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Detection of Microbial Activity in Raw Milk

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Abstract: ***Milk is a nutrient - rich white liquid food produced by mammals and is mostly consumed by human beings in their day to day life. Milk contains various nutrients such as proteins, calcium, Vitamin D, Vitamin K, Vitamin E, Vitamin A, lactose and minerals which are essential for the well being of the human beings. It is sometimes found that there is a presence of infective bacteria in raw milk. These bacteria may cause various diseases in human beings when consumed. This leads to poor health of the people causing economic burden to them along with disruption of their daily activities. Hence, it is essential to identify the presence of disease causing bacteria to analyze the quality of milk in real time , thereby preventing people from buying the infected milk. This work concentrates on identification of concentration of various gases that is produced in the infected raw milk by the disease causing bacteria . This spoilt milk also emanates bad odour and causes change in taste of milk. The proposed system uses PIC microcontroller and gas sensors to detect the concentration of various gases that are produced by various disease causing bacteria in raw milk and sends the data from the sensors to the user via Bluetooth for analysis. This system is very much helpful in real time due to the detection of disease causing microbes that may be present in raw milk which can be identified by the presence of ethanol, acetic acid, propane, methane and acetaldehyde gases, thereby preventing the use of spoilt milk by the people in milk diaries or at home.***

Index terms : Raw milk, bacteria,TGS gas sensors, PIC 16F877A

I. INTRODUCTION

India is one of the largest producer and consumer of milk. People in India consume milk frequently. Raw milk analysis is very necessary because raw milk has many pathogenic organisms that will result in numerous diseases and degrade the quality of milk consumed mostly by children and elderly people. Milking of the cow has to be done in hygienic conditions so as to prevent the infective micro organisms entering into the raw milk. Milk is a valuable source of nutrients such as proteins, vitamins A, vitamin D,vitamin K and minerals[15].

Just like all people, animals do carry microbes. Thes cattle generally spend much of their time grazing in pastures, where they come in contact with a variety of infectious microbes. These pathogens can cause infectious diseases in humans. The other reasons that may cause the microbes to enter may be due to the following situations[4-6]. Dairy processing done under unhygienic conditions cause the entry of infectious microbes. Also, milk provides a very apt climate that suits the growth of microbes.Apart from this, employees continuously working in dairy processing companies may carry harmful microbes that may get into raw milk [11].

II. DESCRIPTION OF BACTERIA

This project is aimed to detect three harmful bacteria namely E.coli, Listeria and Salmonella[7-10,12,18]. *Salmonella* contaminates the raw milk and milk products.There has been many instance of the outbreaks of this bacteria in recent years. Some of the symptoms found in infected people are diarrhoea and high fever.

Listeria monocytogenes , a bacterial pathogen is mostly found in soft cheeses and unpasteurized milk. It survives evens below freezing temperatures and hence it can survive in refrigerators. It is found to affect people having weakened immune systems, namely , pregnant women, peoples suffering from AIDS, young children and the old people . Listeria sometimes even causes miscarriage, and those also pregnant women have an increased chance of acquiring this disease 13 times more.[13].

E. coli O157: a H7 strain of *E. coli* has been a cause of various food-borne disease outbreaks. The infected people suffer from bloody diarrhea. Association with cattle, microbial infection of raw milk and soft cheeses can cause the origin of this disease. This bacteria may lead to a low platelet count in blood leading to bleeding and kidney failure in humans[14].So it is necessary to test the milk before consumption [1-3].

III. METHODOLOGY

The proposed system presents a real time This monitoring system, a tool which allows recognizing These microbes release various concentration of different gases in the raw milk. With the help of PIC microcontroller and other sensors, the microbial content in raw milk is determined and it is sent to the clients or users.

The proposed methodology consists of the following steps to detect the various bacteria consists of various TGS gas sensors.

Step 1 : The milk has to be kept approximately 3 cms away from the gas sensors that detect the gas concentration which are produced by the infectious bacteria.

Step 2 :The TGS gas sensor collects the gas produced in the raw milk by the bacteria.

Step 3 : The data from the TGS gas sensors are sent to the PIC microcontroller for further processing to estimate the concentration of gases based on the generated voltages.

Step 4: These processed data is stored and later sent to the mobile via Bluetooth.

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TGS 822 is used to detect the E.COLI bacteria in the milk by the liberation of methane[15].TGS 813 is used to detect the LISTERIA bacteria in the milk by the liberation of propane and butane.TGS 2620 is used to detect the SALMONELLA bacteria in raw milk by the liberation of ethanol.

5.3 TGS 2620

5.3 TGS 2620

TGS 2620 sensor is made from oxide of alumina . It has higher sensitivity towards alcohol and vapours of organic solvents. It needs two input parameters,namely heater voltage and circuit temperature to function efficiently.[17]

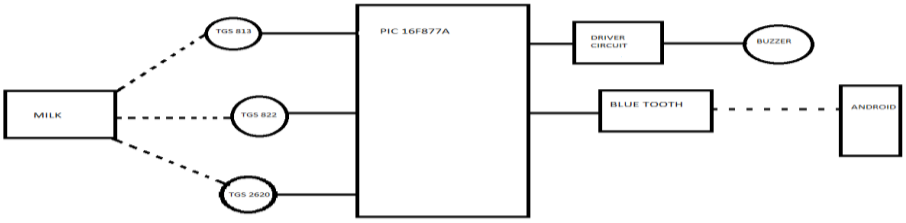

Fig1: Block diagram of the proposed system

IV. BLOCK DIAGRAM OF PROPOSED METHOD

The block diagram of the microbial activity detection in raw milk is shown in the figure 1. The various gas sensors acquires the concentration of gases and and the data are processed in PIC and sent to display , both in LCD screen and mobile phone.

V. SENSOR DESCRIPTION

5.1TGS 813

The TGS 813 sensor with ceramic base has high sensitivity to methane, propane, and butane, making it suitable to detect natural gas and LPG. It is useful in many applications as it can detect a variety of gases.It is cheap and is resistant to extreme temperatures. [16]

5.2TGS 822

TGS 822 sensor is made from tin oxide that has the property of very low conductivity .It is highly sensitive to organic solvent vapours and has high stability and reliability for greater duration. The changes in output across load resistor connected to gas sensor in inversely proportional to the resistance of the sensor based on the gas concentration.

VI. DESCRIPTION AND WORKING

230V step down AC transformer is used to step down voltage to 12V AC. Bridge rectifier is used to convert AC voltage to DC voltage. 7805 Regulator is used in which 78 indicates positive and 05 indicates 5V output. Three sensors namely TGS 813, TGS 822, TGS 2620, is used and it is connected to common positive and common ground. These three sensors are placed above the milk and the gases presented in the milk are detected by these sensors. Finally the output is displayed in LCD. At the same time abnormal milk is indicated by Buzzer and the blue tooth module is used to display result in mobile.

6.1 APPLICATIONS

This proposed system of detection of infectious bacteria in raw milk is particularly helpful to test the quality of milk during acquisition and distribution of milk in milk dairies. If needed, the same set up can be used in homes to check the milk quality procured from milk providers

VII. RESULTS AND DISCUSSION

7.1 SIMULATION OUTPUT

Initially the proposed system is simulated using

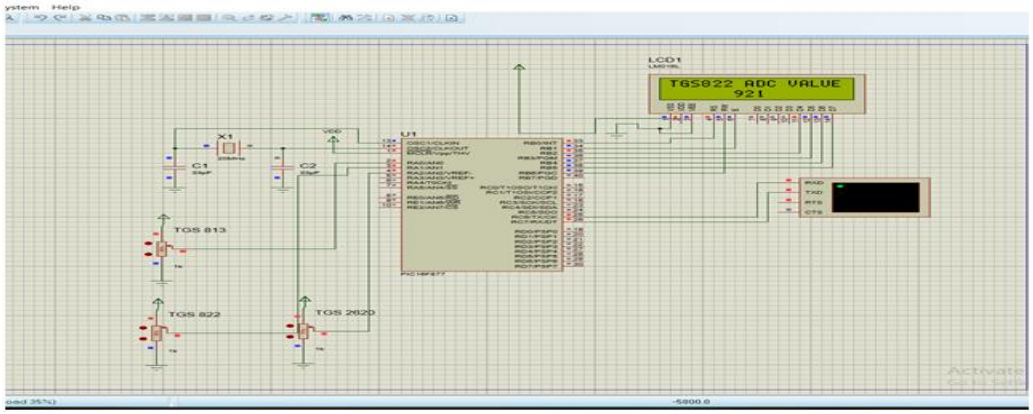

Fig 2: Simulation output

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PROTEOUS Design Suit and the output is shown in figure 2.

7.2 PROJECT SET UP

The entire set up is shown in figure 3.

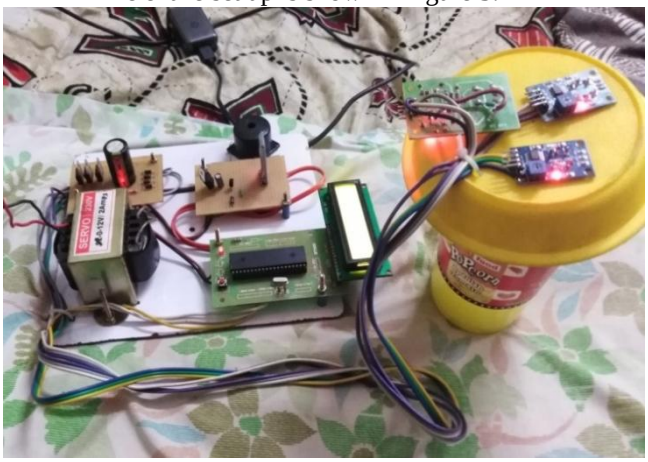

Fig 3: Project set up

7.3 HARDWARE OUTPUT

7.3.1 OUTPUT OF NORMAL MILK

When the bacteria levels are normal in the milk then the output is displayed as follows:

TGS 812 VALUE NORMAL
TGS 822 VALUE NORMAL
TGS 2620 VALUE NORMAL as shown in figure 4 as per reference paper [10].

Fig 4: Output of normal milk

7.3.2 OUTPUT OF SPOILED MILK

When the bacteria levels are beyond normal level then the output is displayed as RAW MILK ABNORMAL as shown in figure 7.4

Fig 7.4 Output of spoiled milk

The bacteria present in the milk is detected and displayed as **SALMONELLA PRESENT**

E. COLI PRESENT

LISTERIA PRESENT as shown in figure 5 as per reference paper [10].

Fig 5: bacteria present in milk

7.3.3 TESTED VALUES OF NORMAL MILK

The bacterial range of normal milk is analyzed and tabulated as shown in table1. From this the normal range is fixed and embedded into the system in order to find the abnormal milk.

Table 1. Tested values of normal milk
Normal Range (Good Milk)

TGS 822(mV)	TGS 813 (mV)	TGS 2620(mV)
63	1008	218
76	1006	208
79	1001	203
54	1007	214
48	1002	200

7.3.4 TESTED VALUES OF ABNORMAL MILK

The values abnormal milk is analyzed and tabulated as shown in table 2

Table 2 Tested values of abnormal milk
Abnormal range (Spoiled Milk)

TGS 822 (mV)	TGS 813 (mV)	TGS 2620 (mV)
126	1015	232
99	1013	228
119	1022	220
96	1019	231
107	1014	230

7.3.5 BACTERIA DETECTED

The bacteria detected from the gas sensors are analyzed and tabulated as shown in table 3.

Table 3 Bacteria detected

SENSOR	GAS LIBERATED	BACTERIA DETECTED
TGS 822	Methane	E. coli
TGS 813	Propane	Listeria
TGS 2620	Ethanol	Salmonella

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VIII. CONCLUSION

The proposed system can be used to detect various bacteria and their level of concentration in raw milk. This system is very much cost effective as it consists of very less components. The system has a very simple construction and it is compact and portable. It is new innovation as it uses different gases liberated from different bacteria to detect the bacterial presence and contamination level and indicates the user about the milk contamination level and thus the users would be able to determine whether the milk is spoiled or not.

Though the system is sensitive towards environmental conditions, it gives accurate results when the samples are kept in a tightly closed container.By using this system it is possible to provide pure milk to the users and thus various diseases like diabetes, diarrhea, nausea and various other diseases which arises by consumption of contaminated milk can be prevented. The system can not only be used in milk industries but also in houses to detect contaminated milk

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Dr.Balambigai Subramanian received her B.E. degree in Electronics and Communication from Bharathiar University, M.E. degree in Applied Electronics and Ph.D from Anna University, Chennai with distinction. She has published 35 papers in various International and National conferences. She is working as an Associate Professor in the Department of Electronics and Communication Engineering in Kongu Engineering College, Perundurai, Erode. Her areas of interest include bio signal processing and computer networks.