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Design and Development of a Portable Instrument for Quantification of Urea in Milk, Alcohol in Vinegar

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Abstract: Milk is the commonly consumed health drink of all ages. To meet the increasing demands of milk, the quality of milk produced has to be increased. This can be achieved by adding unwanted substances called adulterants in milk. Generally, urea is added to increase the quantity of milk and to reduce the quality of milk. The majority of people do not know how to judge about good acetic acid, they are perfectly satisfied if it is sour in taste and has the yellow color or the excellent old cider vinegar that is made by our farmers. It is easy to make cheap vinegar, and no doubt hundreds of people daily use a mixture of vitriol, water, in the firm belief that it is real vinegar because they have purchased a liquid of that name. Therefore, the purpose of this paper is to discuss on the determination of the permissible level of alcohol in vinegar, urea in milk by using portable low cost instrument.

Keywords: Adulterants, Ammonia Sensor, Urea, Alcohol Sensor.

I. INTRODUCTION

Adulteration is one of the most derogatory activities carried out in food products and its derivatives. Adulterant will not normally be present in a specification of the substance, and may not be allowed legally. The addition of adulterants is called adulteration. The food is said to be adulterated if it meets any one of the criteria

(1) If it contains any "poisonous substances "which is injurious to health (2)it has been prepared, packed, or held under unsanitary conditions (insect, rodent or bird infestation)where by it may have become contaminated.

Likewise, milk which is considered to be one of the most nutritious health drinks is adulterated with various substances which are either done to increase its economic value or the amount of production. Among the various adulterants, urea finds a major share and is also found to be harmful to human health as urea, being a pseudo protein rich in ammonia content. Urea being a soluble agent is the commonly found adulterant in milk and other dairy products. The normal concentration of urea in milk is 700 mg/L. the presence of urea in milk deteriorates human health. Hence it is essential that the milk should be tested for purity before consumption. Urea poses a serious threat to human health such as chills or shivering, fever, headache, nausea.

Vinegar is an alcoholic liquid that has been allowed to sour. It is primarily used to flavor and preserve foods and as an ingredient in salads dressings and marinades. It is made from a variety of diluted alcohol products, the most common being wine, beer, and rice. It is a living ingredient created through the process of fermentation. The term "vinegar" actually refers to the two – step process of fermentation from a carbohydrate to an alcohol to an acetic acid. The presence of alcohol in vinegar causes many effects on human health. The acidic nature of vinegar may erode teeth enamel. It also has blood thinning properties. Yeast and vinegar are used together in two completely different applications. One application is the use of vinegar to enhance the rising

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effect of yeast used in bread and pastry baking. The second application is the use of vinegar as a dietary supplement to help control yeast infections in the body.

II. METHODOLOGY

A. Chemical Reaction for urea in milk

The reaction of urea with milk in the presence of an enzyme called urease forms ammonium and bicarbonate ions and is as shown in the equation

$$CH_2N_2O + C_2H_4O_2 \quad CH_3CONH_2 + NH_3 + CO_2$$

Urea + Acetic acid Carbamic + Ammonia + Carbon

Acid gas dioxide

B. Urease

Urease belongs to the superfamily of phospotriesterases and amidohydrolases. In the hydrolysis of urea into carbon dioxide and ammonia, it is used as a catalyst as given in the equation.

$$(NH_2)_2CO + H_2O \quad CO_2 + 2NH_3$$

Urease trend to increase the pH of its environment as it produces ammonia, a basic molecule. Urease is found in numerous bacteria, fungi, plants, algae and some invertebrates, as well as in soils, as a soil enzyme.

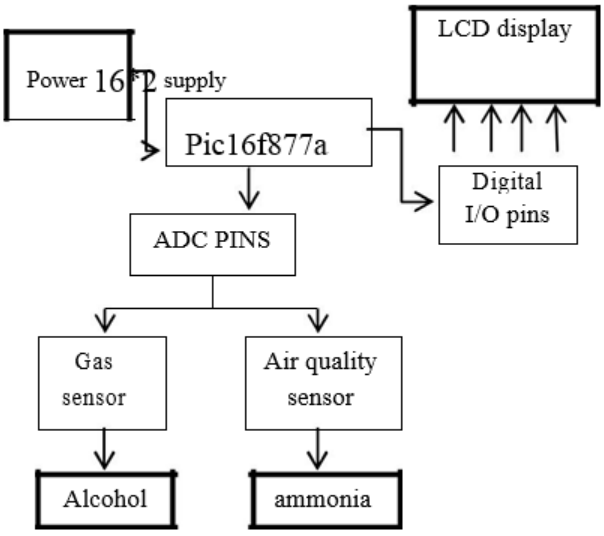
C. Chemical reaction for alcohol in vinegar

The reaction of yeast with vinegar under room temperature and low pressure liberates ethanol and carbon dioxide gas.

$$2CH_3COOH + YEAST \longrightarrow C_2H_3OH + CO_2$$

III. BLOCK DIAGRAM

THE BLOCK DIAGRAM OF PROPOSED SYSTEM IS AS SHOWN IN FIGURE 3.1 BELOW



The gas sensor (MQ135) senses the presence of ammonia gas in milk. (Formed by addition of urease and acetic acid) and gives an appropriate voltage signal. The output of the sensor is a sufficiently strong signal and hence it is directly fed to the microcontroller without any signal conditions. Finally, the amount of urea is displayed on the 16*2 LCD.

Likewise, similar procedure is followed for detection of alcohol in vinegar using air quality sensor (MQ3)

A. Calibration Procedure

STEP-1: Add 5 drops of Acetic Acid to 3 liters of water; this is to standardize the amount of acetic acid that is being used during this procedure. 400ml of this solution is taken in a conical flask as shown in figure

STEP-2: Switch on the sensor, wait for a while until a constant output is obtained on the LCD.

STEP-3: Add urease to milk and allow it to hydrolyse urea.

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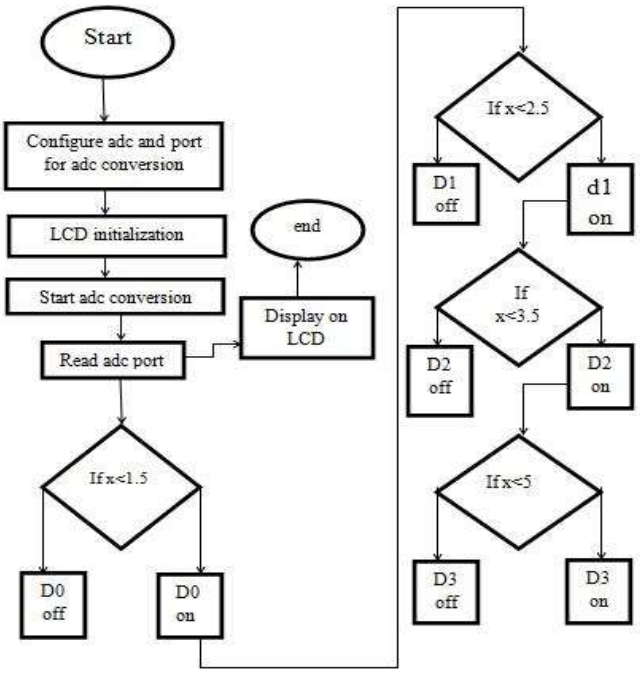
STEP-4: Add urea and observe the voltage obtained.
STEP-5: Repeat the procedure followed above for the different concentration of urea.
STEP-6: Tabulate the readings. Derive a relationship between the amount of urea added and voltage in volts obtained.

B. Algorithm

STEP 1: Start program
STEP 2: Initialize LCD
STEP 3: ADC start the conversion, conversion integer to Boolean, ADC done.
STEP 4: Read ADC ports.
STEP 5: Display appropriate output

IV. FLOW CHART

Initially, the ADC and its parts are configured. LCD initialization is done and this function enables the start conversion function of ADC that has been defined. The analog input to the PIC microcontroller is converted and processed digitally. After reading the sample 18 times and taking the mean, the done bit of ADC is set to indicate the end of conversion. The value is accordingly displayed in the LCD as ammonia and alcohol concentration.



V. RESULTS

A. Calibration of Urea in Milk

Urea is added in steps of 0.5g in 100ml of milk. The output voltage obtained is noted down each time. The microcontroller takes in these values as input, processes it by using a 10-bit ADC to give an equivalent amount of urea present in milk on milligram scale. A linear graph is obtained as seen in table 5.1

Weight of urea added(g)	Output voltage (mV)
0.5	250
1	314
1.5	345
2	410

The results are shown in table 5.1, a linear relation between the sensor output and amount of urea added. The linear equation is y=mx+c. where m=63.8 and c=249.9

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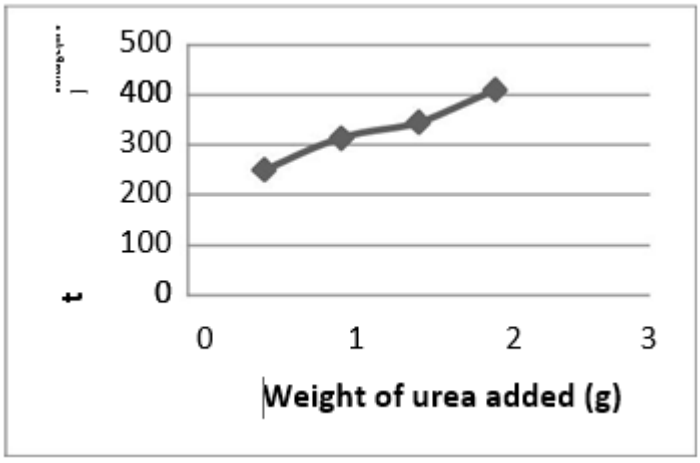

Fig 5.1: Urea added (g) vs. Voltage obtained (mV)

B. Calibration of Alcohol in Vinegar

Yeast is added in steps of 0.5g in vinegar. The output voltage obtained is noted down each time. The microcontroller takes in these values as input, processes it by using a 10-bit ADC to give an equivalent amount of alcohol present in vinegar on milligram scale. A linear graph is obtained as seen in fig 5.2.

Weight of yeast added (g)	Output voltage (mV)
1	539
2	669
3	775
4	879

The results are shown in table 5.2, a linear relation between the sensor output and amount of yeast added. The linearity equation is obtained where m=112.6 and c=434.

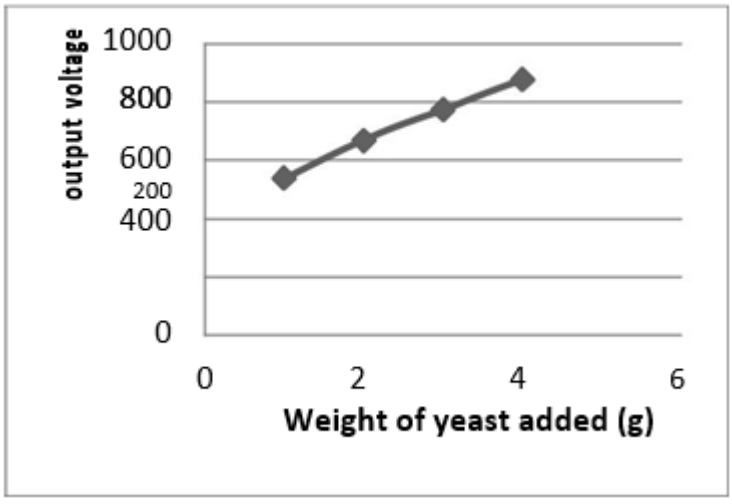

Fig 5.2: Yeast added (g) vs. Voltage obtained (mV)

CONCLUSION

Detection of urea content in milk based on the amount of ammonia gas released during acid test and absorbed by the MQ135 sensor which indicates the amount of urea present in milk and detection of alcohol content in vinegar is based on the amount of alcohol gas released and is absorbed by the MQ3 sensor which indicates the amount of alcohol present in vinegar by semi-automatic system have been developed. The system is effective and it does not require any complicated chemical analysis or lab tests.

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