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Frequencies of pure olive oil at temperature between 50°C to 25°c

Pure Olive Oil at different frequencies

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***Abstract*—A study was carried out to determine the effect of temperature between 50°C to 25°C on the frequency of pure olive oil bought from Malaysia local market. An evaluation module, TDC1000-TDC7200EVM was connected to an ultrasonic 1MHz transducer to transmit and receive the ultrasound wave. The ultrasound wave signals were measured in time of flight values, where the time was calculated when the ultrasonic first tigger the ultrasound wave and when the ultrasonic receive the returning echo of the ultrasound wave. The time of flight data were converted to frequency and monitored the effect at different temperature. Based on the results, at the lowest temperature, the pure olive oil have the highest frequency peak, and vice versa. electronic document is a "live" template and already defines the components of your paper [title, text, heads, etc.] in its style sheet.**

Keywords—olive oils, frequencies, temperature, real-time, impurities.

I. INTRODUCTION (*Heading 1*)

Pure olive oil has very low saturated fats, of which up to 85% of the fats are either monounsaturated fats or polyunsaturated fats of omega-6 and omega-3. These fats have been known to, that assisst in reducing heart disease, and able to improve health in a number of ways [1]. However, due to its benefits and great demand internationally, pure olive oil tend to be adulterated [2]. Either the olive oil is pure or adulterated can be investigated by determining the time of flight or the frequency of the oil itself. In contrast, the relationship of the time of flight and oil velocity can be determined using the ultrasound wave method. A number of studies have already been published regarding the use of ultrasound wave as a method to read the signal of liquids velocity, density, or flowablility on different types of oils [3-6]. It has been well established that temperature has a strong influenced on the oil velocity [7-8]. In this study, the time of flight and velocity of the pure olive oil at the temperature of 50°C, 45°C, 40°C, 35°C, 30°C, and 25°C were investigated. To monitor the peak frequencies, the time of flight are converted using Matlab. For calibration, water as standard liquid was used in the experiment and compared with literatures. The standard value from literatures for the speed of sound for water is 1480 m/s [9].

II. MATERIALS AND METHOD

A. Sample Preparation (Heading 2)

The type of olive oil bought from the local Market chosen was based label indicated on the bottle either pure or 100% olive oil. The olive oil was kept at room temperature. To prepare the sample, olive oil was heated on the day of the experiment. First, 200 ml of olive oil was poured into a glass beaker, then the glass beaker was placed on the hot plate, with temperature set to 60°C. The temperature of the olive oil in the glass beaker was monitored using the infrared thermometer. The time needed for the olive oil to reach 60°C on the glass beaker was between 15-20 minutes. Once, the infrared thermometer read 60°C on the olive oil, the olive oil inside the glass beaker was transferred to the test beaker. In the experiment, the outer side of the test beaker used was attached to 1MHz ultrasonic transducer, and to K-Type thermocouple for real-time temperature reading. The K-Type thermocouple was connected to the Picolab Thermocouple Datalogger Model TC-08, which was then connected to the computer via USB. The top of the test beaker was closed-lid to prevent outside air creating disturbances on the reading of the olive oil.

B. Experimental Method

The type of olive oil bought from the local Market chosen was based label indicated on the bottle either pure or 100% olive oil. The olive oil was kept at room temperature. To prepare the sample, olive oil was heated on the day of the experiment. First, 200 ml of olive oil was poured into a glass beaker, then the glass beaker was placed on the hot plate, with temperature set to 60°C. The temperature of the olive oil in the glass beaker was monitored using the infrared thermometer. The time needed for the olive oil to reach 60°C on the glass beaker was between 15-20 minutes. Once, the infrared thermometer read 60°C on the olive oil, the olive oil inside the glass beaker was transferred to the test beaker. In the experiment, the outer side of the test beaker used was attached to 1MHz ultrasonic transducer, and to K-Type thermocouple for real-time temperature reading. The K-Type thermocouple was connected to the Picolab Thermocouple Datalogger Model TC-08, which was then connected to the computer via USB. The top of the test beaker was closed-lid to prevent outside air creating disturbances on the reading of the olive oil.

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C. Calibration

For calibration, water was used instead of olive oil to observe the efficiency and the accuracy of the evaluation module in the study. The measurement of water used in this experiment was taken at room temperature, no cooling or heating of the water sample is performed. The velocity of the water from standard literature was compared with the experimentation result. The GUI software reads the water velocity 1480 m/s, the same results as the standard literatures. The oscilloscope reads the time of flight where the horizontal cursor was placed on the rising peak of the start signal to the rising peak of the stop signal. Refer to Fig.1 on the experimentation setting of oscilloscope, EVM, experimental beaker, PICO Instrument and the computer for analyzing data.

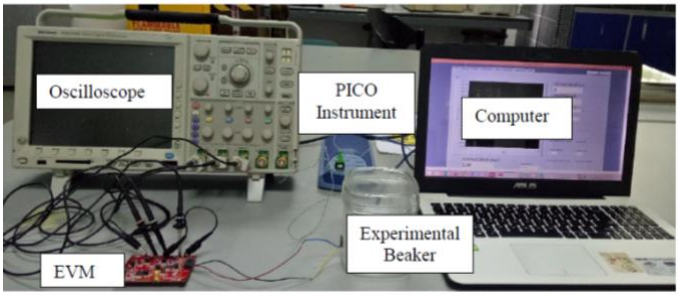

Figure 1. The experimentation setting.

Refer to Equation (1), the value for the water speed of sound also showed result of 1480 m/s. Based on the comparison, the evaluation module showed high accuracy where both the GUI software and the oscilloscope give the same results as the standard literature.

$$\text{Speed of sound} = (2d / \text{Time of flight}) \quad (1)$$

where, d is the length of the test beaker where the ultrasound wave travelled, and time of flight was read from the oscilloscope, d = 8.61 cm, and time of flight = 116,860.47 ns.

III. RESULT AND DISCUSSION

A. Temperature dependency

The olive oil sample was prepared and poured into the test beaker, where the temperature data were recorded starting from 50°C to 25°C using the K-type thermocouple. The velocity of the olive oil was compared to standard literature values at the temperature of 40°C, 30°C and 20°C, and the precision of the comparison was calculated using Equation (2).

$$\text{Precision} = (V_S - V_E)/V_S \text{ X } 100 \quad (2)$$

where, V_S is the standard value of velocity from literature and V_E is the experimental value.

TABLE 1. SPEED OF SOUND OF OLIVE OIL COMPARED TO STANDARD LITERATURE.

Temperature (°C)	Time of flight (ns)	Experimental Speed of sound (m/s)	Standard Speed of sound (m/s)	Precision (%)
20	120077	1432	1431	-0.07
30	121969	1410	1430	1.39
40	124500	1381	1397	1.14

Refer to Table 1, the precision values were less than 2%, which means the results data from the evaluation module compared to standard literature have smaller error and high closeness of the measurements to each other, resulting as the method of using the evaluation module to collect the speed of sound and the time of flight data were acceptable. The olive oil was temperature dependence where from Table 1, the higher the temperature, the lower the speed of sound, and the higher the time of flight values. However, at 40°C temperature, the precision slightly higher, but still below 2%, the possibility is due to random data signal were used to compare instead of using the closely data values to literature used. Hence, a slightly higher precision can be observed.

B. Olive oil Frequency

The method of using echo signal when the time of flight travelled and received by the 1MHz ultrasonic transducer could be analyzed further, where the relationship between the time of flight and frequencies were taken into account. In the study, the echo wave where the transducer received the transmitted signal was recorded from the oscilloscope and converted to frequency. At the temperature interval of 50°C, 45°C, 40°C, 35°C, 30°C and 25°C, the echo signal were recorded and plotted using Matlab. The peak frequencies at different temperature were controlled while the air-condition lab room temperature of 25°C and humidity 70% were monitored using the electronic digital thermometer available in the lab. Fig. 2 show, the echo signals were measured at the different temperature intervals. From the measurement, it is observed that, the echo signal at different temperature could hardly be distinguished as the signals were closely packed to each other. Although there were different on the first rising peaks of each temperature on the sinusoidal wave signals, the differences were subtle.

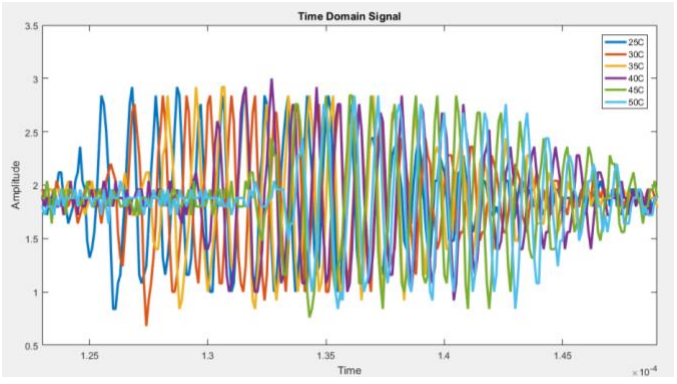

Fig. 2. Received Echo signals of olive oil at temperature intervals of 50°C, 45°C, 40°C, 35°C, 30°C, and 25°C.

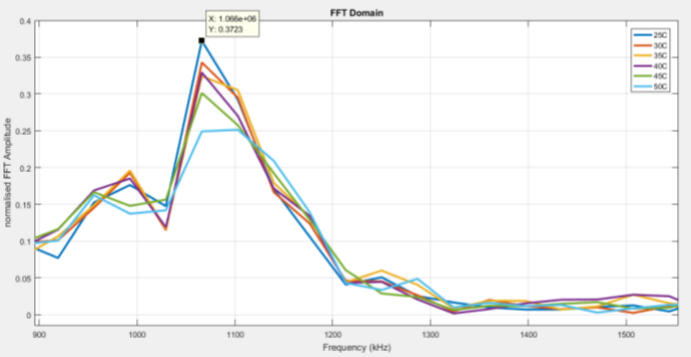

Fig. 3. Frequencies signal after converted from received echo signals of olive oil.

The time of flights echo signals were converted to frequency domain using Eq. 3 and the signals were graphed in Fig. 3. Refer to Fig. 3, the lowest peak is from the 50°C, and the peak frequencies kept on increasing as the temperature decreased. This indicate that the frequency domain can be used to differentiate the signal difference.

$$\text{Frequency} = (1 / t) \quad (3)$$

where, t is the echo received in time domain data.

IV. CONCLUSION

In the study, the results from temperature dependency, it can be conculded that olive oil in terms of velocity, time of flight and frequency did effected by the temperature. The 1MHz ultrasonic transducer using the method of time of flight was able to read the data precisely and accurately when compared to standard literature. When the temperature increased, the speed of sound values decreased proportionally, while the time of flight increased gradually. However, when the echo received signals at time domain with different temperature were compared, the signals were unable to be observed, due to the small distance between each signls.

Hence, when the time domain echo signals were converted to frequencies signal, from the peaks frequency, the difference can be observed. It can be conclude that the frequency signal converted from the time of flight signal can be used to compared with other types of oils due to their obviously differ frequency characteristics. The results from the study using the pure olive oil and pure corn oil can be used to compare with the adulterated olive oil or corn oil to clarify either the oil were adulterated and the level of adulteration can be studied further using the same technique.

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