Regarding Respondents' Level of Understanding

Adolescence is a critical phase of growth that requires balanced nutrition to support both physical development and cognitive performance. However, many students still lack awareness of healthy dietary practices, often consuming foods low in essential nutrients. To address this issue, an educational program was conducted at SMA Negeri 6 Penajam Paser Utara, focusing on the importance of balanced nutrition and the introduction of appropriate technology through biodiesel production from waste cooking oil. The program aimed to improve students' understanding of healthy eating habits while simultaneously raising environmental awareness through waste-to-energy utilization. The methodology involved interactive lectures, discussions, and demonstrations. A pre-test and post-test were administered to measure knowledge improvement, with results showing a significant increase from 45% to 96% understanding after the session among 40 student participants. In addition, students expressed positive feedback, highlighting the relevance of nutrition knowledge and the innovative approach of biodiesel processing. The findings suggest that integrating nutrition education with simple technology introduction not only enhances students' awareness of healthy lifestyles but also promotes environmental responsibility. This dual-focus approach can serve as an effective model for school-based community engagement programs.

Figure 3. Accompanying students of SMAN 6 PPU as participants in the counseling and handing over lunch boxes

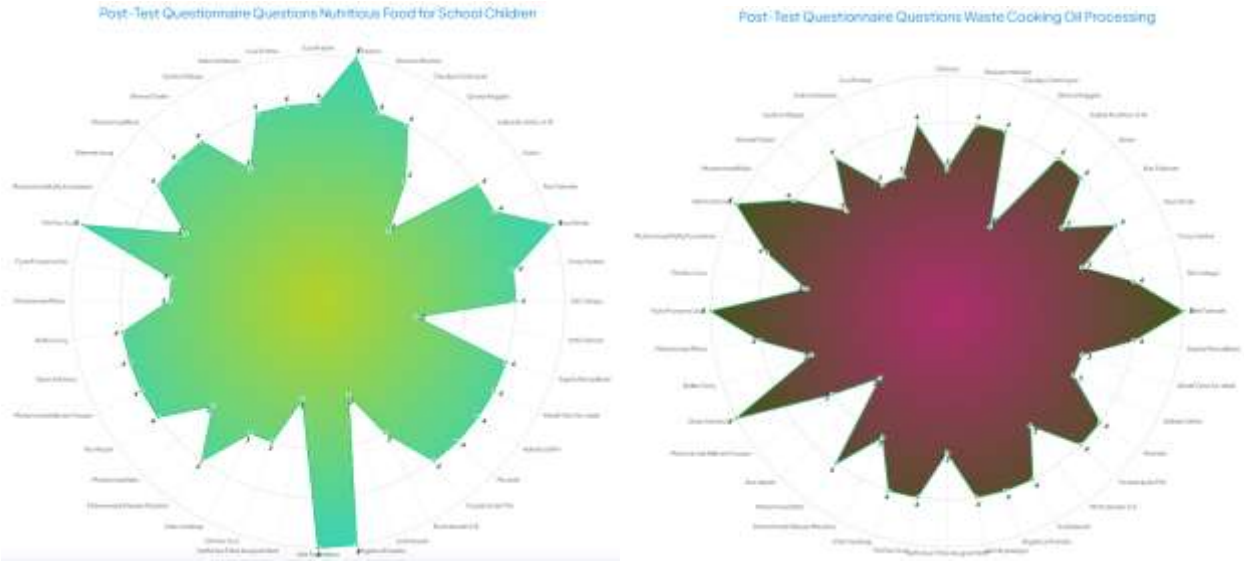

Figure 4. Post and Pre-Test Results Graph on Nutrition Education and Biodiesel Introduction Technology

CONCLUSION

This study demonstrates that integrating balanced nutrition education with the introduction of biodiesel production from waste cooking oil provides a dual-benefit learning approach for students. The program conducted at SMA Negeri 6 Penajam Paser Utara successfully increased students' understanding of healthy eating practices, which are essential during adolescence a period marked by rapid physical and cognitive development. The significant improvement in students' knowledge, reflected by the increase in understanding from 45% to 96%, indicates the effectiveness of interactive lectures, discussions, and hands-on demonstrations. Furthermore, the introduction of simple appropriate technology through biodiesel processing not only enhanced environmental awareness but also exposed students to the concept of renewable energy and sustainable waste management. This dual approach proved effective in fostering healthier lifestyle awareness while cultivating a sense of responsibility toward environmental preservation. Overall, the program shows strong potential as a scalable educational model that integrates health, science, and environmental sustainability for school-based community engagement.

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REFERENCES

[1] H. Munawaroh *et al.*, "The Role of Parents in Fulfilling Balanced Nutrition as an Effort to Prevent Stunting in Children Aged 4–5 Years (in Indonesian)," *Sentra Cendekia*, vol. 3, no. 2, p. 47, 2022, doi: 10.31331/sencenivet.v3i2.2149.

[2] T. U. Kusuma, "The Role of Nutrition Education in Preventing Anemia in Adolescents in Indonesia: A Literature Review (in Indonesian)," *J. Surya Muda*, vol. 4, no. 1, pp. 61–78, 2022, doi: 10.38102/jsm.v4i1.162.

[3] R. Marvelia, R. Kartika, and H. Dewi, "The Relationship Between Breakfast and Student Achievement at State

Senior High School 4, Jambi City in 2020 (in Indonesian)," *Med. Dedication J. Pengabdi. Kpd. Masy. FKIK UNJA*, vol. 4, no. 1, pp. 198–205, 2021, doi: 10.22437/medicaldedication.v4i1.13487.

[4] S. Murdiningrum and H. Handayani, "The Effectiveness of Nutrition Education Media for Improving Adolescents' Nutritional Knowledge (in Indonesian)," *J. Mhs. BK An-Nur Berbeda, Bermakna, Mulia*, vol. 7, no. 3, p. 53, 2021, doi: 10.31602/jmbkan.v7i3.5759.

[5] R. Marbun, S. Sugiyanto, and V. Dea, "Health Education for Adolescents on the Importance of Balanced Nutrition and Physical Activity in the Era of the Covid-19 Pandemic (in Indonesian)," *SELAPARANG J. Pengabdi. Masy. Berkemajuan*, vol. 4, no. 3, p. 508, 2021, doi: 10.31764/jpmb.v4i3.4494.

[6] N. Husnul Khatimah, M. Iksan, Sutriawan, and Erham, "Balanced Nutrition Counseling for Adolescents at State Vocational School 02 Dompu (in Indonesian)," *BERNAS J. Pengabdi. Kpd. Masy.*, vol. 4, no. 2, pp. 1463–1469, 2023, [Online]. Available: https://doi.org/10.31949/jb.v4i2.4797

[7] F. W. Ningtyas, D. A. Purnamasari, Y. Hanin, N. F. W. Astuti, and D. I. Adi, "Introduction to Food Diversity through the Emotional Demonstration Method (EMO DEMO) of Nutritional Tumpeng for Students of MTS Negeri 2 Jember (in Indonesian)," *Pros. Semin. Pengabdi. Masy.*, pp. 142–147, 2019, [Online]. Available: https://prosidingonline.iik.ac.id/index.php/senias/article/view/91

[8] M. S. J. Sofiana, A. Yuliono, W. Warsidah, and I. Safitri, "Socialization of the Utilization of Seafood and Diversification of Processed Seafood as an Effort to Address Stunting in Toddlers in West Kalimantan (in Indonesian)," *J. Community Engagem. Heal.*, vol. 4, no. 1, pp. 103–112, 2021, [Online]. Available: https://www.jceh.org/index.php/JCEH/article/view/121

[9] S. Suardi, R. J. Ikhwani, A. Putri, and R. Aulia, "Effect of Temperature Variations of Corn (Maize) Oil Biodiesel on Torque Values and Thermal Efficiency of Diesel Engines," vol. 7, no. 1, pp. 87–95, 2023, doi: 10.17977/um016v7i12023p087.

[10] E. Siagian, "Balanced Nutrition Education on Knowledge and Attitudes of Adolescents in The Time of," pp. 41–47, 2023, doi: 10.33221/jiiki.v13i02.2457.

[11] M. Hussain, "Effectiveness of Health Education on Knowledge and Practice Regarding the Importance of Well-Balanced Nutrition Among School Students," vol. 69, pp. 78–83, 2019. doi: 10.7176/JHMN/69-10

[12] H. M. Lisboa *et al.*, "Innovative and Sustainable Food Preservation Techniques : Enhancing Food Quality , Safety , and Environmental Sustainability," 2024. https://doi.org/10.3390/su16188223

[13] M. U. P. Suardi, Alamsyah, Andi Mursid Arifuddin, "Experimental Analysis Of Castor Oil And Diesel Oil Mixtures In A 4-Stroke Compression Combustion," *Int. J. Mech. Eng. Technol. Appl.*, vol. 4, no. 5, pp. 167–176, 2023, doi: 10.21776/MECHTA.2023.004.02.6.

[14] R. J. I. Suardi Suardi, Wira Setiawan, Andi Mursid Nugraha Arifuddin, Alamsyah, "Evaluation of Diesel Engine Performance Using Biodiesel from Cooking Oil Waste (WCO)," *J. Ris. Teknol. Pencegah. Pencemaran Ind.*, vol. 14, no. 1, pp. 29–39, 2023, doi: https://doi.org/10.21771/jrtppi.2023.v14.no1.p29-39.

[15] F. Mahmuddin, S. Klara, M. Tasrief, M. U. Pawara, and M. Reza, "Performance and Emission Characteristics of Diesel Engines Using Biodiesel from Waste Cooking Oil with Cetane Number Improver," vol. 9, no. 3, pp. 528–536, 2024. doi: 10.21771/jrtppi.2023.v14.no1.p29-39

[16] F. Mahmuddin, S. Klara, W. Setiawan, and M. U. Pawara, "Conversion of Waste Cooking Oil Combined with Corn Oil into Biodiesel Using the Trans- esterification Method," vol. 9, no. 1, pp. 1–9, 2024. doi: 10.21776/MECHTA.2023.004.02.6