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Analysis of the Viscosity Value of Packaged Oil with Bulk Oil Using Tracker Video Analysis

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ABSTRACT

The utilization of STEM-based technology is essential for activating students in learning. One of the media that can be used in STEM-based learning is the Analysis Video Tracker. Analysis Video Tracker is an application used to analyze speed, velocity, acceleration, force, gravitational field, conversion, and energy conservation. This study used the Video Tracker Analysis application, which aims to observe the effect of object mass in measuring viscosity. Second, to assess the viscosity values between bulk oil and packaged oil. Finally, to examine the reliability of data generated by video tracker analysis application. The research method used in this study is an experimental method of analyzing video recordings of the motion of falling objects into a liquid with Tracker Software version 6.1.0. This research data was analyzed through the Analysis Video Tracker application, excel, and SPSS version 25. The results of the research in this article. First, the mass of the object used to measure affects viscosity time (s), distance traveled (cm), speed (cm/s), and acceleration (cm/s^2). Secondly, the viscosity value of bulk oil is higher (3.978 Nm/s^2) than packaged oil (3.124 Nm/s^2). Third, the data obtained from the video tracker analysis application is reliable or consistent. The results of this research are expected to serve as a reference and alternative in using learning media, especially on the topic of viscosity, and to become a reference in selecting oils for food processing.

INTRODUCTION

Currently, education that can create a generation that is creative, innovative, and competitive is necessary to survive in the fourth industrial revolution (Doringin et al., 2020). This can be achieved one way by optimizing technology as a tool in learning. One of the uses of technology in education, especially science, is learning based on Science, Technology, Engineering, and Mathematics (STEM) (Maulidah & Prima, 2018). In STEM-based learning, students are directed to use technology, be active, and participate in education. STEM-based learning can make it easier for educators and students to achieve maximum learning outcomes (Yasin et al., 2018). In addition, STEM-based learning can increase students' interest in learning so that it has an impact on improving students' science learning outcomes (Wahyuni, 2021).

However, many educators still do not pay attention to this when using STEM-based learning, where many educators still use conventional methods or only use outdated tools without involving technology for learning purposes (Fadlilah et al., 2020). The employment of learning materials exclusively reliant on printed materials, coupled with the utilization of antiquated instruments, such as analog stopwatches during practical sessions, exemplifies the

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limitations of the instructional approach. In addition to conventional methods, teachers sometimes do not use everyday life approaches in learning, even though students can increase their motivation to learn by using everyday life approaches. According to (Satriawan et al., 2020), there is an increase in learning activities because students become more motivated and interested in the learning process by using phenomena or events that they experience in their daily lives. This is attributed to their engagement in a real-life context that utilizes phenomena or events from everyday life. This elevation enhances students' motivation and interest, stemming from the direct correlation with their own experiences.

One of the subjects that should use the STEM approach is science education, especially Physics on Viscosity material. Generally, viscosity practicum usually uses manual methods in data collection, resulting in inaccurate results. This is attributed to the potential for human measurement errors, subjective variability in data interpretation, and the limited precision of the tools used. These factors can introduce uncertainty and result in less accurate outcomes when compared to more sophisticated or automated measurement methods. According to (Susanti & Asmoro, 2019), previous experiments still used manual data collection systems, resulting in less accurate results. In addition, students have difficulties practicing and understanding the step-by-step instructions in laboratory activities, so students will be very interested if physics education can utilize technology in laboratory activities (Fadilah & Yohandri, 2019).

In addition to problems related to using tools to measure viscosity, it is also essential to use a contextual learning approach pertaining to daily life. One of the materials related to viscosity is cooking oil. Oil is generally used for frying food, a popular food processing method worldwide (Adhikesavan et al., 2022). Common cooking oils used in society are packaged oil and bulk oil. Previous research has shown that packaged cooking oil undergoes two filtering processes, while bulk oil undergoes only one (Nurrahmah & Firly, 2020). However, increasing cooking oil prices in 2022 will also impact people's oil selection (Wulandari et al., 2022; Hussain et al., 2019). In addition to the increase in oil prices, the quality of the oil is also important to consider (Uçar et al., 2022), such as texture, shape, and nutrient content because it will affect human health (Adhikesavan et al., 2022; Jeong et al., 2019; Kazeem et al., 2022; Wendin et al., 2020). The viscosity of oil in frying is closely related to the quality of the oil. Optimal viscosity is required to ensure an even coating of oil on food materials, affecting heat transfer and mass transfer (Safari et al., 2018). Oils with appropriate viscosity can provide good frying results, while changes in viscosity during extended use can be an indicator of oil quality degradation, affected by exposure to heat and oxygen (Sutanto et al., 2016). Monitoring oil viscosity is important to maintain frying quality and minimize negative impacts on food health and taste. Therefore, conducting a viscosity test is one physics learning method to determine the quality of the oil. The best cooking oil has a high viscosity and refractive index value (Rosmalinda, 2019).

Based on the two problems mentioned above, this article proposes using the Tracker Video Analysis application. Tracker Video Analysis is an application used to analyze speed, velocity, acceleration, force, gravitational field, conversion, and energy conservation (Asrizal et al., 2022). This video tracker application is suitable for use in science education to help students interpret data produced in graphs and data tables and to facilitate students in identifying data correctly (Ramadhanti et al., 2021). Tracker Video Analysis can also improve learning outcomes by helping students analyze experiment results through data and graphs displayed (Susilawati et al., 2020). In addition, using this tracker has a very good impact on students' learning process, as students are seen to be very active during the learning process (Raflesiana et al., 2019). Through this application, students can activate their process skills. The data obtained in graphs and tables accurately produce a liquid's viscosity value, especially in Packaged Oil and Bulk Oil (Fianti et al., 2020). Thus, the achievement or success of learning is not only seen from the aspect of learning outcomes but also from the process of obtaining these results.

The relevant research review that used tracker application in viscosity material includes measuring the viscosity of water, oil, grease, and liquid soap (Putra & Ayu, 2022), measuring the viscosity of water using the damped oscillation method (Khairunnisa, 2019), measuring the effect of tracker application in teaching viscosity material (Fahrudin, 2022), and measuring the viscosity of water using the falling ball method (Akhlis et al., 2020). From the previous research review, no one has measured and compared the viscosity value of packaged and unpackaged oil. In addition, no one has measured the reliability of data produced by the video tracker application. Therefore, this research aims to observe the effect of object mass in measuring viscosity. Secondly, to compare the viscosity value between packaged and unpackaged oil. Finally, the data reliability produced by the video analysis tracker application will be examined. In addition, this research contributes to the field of physics education. This research describes how to apply video tracker analysis, especially on the concept of viscosity. Therefore, this research is used as a reference to carry out further research or as a reference in implementing video tracker analysis in physics learning.

METHODS

The research method used in this article is an experiment. In this study, a video tracker application was utilized to obtain the required data, such as time (s), distance traveled (cm), speed (cm/s), and acceleration (cm/s^2), in measuring the viscosity value of each fluid substance. The obtained data will be processed using Microsoft Excel and SPSS and analyzed and calculated based on the principles of Stokes' law of viscosity (Feser & Krumphals, 2022). If the object is spherical, according to Stokes, this force can be formulated as follows:

$$Fs = 6\eta\pi vr \quad (1)$$

Where the resistance force (Fs), the viscosity coefficient (η), the radius of the ball (r), 22/7 (π), and the relative speed of the object to the fluid can be seen in Figure 1.

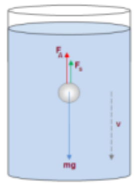

Figure 1. Forces Acting on the Sphere when It Falls into the Viscous Liquid

Stokes' law, in its application, requires several conditions: the size of the ball is much smaller than the amount of fluid, there is no turbulent flow in the liquid, and the terminal velocity is incorrect. On a solid ball that is released without initial rate from the liquid surface, three forces are exerted during its movement: the ball's gravity, Archimedes' energy, and Stokes' force (Chen et al., 2022).

If a sphere having a density ρ is released onto the surface of a liquid with no initial velocity, the ball will initially be subjected to an experiment. With an increase in the initial speed, the Stokes force on the ball will also increase so that, at one point, the ball will move at the same rate. There is a balance between the vector force, the Archimedes force, and the Stokes force on the ball. If the ball has been moving at a constant speed, then the equation applies:

$$\eta = \frac{2r^2g}{9h}(\rho_b - \rho_f) \quad (2)$$

Where the density of the ball (ρb), the density of the fluid (ρf), the time (t), the distance traveled (h), and the coefficient of liquid viscosity (η) (Primaryputri & Suprapto, 2019)

Tools and Materials

In this study, several pieces of equipment were needed: a digital caliper, digital balance, measuring cup (60 cm), three iron balls, a camera, and laptops. The material is shown in Figure 2.

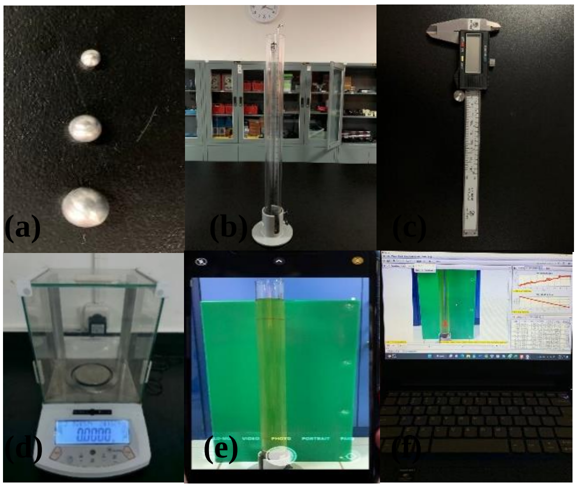

Figure 2. (a) Three Balls, (b) Measuring Cup (60 Cm), (c) Digital Caliper, (d) Digital Balance, (e) Camera, and (f) Laptop.

Each ball used has a different mass and diameter. Details can be seen in **Table 1**.

Table 1. The Mass and Diameter of the Balls

	Ball 1	Ball 2	Ball 3
Mass	0.5 g	0.2 g	0.004 g
Diameter	6.00 mm	3.90 mm	1.90 mm

For the research procedure in this study, the first is to conduct a study of literature and formulations of a research problem. The second is to prepare materials and tools; the third is to research data collection using Tracker Video Analysis; the fourth is Analysis using SPSS and Excel; and the last is the conclusion. The flowchart can be seen in Figure 3.

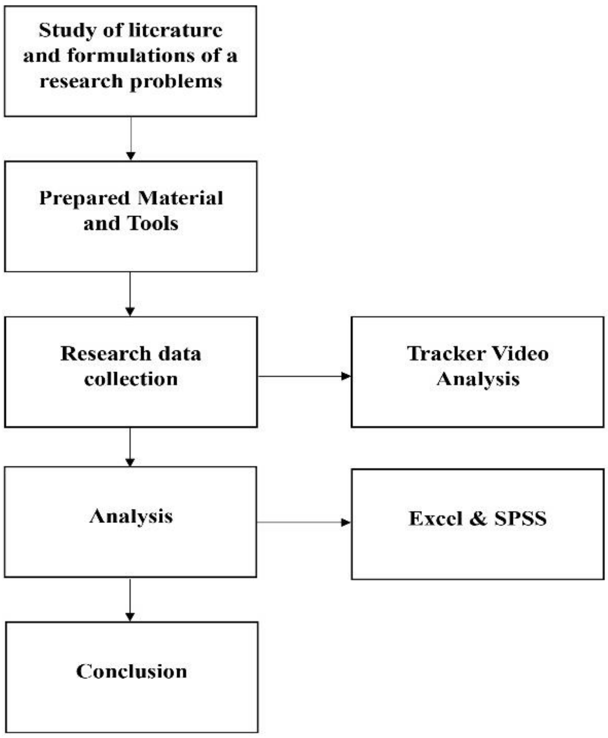

Figure 3. Research Procedure Flowchart

As for the materials used in this study, they are packaged oil and bulk oil. The packaged oil used in this article is Bimoli oil, as it is one of the most widely used oils by the community, as shown in Figure 4.

(a) (b)

Figure 4. (a) Packaged Oil; (b) Bulk Oil

Variables

This experiment has three variables: the independent variable, the dependent variable, and the control variable. These variables are described in detail in Table 2.

Table 2. Experiment Parameter

Parameter	Details
Independent	Packaged oil and bulk oil
Dependent	Viscosity
Control	Ball 1 (0.5g), ball 2 (0.2 g), ball 3 (0.004 g)

Procedure

The method used in this article is to experiment with analyzing the video recorded on the motion of objects falling into a liquid with the Tracker Software version 6.1.0. By tracking the video recording of the activity of the aluminum ball falling into the liquid, data on time, distance, speed, and acceleration can be obtained. A flowchart model was used to illustrate the research procedure. The resulting flowchart can be seen in Figure 3.

From Figure 3, the research procedure can be described as follows: First, prepare the equipment and materials by measuring the masses of balls 1, 2, and 3, which will be used to measure the viscosity of the liquid. Then, measure the volume of the fluid and calculate its density. Then, measure the volume of the fluid and calculate its density. After that, measure the distance traveled and give it a marking limit on a measuring cup containing 0.40 m fluid. Second, then insert balls 1, 2, and 3 for 5 times alternately, then video.

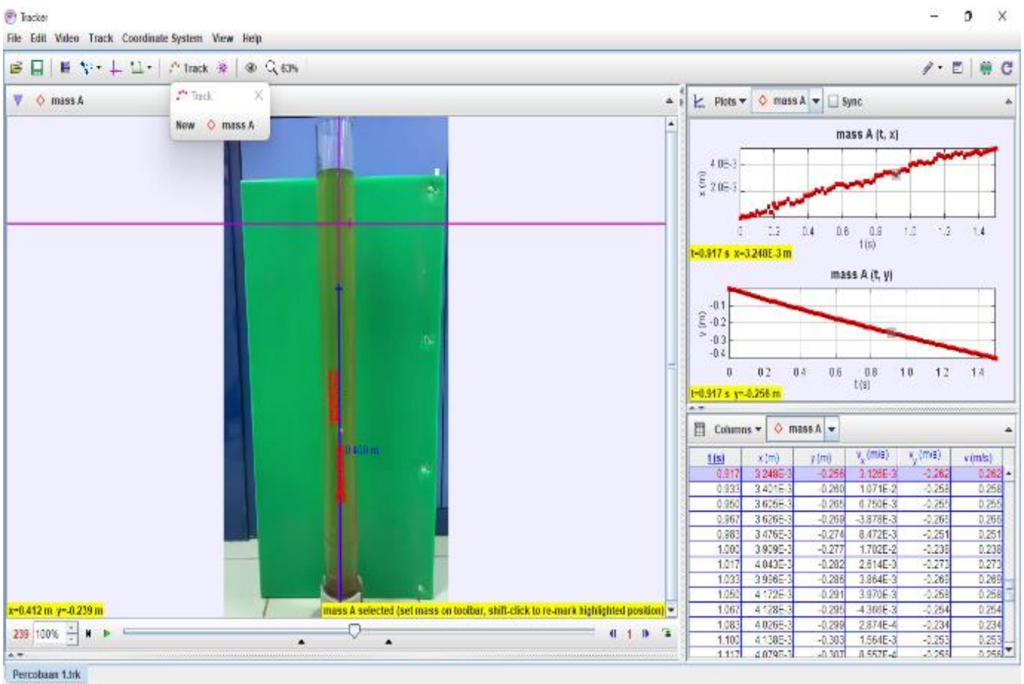

Figure 5. Tracking Process Display

After taking the student videos and installing the Tracker Software, the application can be downloaded at https://physlets.org/tracker/. Third, the video is then inserted and analyzed. After being analyzed, data on time, distance traveled, and speed of the ball were obtained. It should be remembered that the video must be taken perpendicularly and with high resolution so that it will not affect the results of the analysis to be carried out. On the other hand, in taking a video, the object being analyzed must have a different color from the background color so that when retrieving data, there will be no errors when carrying out the analysis process in the application (Akhlis et al., 2020). Fourth, after data collection, the application program will display graphs and tables of moving objects. From the application, you can see the x and y axes. The tracker process can be seen in Figure 5.

Finally, when the data has been obtained from the analysis process, the first thing to do is to test the reliability using SPSS from the data obtained from the video tracker analysis application, then compare the time (s), speed (cm/s), and acceleration (cm/s^2) data using graph then compare the data of the two fluids.

RESULTS AND DISCUSSION

Results

Based on the observations and analysis results using video tracker analysis, the authors discuss several vital points in this research. The first to see or examine the effect of mass on distance traveled (y), speed (vy), and acceleration (a). From the results of the first study, the effect of mass on mileage can be seen in Figure 6.

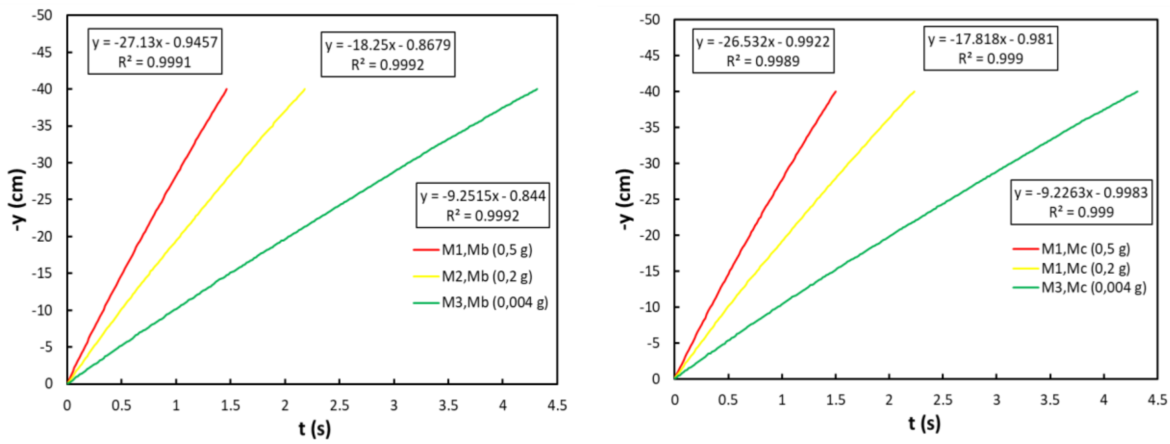

Figure 6. The Effect of Mass (m) on Mileage in Packaged Oil (Mb) and Bulk Oil (Mc)

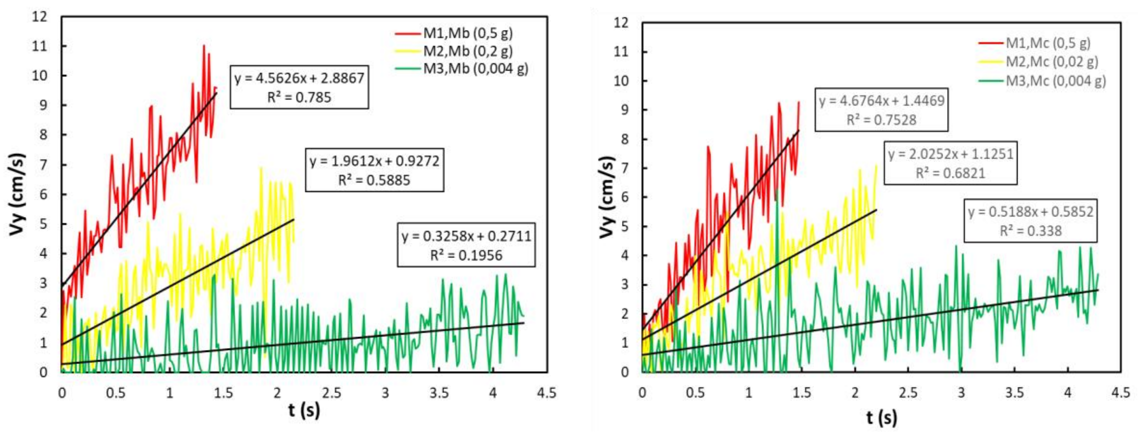

Figure 7. The Effect of Mass (m) on Speed in Packaged Oil (Mb) and Bulk Oil (Mc)

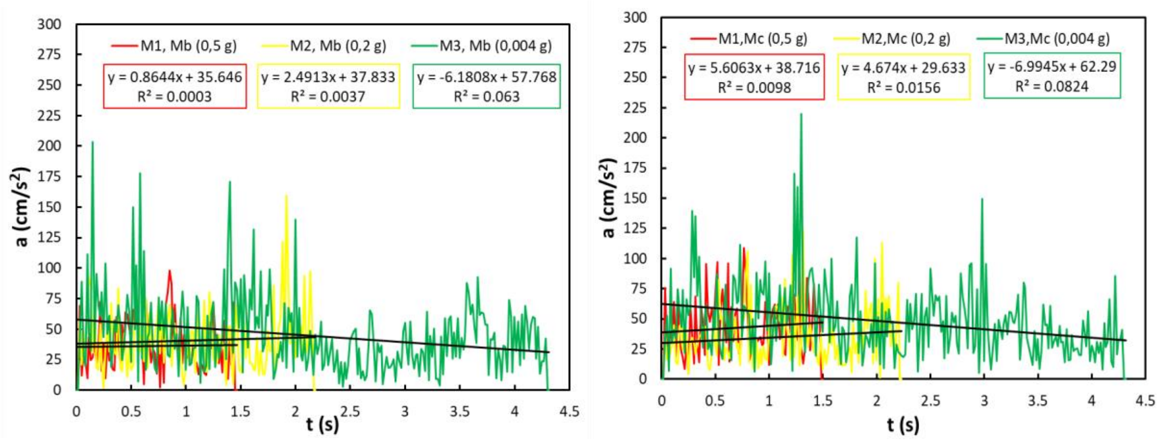

Figure 8. The Effect of Mass (m) on Acceleration in Packaged Oil (Mb) and Bulk Oil (Mc)

From Figure 6, it can be said that the higher the mass of the object used in the fluid, the faster the time it takes to travel the specified distance. Conversely, the lower the mass of the object used, the longer it will take To travel a predetermined distance. Next is the effect of mass on speed. The results of the experiments carried out can be seen in Figure 7.

From Figure 7, it can be said that. The greater the mass used, the faster the ball moves toward the travel point. Conversely, the lower the mass used, the slower the object moves toward the travel point. However, as seen in the graph above, there is a change in velocity every time, so it can be said that there is a change in speed at different times. Furthermore, the effect of mass on acceleration. This is in accordance with previous research, which states that Tracker Video Analysis, suitable for science education, aids students in interpreting data from graphs and tables, enabling accurate data identification (Asrizal et al., 2022; Ramadhanti et al., 2021). Graphical data from the experiments conducted can be seen in Figure 8.

From Figure 8, it can be said that the higher the mass of an object in a fluid substance, the lower the acceleration that the object has. Conversely, the lower the mass of an object, the higher the acceleration that an object has concerning the fluid. After Seeing the effect of the object's mass on the two fluids (packaged and bulk oil), the viscosity values of the two fluids were measured. The measurement results for packaged oil and bulk oil can be seen in Tables 3 & 4.

Table 3. The Results of Measuring the Viscosity Value of Packaged Oil

Packaged Oil	Distance (40 cm)								
	Ball 1			Ball 2			Ball 3		
	Mass (0.05 g)			Mass (0.02 g)			Massa (0.004 g)		
	Radius (6.00 mm)			Radius (3.90 mm)			Radius (1.90 mm)		
	t (s)	v (m/s)	η (Nm/s^2)	t (s)	v (m/s)	η (Nm/s^2)	t (s)	v (m/s)	η (Nm/s^2)
Experiment 1	1.481	0.257	1.906	2.181	0.169	4.39	4.331	0.085	4.920
Experiment 2	1.466	0.249	1.670	2.183	0.157	4.727	4.316	0.082	5.100
Experiment 3	1.466	0.260	1.6	2.183	0.159	4.668	4.348	0.096	2.629
Experiment 4	1.483	0.251	1.112	2.183	0.165	4.289	4.383	0.074	5.651
Experiment 5	1.466	0.238	1.104	2.183	0.169	4.391	4.331	0.089	4.699
Average	**1.472**	**0.251**	**1448**	**2.182**	**0.163**	**4518.7**	**4.341**	**0.085**	**4599.8**
S. Deviation	*0.007*	*0.007*	*350.1*	*0.008*	*0.004*	*183.5*	*0.022*	*0.007*	*1034.5*

Table 4. The Results of Measuring the Viscosity Value of Bulk Oil

Bulk Oil	Distance 40 cm								
	Ball 1			Ball 2			Ball 3		
	Mass (0.05 g)			Mass (0.02 g)			Mass (0.004 g)		
	Radius (6,00 mm)			Radius (3,90 mm)			Radius (1,90 mm)		
	t (s)	v (m/s)	η (Nm/s^2)	t (s)	v (m/s)	η (Nm/s^2)	t (s)	v (m/s)	η (Nm/s^2)
Experiment 1	1.500	0.222	1.873	2.215	0.167	4.814	4.315	0.075	5.577
Experiment 2	1.500	0.230	1.808	2.215	0.169	4.757	4.315	0.078	5.361
Experiment 3	1.498	0.251	1.657	2.198	0.162	4.964	4.331	0.090	4.646
Experiment 4	1.481	0.238	1.747	2.231	0.159	5.057	4.281	0.083	5.040
Experiment 5	1.498	0.240	1.733	2.231	0.142	5.662	4.298	0.084	4.979
Average	**1.495**	**0.236**	**1763.6**	**2.218**	**0.159**	**5050.8**	**4.308**	**0.082**	**5120.6**
S. Deviation	*0.007*	*0.009*	*72.821*	*0.012*	*0.009*	*323.58*	*0.017*	*0.005*	*321.83*

From the measurement results with five experiments on each fluid, it can be said that the viscosity value of bulk oil is higher than the viscosity result of packaged oil. Henceforth, we will compare the viscosities of the two fluids; in this comparison, the mass used is the second mass with the mass size in the middle. First, the comparison to the distance (s) traveled. Graphic data can be seen in Figure 9.

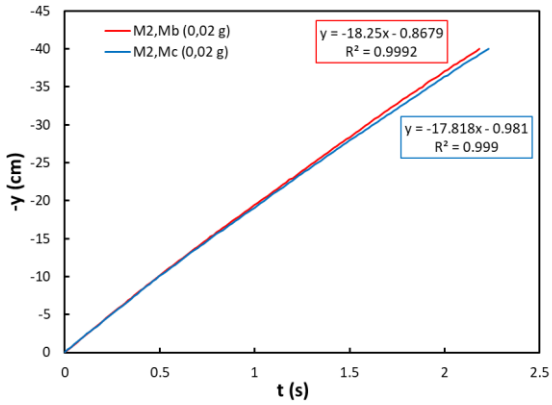

Figure 9. Chart Comparison of the Distance Travelled on Packaged Oil and Bulk Oil

From Figure 9, it can be said that the travel time for bulk oil is longer than the travel time used for permissible oil, where the maximum time obtained for packaged oil is 2,183 seconds, while for bulk oil, it is 2.231 seconds. Next is the comparison of the velocity of the two fluids. The results of the graphic data can be seen in Figure 10.

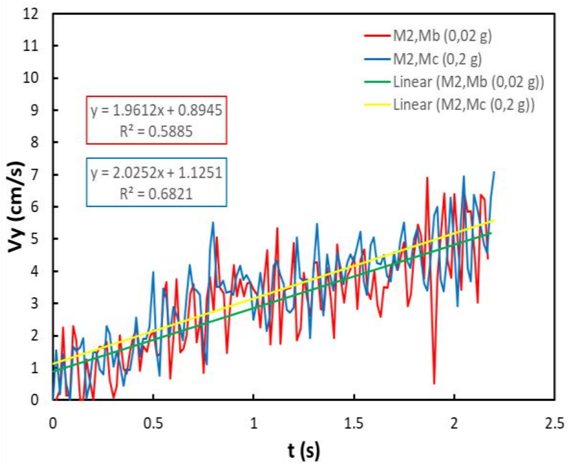

Figure 10. Chart Comparison of the Speed of Packaged Oil and Bulk Oil

Based on the data taken from the video tracker analysis application, the velocity (cm/s) contained in the packaged oil fluid is slightly faster than that of bulk oil. Still, at different times, the speed found in bulk oil is faster, but overall, packaged oil is faster than bulk oil, with the maximum speed obtained for packaged oil being 6,404 cm/s, where its viscosity level is 4518.7. The bulk oil is 6,380 cm/s, where its viscosity level is 5050.8. This can be seen in the graph above—next, comparing the accelerations in the two fluids. The results of the graphic data can be seen in Figure 11.

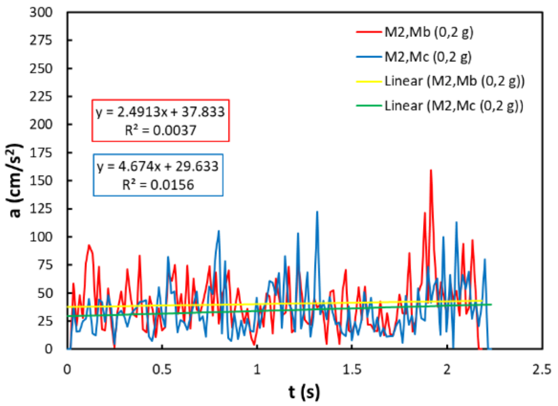

Figure 11. Chart Comparison of the Accelerations on Packaged Oil and Bulk Oil

Figure 11 shows that the acceleration contained in packaged oil is higher than that of bulk oil. The maximum data contained in packaged oil is taken from video tracker analysis application data of 159.523 cm/s^2, while the bulk oil is 105.669 cm/s s^2.

Finally, look at the reliability or consistency of the data generated by the video tracker analysis application, where the reliability of time data (t) for packaged oil obtained from the video tracker analysis application is calculated, and the results can be seen in Table 5.

Table 5. Reliability Analysis Video Tracker

Reliability Statistics	
Cronbach's Alpha	N of Items
1.000	10

Data is said to be reliable when the alpha value> 0.7 means sufficient reliability, while if alpha > 0.80, this suggests that all reliable items consistently have strong reliability (Suryabrata, 2011). From the results of the reliability data obtained for the two fluids, in this case, packaged oil and bulk oil for time (t) and speed (v), it can be said that the data results obtained by the video tracker application are reliable or consistent.

Discussion

The principle of this research is to record the falling of balls into tubes containing fluids using a camera. Then, the recorded video is transferred to a laptop to be analyzed using tracker software. The ball object in the video is tracked to obtain data on time, velocity, and acceleration and calculate the viscosity value. The data is processed and compared using graphs. The results for both fluids show more accurate values than manual calculations (Ali et al., 2019). The average viscosity values for the first, second, and third balls of Bimoli oil are 1448 Nm/s^2, 4518.7 Nm/s^2, and 4599.8 Nm/s^2, respectively. For bulk oil, the viscosity values for the first, second, and third balls are 1763.6 Nm/s^2, 5050.8 Nm/s^2, and 5120.6 Nm/s^2, respectively. Therefore, it can be concluded that the video tracker application is suitable for use as a teaching medium, especially in the viscosity material (Fahrudin, 2022).

The Analysis Video Tracker operates by tracking object movement in a video and generating relevant physics data. Users choose an object for analysis, and the software employs tracking algorithms to identify and monitor the object's movement throughout the recording. Data on the object's movement, including position at each frame, time, and other parameters necessary for physics analysis, is then extracted. Subsequently, the software conducts a mathematical analysis of the data to calculate physical parameters such as velocity and acceleration. The analysis results can be visualized through graphs or tables for easy interpretation. With this principle, Analysis Video Tracker simplifies the acquisition of physics data from video recordings, proving to be a valuable tool in the realm of physics experiments and learning (Fianti et al., 2020; Hsu et al., 2022).

Besides being suitable as a learning media, this tracker application is also easy to use, and the resulting data is quite accurate compared to manual calculations (Munir et al., 2022). To test the accuracy of the resulting data, this study also attempted to analyze the reliability of the data. From the calculations using SPSS, a reliability value of 1.000 was obtained, where alpha > 0.80 suggests that all items are consistently reliable and have strong reliability (Suryabrata, 2011), so the data generated can be trusted. With consistent data, the possibility of calculation errors is lower, making learning more effective, as explained in the study (Fianti et al., 2020), which states that using tracker applications is effective in teaching physics. This aligns with the opinion (Kettle, 2020) that video tracker-based learning can lead to improved learning outcomes as students are more active and motivated, thus achieving the learning objectives effectively.

Learning using this tracker application also allows students to be more active and engaged in learning because technology is an interesting thing for every student (Akhlis et al., 2020). This statement is supported by a study (Putra & Ayu, 2022) that states that students are more active and motivated because they find learning media, such as a video analysis tracker, attractive. In addition, it is important to take a relaxed approach to learning (Wahyuni, 2021). This study examines cooking oil that is closely related to students' daily lives.

Through this tracker application, students can activate their process skills. The data generated in graphs and tables are accurate for determining the viscosity values of fluids, especially in packaged and bulk oils. According to (Rosmalinda, 2019), good quality oil has a high viscosity and refractive index. Therefore, it can be said that good oil, according to this study, is packaged because it has a high viscosity and index values. In addition, (Ozogul et al., 2020) research state that oil with high viscosity affects food to slow down bacterial attacks, making it an alternative for use in packaged foods. Furthermore, the results of this study can serve as a reference for selecting and determining the oil to be used in food production.

The results of the study show that the viscosity level of bulk oil is higher than that of packaged oil. It can be said that the viscosity of bulk oil is thicker than the viscosity of packaged oil. According to previous research, the best cooking oil has a high viscosity value and refractive index (Rosmalinda, 2019).

The limitation of this research is that it would be advisable to add more samples or materials to be studied so that not only bulk oil and packaged oil are compared but also other oils that are currently prevalent in the community's environment, thus expanding the scope of the study.

CONCLUSION AND SUGGESTION

From the results and discussion above, it can be concluded that First, the mass of the object used to measure viscosity affects time (s), distance traveled (cm), speed (cm/s), and acceleration (cm/s^2), so it becomes a consideration to use several objects of mass when measuring viscosity.

Second, the measurement of the viscosity value for bulk oil is higher than for bulk oil, where the average yield obtained for bulk oil is 3.978 Nm/s^2, while for packaged oil, it is 3.124 Nm/s^2.

Finally, the experiment was carried out five times on the two fluids and then dialyzed using the video tracker application, which has a high reliability or consistency value so that it can be used with several experiments; on the other hand, video analysis can also be implemented in learning, especially in learning viscosity.

This study elucidates the utilization of the video tracker analysis application in exploring the concept of viscosity. Additionally, it compares the viscosity levels between bulk oil and packaged oil. The findings serve as a valuable reference for conducting laboratory experiments, particularly in the study of viscosity materials. Furthermore, the study provides insights that can be utilized as a reference in the selection of cooking oil.

The suggestion for further research is to try this video tracker analysis application on different concepts so that this application can be utilized in physics education. In addition, it can also compare not only packaging oil and bulk oil but also packaging oil with other packaging oils. It would be more interesting if there were more research materials to compare.

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AUTHORS CONTRIBUTION

B, ECP constructing and reviewing the literature. **ECP, R, and IRS** reviewed the literature and edited the manuscript. **B** edited the manuscript. All authors read and approve the final manuscript.

REFERENCES

Adhikesavan, C., Ganesh, D., & Charles Augustin, V. (2022). Effect of quality of waste cooking oil on the properties of biodiesel, engine performance and emissions. *Cleaner Chemical Engineering*, *4*(December 2021), 100070. https://doi.org/10.1016/j.clce.2022.100070

Akhlis, I., Syaifurrozaq, M., Sugiyanto, Marwoto, P., & Iswari, R. S. (2020). The determination of fluid viscosity using tracker-assisted falling ball viscosimeter. *Journal of Physics: Conference Series*, *1567*(4), 2–6. https://doi.org/10.1088/1742-6596/1567/4/042102

Ali, S. H., Al-Zuky, A. A. D., Al-Saleh, A. H., & Mohamad, H. J. (2019). Measure liquid viscosity by tracking falling ball automatically depending on image processing algorithm. *Journal of Physics: Conference Series*, *1294*(2). https://doi.org/10.1088/1742-6596/1294/2/022002

Asrizal, Pratiwi, T., & Yohandri. (2022). Tool modelling system of atwood machine with remote control of released objects for tracker video analysis. *Journal of Physics: Conference Series*, *2309*(1). https://doi.org/10.1088/1742-6596/2309/1/012043

Chen, T., Yang, Y., Bing, S., Sun, Z., Ma, B., & Yang, Z. (2022). Study on in situ viscosity model of tight oil and its measurement method. *Energy Reports*, *8*, 547–558. https://doi.org/10.1016/j.egyr.2022.02.003

Doringin, F., Tarigan, N. M., & Prihanto, J. N. (2020). Eksistensi pendidikan di era revolusi industri 4.0. *Jurnal Teknologi Industri Dan Rekayasa (JTIR)*, *1*(1), 43–48. https://doi.org/10.53091/jtir.v1i1.17

Fadilah, R., & Yohandri. (2019). Need analysis of student worksheet based on tracker on static fluid learning material in high school. *Journal of Physics: Conference Series*, *1185*(1), 0–7. https://doi.org/10.1088/1742-6596/1185/1/012115

Fadlilah, N., Sulisworo, D., & Maruto, G. (2020). The effectiveness of a video-based laboratory on discovery learning to enhance learning outcomes. *Universal Journal of Educational Research*, *8*(8), 3648–3654. https://doi.org/10.13189/ujer.2020.080843

Fahrudin, A. (2022). Pengaruh penggunaan software treker terhadap hasil belajar fisika mahasiswa pada pokok bahasan viskositas fluida. *Jurnal Pendidikan Sains Dan Komputer*, *2*(01), 41–48. https://doi.org/10.47709/jpsk.v2i01.1357

Farisa Wulandari, Natasyaputri Sendhe Siregar, & Riyan Tika Syafitri. (2022). Dampak kenaikan harga minyak goreng terhadap industri kecil menengah (IKM) di Kota Tanjungpinang tahun 2022. *Madika: Jurnal Politik Dan Governance*, *2*(1), 33–41. https://doi.org/10.24239/madika.v2i1.1027

Feser, M. S., & Krumphals, I. (2022). Preparing pre-service physics teachers to diagnose students' conceptions not covered by physics education textbooks.

The Physics Educator, *4*(2). https://doi.org/10.1142/S2661339522500081

Fianti, Listiagfiroh, W., & Susilo. (2020). Video tracker analysis: A strategy for measuring students communication and collaboration skills. *Journal of Physics: Conference Series*, *1567*(2). https://doi.org/10.1088/1742-6596/1567/2/022019

Hsu, W. Y., Cheng, Y. W., & Tsai, C. Bin. (2022). An effective algorithm to analyze the optokinetic nystagmus waveforms from a low-cost eye tracker. *Healthcare (Switzerland)*, *10*(7). https://doi.org/10.3390/healthcare10071281

Hussain, A. A. A., Vincent-Bonnieu, S., Kamarul Bahrim, R. Z., Pilus, R. M., & Rossen, W. R. (2019). The impacts of solubilized and dispersed crude oil on foam in a porous medium. *Colloids and Surfaces A: Physicochemical and Engineering Aspects*, *579*(July), 123671. https://doi.org/10.1016/j.colsurfa.2019.123671

Jeong, S., Cho, C. H., Lee, J. S., Lee, H. G., & Yoo, S. (2019). Development of active packaging technology for kimchi: One-way gas valve. *ACS Symposium Series*, *1303*, 11–23. https://doi.org/10.1021/bk-2019-1303.ch002

Kazeem, R. A., Fadare, D. A., Ikumapayi, O. M., Akinlabi, S. A., Afolalu, S. A., & Akinlabi, E. T. (2022). Analysis of the physicochemical properties of some selected non-edible vegetable oil-based cutting fluids using the design of experiment (DOE) approach. *Lubricants*, *10*(2). https://doi.org/10.3390/lubricants10020016

Kettle, M. (2020). How videos are used in secondary school physics teaching. *Physics Education*, *55*(3). https://doi.org/10.1088/1361-6552/ab7084

Khairunnisa. (2019). Pembelajaran fisika berbasis tracker dalam penentuan viskositas air menggunakan metode osilasi teredam. *PeningkatanMutu Pendidikan MIPA Dan Teknologi Di Era RevolusiIndustri 4.0*, *September*, 108–115.

Maulidah, S. S., & Prima, E. C. (2018). Using physics education technology as virtual laboratory in learning waves and sounds. *Journal of Science Learning*, *1*(3), 116. https://doi.org/10.17509/jsl.v1i3.11797

Munir, R., Amalia, N., & Munir, R. (2022). Physic laboratory by video tracker and visual basic for application at home during covid-19 pandemic: Material elasticity measurement. *AIP Conference Proceedings*, *2668*. https://doi.org/10.1063/5.0113768

Nurrahmah, A., & Firly, S. (2020). Analisis perbandingan penggunaan minyak curah dan minyak kemasan menggunakan uji hipotesis dua proporsi. *Bulletin of Applied Industrial Engineering Theory*, *2*(1), 65–66. http://jim.unindra.ac.id/index.php/baiet/article/view/2846

Ozogul, Y., Kuley Boğa, E., Akyol, I., Durmus, M., Ucar, Y., Regenstein, J. M., & Köşker, A. R. (2020). Antimicrobial activity of thyme essential oil nanoemulsions on spoilage bacteria of fish and food-borne pathogens. *Food Bioscience*, *36*(February). https://doi.org/10.1016/j.fbio.2020.100635

Primaryputri, N., & Suprapto, N. (2019). *Buku panduan praktikum fisika dasar 1*. Penerbit JDS.

Putra, B. E., & Ayu, D. P. Ni. (2022). Implementasi media pembelajaran fisika berupa tabung viskositas dengan analisis video menggunakan software tracker. *Jurnal Pendidikan Fisika dan Sains (JPFS)*, *5*(1), 10–15. https://doi.org/https://doi.org/10.52188/jpfs.v5i1.207

Raflesiana, V., Herlina, K., & Wahyudi, I. (2019). Pengaruh penggunaan tracker pada pembelajaran gerak harmonik sederhana berbasis inkuiri terbimbing terhadap keterampilan interpretasi grafik siswa. *Gravity : Jurnal Ilmiah Penelitian Dan Pembelajaran Fisika*, *5*(1), 1–12. https://doi.org/10.30870/gravity.v5i1.5207

Ramadhanti*, D., Kuswanto, H., Hestiana, H., & Azalia, A. (2021). Penggunaan analisis video gerak kucing melompat berbantuan aplikasi tracker sebagai kegiatan praktikum mandiri materi gerak pada peserta didik SMP. *Jurnal Pendidikan Sains Indonesia*, *9*(3), 459–470. https://doi.org/10.24815/jpsi.v9i3.20547

Rosmalinda, R. (2019). Analisis viskositas dan indeks bias terhadap kualitas minyak goreng kemasan dan curah. *Jurnal Hadron*, *1*(02), 17–21.

Safari, A., Salamat, R., & Baik, O. D. (2018). A review on heat and mass transfer coefficients during deep-fat frying: Determination methods and influencing factors. *Journal of Food Engineering*, *230*, 114–123. https://doi.org/10.1016/j.jfoodeng.2018.01.022

Satriawan, M., Rosmiati, R., Widia, W., Sarnita, F., Suswati, L., Subhan, M., & Fatimah, F. (2020). Physics learning based contextual problems to enhance students' creative thinking skills in fluid topic. *Journal of Physics: Conference Series*, *1521*(2). https://doi.org/10.1088/1742-6596/1521/2/022036

Suryabrata, S. (2011). *Metode penelitian*. PT. Raja Grafindo Persada.

Susanti, H., & Asmoro, C. P. (2019). Rekonstruksi Set Alat Percobaan Viskositas. *WaPFi (Wahana Pendidikan Fisika)*, *4*(1), 31. https://doi.org/10.17509/wapfi.v4i1.15812

Susilawati, S., Satriawan, M., Rizal, R., & Sutarno, S. (2020). Fluid experiment design using video tracker and ultrasonic sensor devices to improve understanding of viscosity concept. *Journal of Physics: Conference Series*, *1521*(2). https://doi.org/10.1088/1742-6596/1521/2/022039

Sutanto, S., Rahman, R., & Abriana, A. (2016). Pengaruh pengulangan penggorengan terhadap kandungan asam lemak bebas dan viskositas minyak hasil penggorengan. *Jurnal Ecosystem*, *16*(3), 498–514. https://journal.unibos.ac.id/eco/article/view/933/484

Uçar, Y., Durmuş, M., Küley, E., & Korkmaz, K. (2022). Inhibitory effect of rosemary essential oil and its nanoemulsion on the formation of biogenic amines by food-borne pathogens and fish spoilage bacteria. *Yuzuncu Yil University Journal of Agricultural Sciences*, *32*(1), 199–212. https://doi.org/10.29133/yyutbd.1035443

Wahyuni, N. P. (2021). Penerapan model pembelajaran berbasis STEM untuk meningkatkan hasil belajar IPA. *Jurnal of Education Action Research*, *5*(1), 109–117.

Wendin, K., Martensson, L., Djerf, H., & Langton, M. (2020). Product quality during the storage of foods with insects as an ingredient: Impact of particle size, antioxidant, oil content and salt content. *Foods*, *9*(6). https://doi.org/10.3390/foods9060791

Yasin, A. I., Prima, E. C., & Sholihin, H. (2018). Learning electricity using arduino-android based game to improve stem literacy. *Journal of Science Learning*, *1*(3), 77. https://doi.org/10.17509/jsl.v1i3.11789