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Determining the Quality of Cooking Oil Judging from the Refractive Index Parameters

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ABSTRACT

This research aims to test the quality of cooking oil using refractive index as a parameter using a simple refractometer which is constructed from mica plastic sheet. The principle of this cooking oil test is based on Snell's law. The cooking oil samples used were four brands of cooking oil with new conditions labeled A, B, C, and D. Based on the research, it was found that cooking oil A and D with refractive index values of 1.604 and 1.764 referring to both standard had poor quality, cooking oil B with a refractive index of 1.547 referring to standard 1 has good quality and when referring to standard 2 it has poor quality, and cooking oil C with a refractive index of 1.494 refers to both standar having good quality. Therefore, it can be concluded that C cooking oil has the best quality than the other three cooking oil samples.

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1. INTRODUCTION

Cooking oil is a primary necessity for Indonesian people which is used in the process of frying food. Cooking oil is obtained by refining parts of vegetable, animal or other synthetic fats. The average cooking oil in Indonesia is palm oil and has standards determined by the Indonesian Standardization Agency (BSN) [1]. On the basis of determining the quality criteria for palm cooking oil, there are several standards for testing the quality criteria for palm oil vegetable oil which serve as a reference for the production and sale of palm oil vegetable oil in Indonesia, namely free fatty acid content, water and impurity content, peroxide value, and color level. cooking oil.

The quality standards for palm cooking oil in Indonesia have not been implemented properly, which has resulted in the circulation of a lot of cooking oil that does not comply with the established standards, in addition to the consumption of cooking oil which is increasing every year. Reporting from kompas.com, it was revealed that GAPKI noted that in 2021 consumption of palm oil cooking oil in Indonesia reached 18,422 million tons or an increase of 6 percent compared to consumption of palm oil cooking oil of 17,349 million tons in 2020. This increase in demand for cooking oil has encouraged various parties to produce and distribute poor or even bad quality cooking oil to consumers in order to gain more profits. This poor quality cooking oil can be produced through blending, namely mixing used cooking oil from industry, hotels and restaurants with new cooking oil in a more favorable ratio. Therefore, there is a need to study the quality of cooking oil circulating in the community.

Basically, several physical instruments used to determine the quality of cooking oil are bought and sold on the market, such as refractometers, interferometers, Ostwald viscometers, and others. Several previous researchers have conducted research with refractometers. The Double Window Phenomenon for Surface Plasmon Resonance Sensors Based on Plastic Optical Fibers was researched by Lin [1]. The design of a hybrid photonic-plasmonic crystal refractive index sensor for highly sensitive and high-resolution sensing applications was researched by Hajshahvaladi [2]. An inverted DVD-R lattice structured SPR sensor platform with high sensitivity and a decent figure was researched by Choi [3].

Demodulation of the transmission signal of an inclined fiber Bragg grating using a modified Delaunay triangulation of the α form was researched by Fazzi [4]. Refractive index sensing by asymmetric dielectric gratings with both bound states in continuum resonance and guided modes was investigated by Liu [5]. The design of a cost-effective graphene metasurface-based pregnancy test with NOR gate realization and parametric optimization was researched by Surve [6].

Solvent-Free Nanofabrication Based on Ice-Assisted Electron Beam Lithography was researched by Hong [7]. Coordinating multi-band absorbers with irrelevant patterned graphene patches based on multi-layer film structures was researched by Bao [8]. A Very Fast One Step Process for Long Run Microfiber Grating Fabrication was researched by Maghsoudian [9].

Highly Directed Fano Resonances in Individual Silicon Nanorods were investigated by Xu [10]. The refractive index of phosphate-containing saline in the telecommunication infrared C + L band was investigated by Janeiro [11]. A polarization-independent tetramer metasurface with multi-Fano resonances based on symmetry-protected bound states in the continuum was researched by Fan [12].

The assessment of ghee adulterated with oils and fats in Bangladesh was studied by Ahmed [13]. High-pressure crystallization of binary unsaturated fatty acids in cylindrical cells was investigated by Maeda [14]. Electromagnetic multipolar quasi-bound states in the continuum for optical sensing were investigated by Chen [15].

Lossy Mode Resonance Sensors Based on Double ITO/TiO2 and Triple TiO2/ITO/TiO2 Thin Film Coated Single Mode Fiber Taper were researched by Golant [16]. Delafossite AgAlO 2 modified long-range grating for a highly sensitive ammonia sensor was researched by Rong [17]. Coreless fiber with independent image length optimization for optics-based refractive index sensors was researched by Mohd Razali [18].

A highly sensitive fiber optic refractive index sensor based on lossy mode resonance using bilayer FTO/HfO 2 for operation in the visible region was investigated by Semwal [19]. BioSAXS on the SWING beam line at the SOLEIL Synchrotron was investigated by Thureau [20]. An optical calibration system for refractometers was investigated by O'Neal [21].

The coexistence of circular dichroism and asymmetric transmission in stretchable chiral metamaterials was investigated by Zhou [22]. A comparison of various methods used in drug abuse for testing sample validity including pH method, specific gravity method, TECO™ Drug Adulteration Test Strips and oxidant test was researched by Mina [23]. A dynamic aberrometer/topography designed for clinical measurement and treatment of highly aberrant eyes was investigated by Neal [24].

A very high refractive index sensor based on Rayleigh anomalous resonance was investigated by Rahimi [25]. The validation of the Brix refractometer to estimate the concentration of immunoglobulin G in goat colostrum was investigated by Buranakarl [26]. Resonance Effects in a Bent Waveguide-Based Fabry–Perot Resonator with Spatially Varying Reflectivity Mirrors were investigated by Dyshlyuk [27].

Planar Plasmonic Terahertz Waveguide Based on One-Dimensional Array of Pyramid Waves and Refractive Index Sensing was researched by Dhriti [28]. The design and investigation of a hollow core negative curvature fiber based refractive index sensor for tuberculosis monitoring was investigated by Parvin [29]. Refractive Index Measurement Based on Thin Core Fiber Mach-Zehnder Interferometer and Differential Intensity Demodulation were investigated by Cai [30].

However, in general, this tool is relatively difficult to use and the price is more expensive, which means that this instrument is only available in certain laboratories, one of which is the Testing Laboratory of the Food and Drug Monitoring Agency (BPOM). These instruments are not available to the public who need quick and cheap testing of the quality of the cooking oil they consume. Therefore, it is necessary to develop instruments that are in principle simpler and cheaper to use.

Previous research using an Ostwald viscometer and refractive index measurements showed that cooking oil has good quality if it has a large refractive index value, the refractive index value is 1.44. Other research using a hollow prism shows that the refractive index of good cooking oil is 1.5152. Cooking oil that has a refractive index far from this value is considered to be of poor quality. Based on previous problems and research on the quality of cooking oil, this article aims to find out how much the cooking oil index value is using Snell's law with a simple refractometer constructed from mica plastic sheet.

2. METHODS

This research is divided into three stages, namely the first stage of design and construction of the refractometer, the second stage of measuring the refractive index of cooking oil, and the third stage of analysis of the measurement results. This refractometer is a tool resulting from the development of an existing tool, namely parallel plan glass. The materials needed to design this simple refractometer are a thin mica plastic sheet measuring 10 cm × 4 cm × 4 cm, paper, protractor, ruler and scissors. This refractometer is in the form of a container made of mica plastic sheet with paper underneath which has a picture of an indicator reading the angle of entry and exit of the laser light. The entry angles used in this study consisted of 10°, 20°, 30°, 40°, 50°, and 60°.

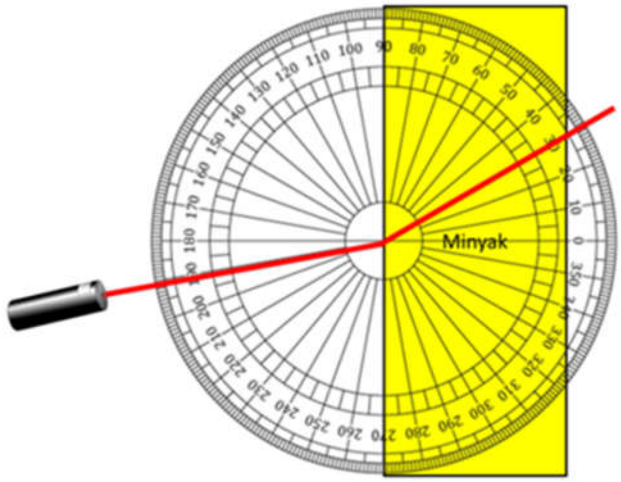

Fig. 1. The scheme for measuring the refractive index of cooking oil uses a container made of mica sheet by passing laser light through a container filled with the cooking oil sample to be tested

After the simple refractometer has been designed, the next stage is measuring the refractive index of cooking oil. The samples used in this research were four different brands of cooking oil in new condition, namely brand A, brand B, brand C, and brand D. The principle of the test, namely when a light enters from the initial medium with a refractive index n_1 at an angle θ_1 from the line normal to medium two with a refractive index n_2, then the incoming light line will be bent by θ_2 towards the normal line. The relationship between the angle of incidence and the refractive index of the original medium and the refracting medium can be predicted using the following Snell's law.

$$n_1 \sin(\theta_1) = n_2 \sin(\theta_2) \tag{1}$$

Oil quality testing is carried out by filling the container with the cooking oil to be tested. The container containing the cooking oil is then placed on paper with indicators reading the angle of entry and angle of exit. Then the laser light is directed towards the oil surface wall at a certain angle. The output of the laser light can be calculated into an output angle which can be calculated using Snell's law and the refractive index of the oil is obtained.

Refractive index calculations using Snell's law are carried out by repeated measurements through various input angle directions. The calculation results will produce several refractive index values for one brand of oil. The refractive index is then searched for the average value to find the refractive index of the cooking oil to be tested, then the refractive index value of the cooking oil that has been tested is compared with research as standard 1 and standard 2 which has been carried out by Sutiah (2008) with the index results the bias is 1.44 and research by Nasrullah et al (2017) results in a refractive index of 1.5152.

3. RESULTS AND DISCUSSION

The development of a simple refractometer can be seen in Figure 2. Ice cream sticks or wooden sticks can be attached to strengthen the structure of the mica container, while razor blades can be attached to the side where the laser light is directed towards the liquid to cut the laser light and make measurements more accurate by reducing the size of the laser light.

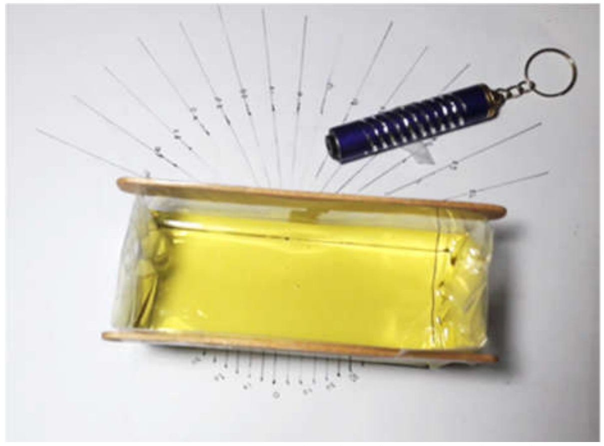

Fig. 2. Refractometer that has been developed

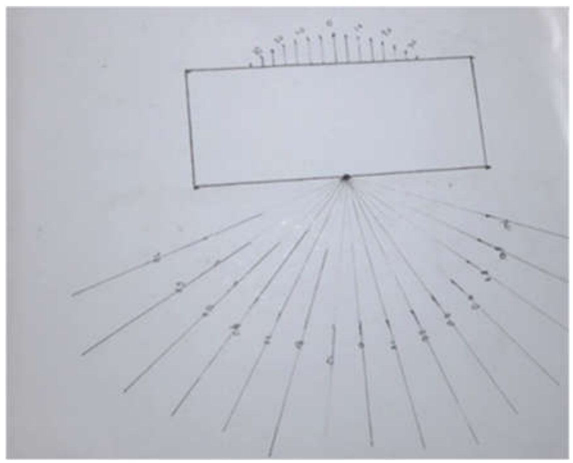

Fig. 3. Paper with inlet angle and exit angle reader indicators (inlet angle values are 10°, 20°, 30°, 40°, 50°, and 60°)

After the refractometer was developed and the mathematical equation was obtained, the next step was measuring the refractive index of cooking oil with varying angles of incidence as shown in Figure 3.

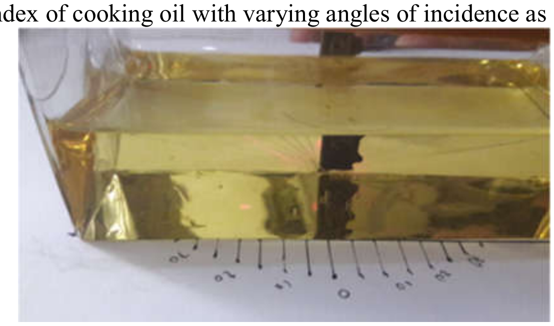

Fig. 4. Measurement of the refractive index of cooking oil using a refractometer that has been developed

The results of measuring the refractive index for cooking oil can be seen in Table 1.

Table 1. Refractive Index Measurement Results for Cooking Oil

Sample	Sample Average Refractive Index Value of Cooking Oil
A	1.604
B	1.547
C	1.494
D	1.764

Referring to research as standard 1 and standard 2 which was carried out by Sutiah (2008) with a refractive index result of 1.44 and research by Nasrullah et al (2017) with a refractive index result of 1.5152, a comparison of the results is obtained in Table 2.

Table 2. Comparison between the results of measuring the refractive index for cooking oil and previous research

Type	Refractive index	Standard 1 (1,5152)		Standard 2 (1,44)		Standard average 1 and standard 2 (1,4776)	
		Sig.	Quality	Sig.	Quality	Sig.	Quality
A	1,604	5.9%	Not good	11.4%	Not good	8.6%	Not good
B	1,547	2.1%	Good	7.4%	Not good	4.7%	Good
C	1,494	1.4%	Good	3.8%	Good	1.1%	Good
D	1,746	15.2%	Not good	21.3%	Not good	18.2%	Not good

Based on Table 2, which refers to both standards, it can be said that brand A and brand D cooking oil are of poor quality with refractive index values of 1,604 and 1,746 respectively. For brand B cooking oil with a refractive index value of 1.547 referring to standard 1 as having good quality and referring to standard 2 as having poor quality, while for brand C cooking oil with a refractive index of 1.494 referring to both standards as having good quality. Therefore, it can be said that of the four brands of cooking oil, brand C cooking oil is the cooking oil that has the best quality compared to the other three brand samples. The results of research on the quality of cooking oil based on the refractive index can be used as a reference standard for the quality of cooking oil in producing good quality cooking oil. Not infrequently, there is a lot of low quality cooking oil circulating in the community.

4. CONCLUSION

Based on the research that has been carried out, it can be concluded that brand A and brand D cooking oils referring to both standards (standard 1 and standard 2) have poor quality with refractive index values of 1,604 and 1,746 respectively. Brand B cooking oil with a refractive index value of 1.547 has good quality when referring to standard 1 and poor quality when referring to standard 2. Brand C cooking oil refers to both standards and has good quality with a refractive index value of 1.494. Therefore, brand C cooking oil has the best cooking oil quality compared to the other three samples of cooking oil brands with a refractive index of 1.494.

The refractometer that has been developed has advantages and disadvantages. The advantages of this tool are that it is able to differentiate the refractive index of the four types of cooking oil and the materials used are easy to obtain. Meanwhile, the disadvantage of this tool is the lack of accuracy in determining the distance between the refracted rays and the normal line. By knowing the shortcomings of this tool, for further research it is necessary to develop a better simple refractometer tool that is more precise in determining the distance between the refracted rays and the normal line in order to minimize the occurrence of these shortcomings, so that this simple refractometer tool constructed from mica plastic sheet can be marketed. to the wider community.

DECLARATION

Author Contribution

This research is divided into three stages, namely the first stage of design and construction of the refractometer, the second stage of measuring the refractive index of cooking oil, and the third stage of analysis of the measurement results.

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Conflict of Interest
Declare conflicts of interest or state "The authors declare no conflict of interest."

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