Acoustic Attenuation Technique for the Detection of Adulteration in Milk

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ABSTRACT
An ultrasonic sensor has been used for detecting the amount of adulteration in full cream milk with water. The sample under test is filled in a rectangular perplex glass cell, containing ultrasonic transmitter and receiver which is kept in through transmitter mode for generating the ultrasonic waves. The acoustic wave passing through the sample gets attenuated. The level of attenuation varies with the amount of adulteration with the sample of milk. Hence, the attenuation is the measure of adulteration and can be calibrated with standard adulterated milk samples with water at room temperature. The percentage of adulteration in milk is found to be linearly related with the attenuation of ultrasonic waves passing through it. The method would help in easy and quick detection of adulteration in milk, which is the need of the hour for better health care of masses.

Keywords- Milk adulteration; Ultrasonic transducer; Attenuation

1. INTRODUCTION
In recent years, a very large proportion of infant mortality is traceable to the use of impure milk, and that many diseases, especially diarrhea disorders of summer, are preventable when proper care is exercised to protect the milk supply. The commonest method of adulterating milk, and the one often most difficult of detection, is by dilution with water. If the water thus used is pure, it does no harm other than to defraud the consumer; but if impure, as it often is, may prove fatal [1].
Ultrasound is widely used medically and in industrial process control nevertheless the application of ultrasound in the quality control of foods, and biological media is yet to be sought after. Ultrasonic techniques can avoid the important hazard of product contamination. Another important feature of ultrasonic measuring techniques is that, in most cases, neither reactive nor replaceable elements need to be added to the medium under test. This implies that the ultrasonic inspection and quality control system may be implemented in an environmentally friendly and economical manner [2]. Among the physical parameters characterizing the interaction of the ultrasonic beam with its supporting medium, ultrasonic attenuation is a very important input parameter for these models because it limits the volume of the system that can be inspected, and may alter the quantitative assessment of the properties of a defect the inspecting wave may detect [3].
When pure milk is adulterated by mixing with water, then its viscosity, density, freezing point, electrical admittance [4] or conductance [5] Change. However, most of these techniques are expensive and time consuming. It has therefore become necessary to develop better instrumentation for rapid and reliable detection of this kind of adulteration.
This paper intents to help in easy and quick detection of adulteration of full cream milk by water and thereby resulting in better health care of masses as compared to, alternative techniques suggested by recent developments in this area.

2. PRINCIPLE OF OPERATION
An ultrasonic transducer converts an input continuous wave electrical signal to an ultrasound signal of a certain frequency and intensity and launches it into the sample. The intensity of this signal decays as it passes through the sample due to interaction with the fluid. A second ultrasonic transducer converts this weakened acoustic signal back to an electric continuous wave signal and sends it to the Digital Signal Oscilloscope for comparison with the initial input signal. The total loss and time delay from the input to output transducer for each frequency and gap can be considered the raw data from which further interpretation is made [6].
Attenuation can be described as the overall loss of power in an ultrasound wave. These losses include all forms of energy loss, most of which results from absorption and reflection. This is medium specific and frequency dependent [7].

3. EXPERIMENTAL METHODS
For experimental testing in our laboratory, we have selected the most popular and commercially available brand of milk viz; Amul which is packed as full cream milk having a minimum of 6% fat and 9.0% SNF (commercially available information). Different amounts of double distilled water are added as adulterants in the pure sample of milk and ultrasonic attenuation was measured in terms of peak-to-peak output voltage. Double distilled water is mixed with milk in concentrations of 0%, 20%, 50%, 70% to create different adulterated samples for analysis. Generally to check for more than 70% of water in a sample is of no practical significance. To keep away the complicacy and also for the wider acceptance of these observations, the temperature throughout the experiment was maintained the room temperature. Double probe through transmission technique is used for the measurement of ultrasonic attenuation. The transducers of 0.5 MHz are used at the transmitting and receiving ends. The experimental set up includes the rectangular perplex glass cell (70*40*65 mm), the transducers are fixed in the cell and were aligned horizontally opposite to each other, and placed 14 mm apart. The samples under test are filled in this cell, and acoustics waves passed through them, resulting in the alteration of output peak-to-peak voltage. For each sample measurement the sensor is washed with double distilled water.
The transducers are connected to function generator and digital signal oscilloscope to enable measurements and analysis. Whole system is configured to transmit and receive

at a frequency of 502.5 KHz. The experimental setup is shown in Fig. 1.

Fig. 1. Experimental setup

4. EXPERIMENTAL RESULTS

The experiments discussed in this paper are focused on detecting the amount of water as an adulterant in full cream milk. The process is purely phenomenological in that it requires no assumptions or model of the disperse system under investigation. This includes calculation of the acoustic property (attenuation) and describes the relationship between the raw data (output intensity) and the desired acoustic property.

The measurements are obtained from the instrumentation in the form of peak-to-peak voltage of received signal at the output of the proposed system at room temperature. The milk samples were prepared by adding the double distilled water with the full cream milk in various proportions, from Fig 3 it is evident that peak-to-peak output voltage increases with increase in adulteration

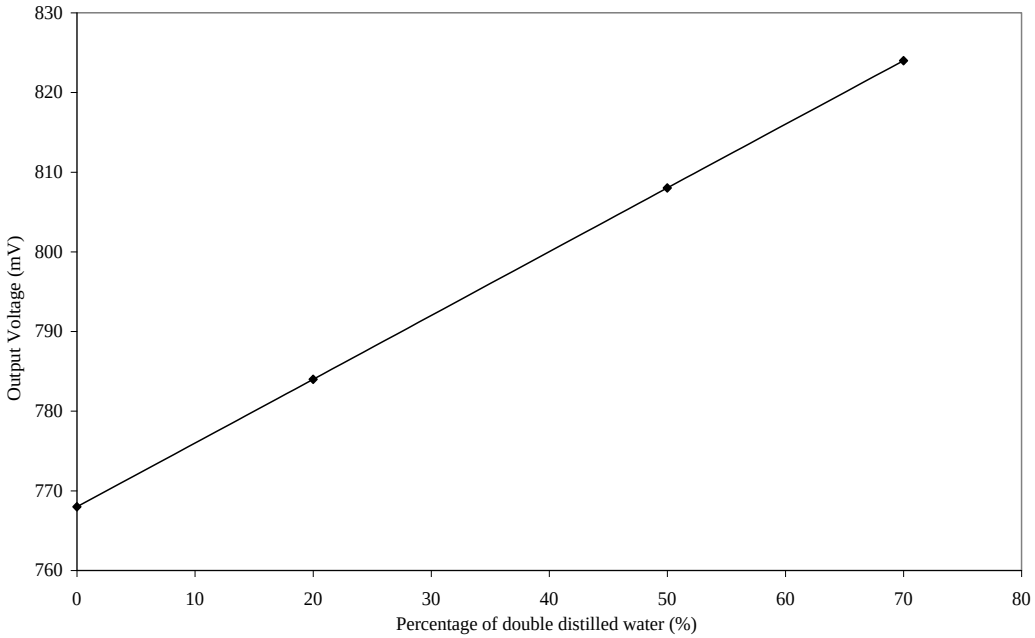

Fig. 3. Output Voltage (mV) with percentage concentration of double distilled water

5. CONCLUSION

We have observed statistically significant difference between various adulterated samples of milk on ultrasonic inspection at 502.5 KHz and room temperature. The proposed method shows the possibility of developing reusable equipment by which it will be quick and easy to detect the water in milk. This method can be extended to determine the properties of food products (density, moisture content, viscosity etc.) and to control quality of both fresh and processed foodstuffs in the packages.

6. REFERENCES

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