A PROFICIENT SYSTEM TO DETECT AND MONITOR THE FRESHNESS AND QUALITY OF FOOD

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Abstract: Food plays a very important role in our day-to-day life. With an increase in globalization quality of food decreases day by day. In most of the time various food processing is done to keep the food fresh. Various preservatives or the ingredients are added in the food so that it looks like fresh or tempting. Now most of the food is preserved with the chemicals which causes the food contamination. This contamination leads to various diseases which results that the consumer want healthy food. The people want organic food for healthy lifestyle. So, to avoid the problems associated with the food without human interpretation we need such a device which helps to determine the quality of food. There is a requirement of such a device which guide us about the hygienic food. Hence to fulfill this consumer demand we made a device that checks whether the quality of food is good or bad. This paper represents the use of various sensors in the field of the food industry. The sensors like pH sensor, gas sensor, temperature sensor help in identifying the condition of food. This system makes an effective presence in restaurants, households, small scale industries. Due to presence of harmful chemicals and microorganisms in food, food contamination will be caused which causes illness to the people. The proposed scheme addresses the chemical contamination of foods, as opposed to microbiological contamination, which can be found under food borne illness. Food poisoning occurs by harmful bacteria on food. Food poisoning can be caused by eating contaminated food with bacteria viruses, chemicals or poisonous metals such as lead or cadmium etc. and including chicken, meat, sea food, eggs, cooked rice, ham, salami, milk and all dairy foods. Bacteria and viruses are the most common cause of food poisoning. Symptoms of food poisoning include Nausea, vomiting, stomach pain feeling weak, fever etc. In order to monitor the food poisoning, the new implementation has been made by using IoT. The monitoring system is based on many embedded sensors like thermostat, odour sensor, biosensor, pH sensor which depend on the out coming electric signals or digital value of the quality factors. In proposed system the biosensor plays a vital role to detect the bacterial contamination in food sample. Based on the combination of the sensor output, quality of the food should be detected which is reported to the health center through IOT.

Index Terms **–**Food freshness, Food quality, LCD, Arduino, Moisture sensor, IoT, pH sensor, Temperature sensor, Gas sensor, HACCP, FDA.

I. INTRODUCTION

Food is the basic need for any kind of living being to maintain the energy for their survival. Healthy food provides nutrients and energy that keep the body active and healthy. In agriculture field for increasing the yield most of farmers are used pesticides and these pesticides contribute a major role in the contamination of food these pesticides eating unhealthy food is like an invitation to diseases. Unhealthy food causes illness, obesity insufficiency of nutrients. Nowadays the youth is interested in healthy lifestyle, they are very much concerned about their fitness. So, to maintain the fitness the quality of food plays an important role. Food poisoning is also a major problem in today's lifestyle.it becomes the source of innumerable diseases. The comprehensive research is done on checking the quality of food. The scientists are very much focused on what types of bacteria present in the food; they are trying to meet the expectations of people. Scientists and technology contribute largely to thinking about food quality. From today's scenario, it is seen that we required such a device which detects the quality of food. Our system checks the quality of food by using the PH sensor, temperature sensor, and the odour sensor. The mq3 sensor and MQ135 is the odour sensor which detects the number of harmful gases present in the food these devices monitoring the quality of the food which keep watch on factors like temperature, humidity, harmful gases. This paper is purposive to develop a prototype to collect intake sensor data. The required output of the system is displayed on the screen.

Food Freshness is a key factor for public safety. Management and monitoring of food quality are important food stage and transition. Food safety issue is a vital concern as shown in the Hazard and Critical Control Point (HACCP) by the U.S. Food and Drug Administration (FDA). There are up to 81 million of Americans each year suffering from food-borne illness and 9100 cases of fatality. The waste of food due to spoilage is also a major concern for not only business owners but also many countries. The latest commercial iPhone application, meals snap, can assist users to record and recognize food images. Automatic food intake assessment that avoids the inaccuracy in manual recording and food estimation deserves more research effort for obesity management.

Food poisoning comes from harmful bacteria on food. Food poisoning can be caused by eating contaminated food (with bacteria and viruses) chemicals or poisonous metals such as lead or cadmium, etc and including chicken, meat, sea food, eggs, cooked rice, ham, salami, milk and all dairy foods. Bacteria and viruses are the most common cause of food poisoning. Food poisonings also called food borne illness is illness caused by eating contaminated food. Infection organisms including bacteria viruses and parasites, or their toxins are the most common causes of food poisoning. The symptoms of food poisoning are Nausea, Vomiting, Stomach pains, Diarrhea, Feeling weak, Fever or chills/sweating, Headache.

Ensuring the freshness and quality of food is critical for maintaining public health and consumer satisfaction. With the increasing complexity of food supply chains, it has become essential to develop advanced systems that can efficiently detect and monitor these attributes. An efficient system to detect and monitor the freshness and quality of food can help reduce food waste, prevent foodborne illnesses, and assure consumers of the safety and nutritional value of their food.

This paper introduces a novel system designed to address these challenges by leveraging cutting-edge technologies and methodologies. The system integrates various sensors, data analytics, and machine learning algorithms to provide real-time insights into the condition of food products from production to consumption. By implementing such a system, stakeholders across the food supply chain can benefit from improved transparency, better inventory management, and enhanced quality control measures.

The proposed system's key features include the ability to accurately detect spoilage indicators, monitor environmental conditions, and predict shelf life with high precision. This comprehensive approach ensures that food products remain within safe and optimal quality standards throughout their lifecycle. The following sections will delve into the system's architecture, the technologies employed, and the benefits it offers to various stakeholders in the food industry.

II. REVIEW OF LITERATURE

The manual method includes checking fruits and food items by human force i-e by color checking and by smelling but food checking is expensive, time consuming, and less efficient due to human errors and environmental effects.

The image processing method is use of computer algorithms to perform image processing. In order to check fruit quality, Omit et al. used color, shape, and texture to sort tomato fruits according to their color (redness), size, shape, circularity, maturity and defects [1]. They achieved 84.4% accuracy by checking different samples of tomato fruit. But this method only gives information about outer surface and structure of fruit but outer appearance of fruit is not enough to measure freshness of fruit as different fruits starts ripening from inside. An electronic nose term used for sensing food freshness by checking fruits optical and gaseous properties. Number of different sensors have been developed for multi-sensor arrays [2]. These types of sensors demonstrate physical and chemical interactions with the chemical compounds when they flow over or are in contact with the sensors. The biosensors, odor sensors, moisture sensors, and constitutes the piezoelectric crystal sensors.

Yating chai et al. [3] this system uses coil detector magneto elastic bio sensor for the bacteria detection on food surface. Biosensor used in the technology very less expensive. This technology is implemented time that is salmonella bacteria was detected in fresh watermelon using this method. Issues to be addressed are this process is time consuming and costly samples have to be prepared before the experiments.

Reiner jedermaan et al. [4] this paper used TMT-8500 class 3 RFID temperature monitoring tag to sense& maintains the cold temperature of food. It enables the wide application of sensor network in logistics. The obstacle in the field test is high signal attenuation at 2.5 GHZ and extending the battery time is still challenging.

Ahsen rayman et al. [5] indicators and sensors are used to give the alert for fruit safety rather than the expensive and time-consuming measurement. Through this technique temperature, freshness, microbial spoilage can be monitored and controlled. However, the practical concepts of using intelligent packing indicator for freshness detection are very limited.

Livia et al. [6] bio sensors are used in this technique for fruit analysis. Malpractice by manufactures, analysis and other effects to fruit system can be managed. These biosensors can be tested only on distilled water or buffer solutions.

III. PROPOSED METHODOLOGY

The system involves a series of sensors attached to a sensor reader that monitors various aspects of food quality. These sensors transmit data to an Arduino processor, where the information is processed. A key component of this system is the thermostat, an instrument that operates at full capacity until the target temperature is achieved. Once this specific temperature is reached, the thermostat turns off and displays the accurate temperature of the food item. Monitoring the temperature of food is crucial because it is a significant factor in determining its freshness. Different food varieties may require different temperature settings to maintain their quality. Odor is another critical factor in food quality management. The nature of an odor, whether pleasant or unpleasant, can provide valuable information about the quality of the food. The odor sensor in the system detects chemical smells, such as alcohol and amines, which are commonly found in beverages. The pH sensor, considered a passive device, is used to detect hydrogen ion activity in a solution, thereby measuring its acidity or alkalinity. This measurement is essential for assessing the freshness and safety of various food items. Additionally, the system incorporates a biosensor to detect bacterial contamination in food samples. This sensor receives signals reflected from bacteria and fungi present in food items, such as beverages. The biosensor is specifically designed for food quality control, allowing for the detection of invisible microorganisms. It uses different types of transducers to produce an electric current proportional to the presence of analytes, which are chemical compounds indicating the presence of microorganisms. To enhance food safety monitoring, the system employs Internet of Things (IoT) technology. This implementation involves multiple embedded sensors, including the thermostat, odor sensor, biosensor, and pH sensor. These sensors depend on the electric signals or digital values they produce, which correspond to various quality factors. In this system, the biosensor plays a vital role in detecting bacterial contamination in food samples. By combining the outputs from these sensors, the overall quality of the food can be determined. This information is then reported to health centers through IoT, ensuring timely and accurate monitoring of food quality to prevent food poisoning.

- Sensors monitor the food quality. Oxygen & ammonia sensors measure the oxygen and ammonia content for particular food item.
- The food is detected to check whether the food item is spoilt or not.
- The microcontroller sounds a buzzer when it encounters a spoiled food item.
- This data is sent to a cloud platform.
- Number of spoilt food occurrences can be monitored.

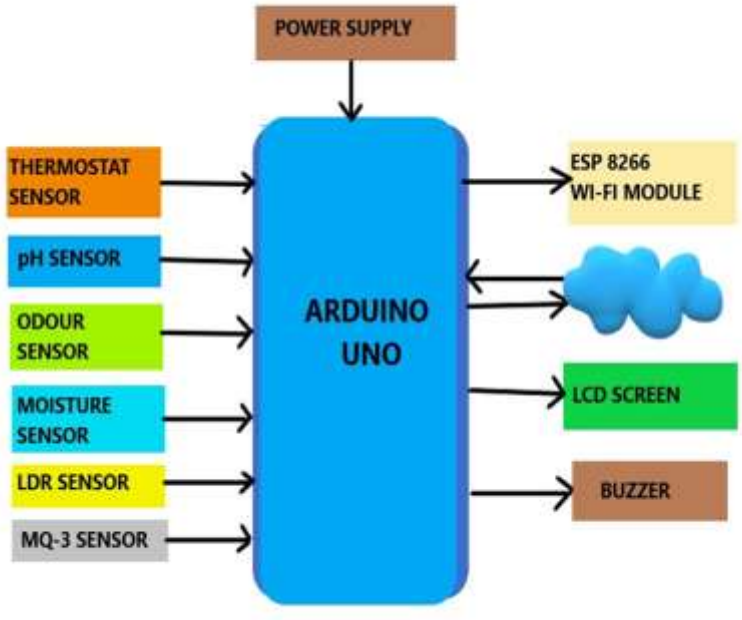

Fig 1.1: Block diagram of the system

IV. RESULT & DISCUSION

A. pH Trend of Milk

pH, a measure of the acidity or alkalinity of a solution, plays a crucial role in food processing. It affects various aspects of food quality, safety, preservation, and sensory characteristics. Understanding and controlling pH is essential for food manufacturers to ensure product consistency, extend shelf life, and comply with regulatory standards.

Importance of pH in Food Processing

Microbial Control: pH levels influence the growth of microorganisms in food. Most bacteria thrive in neutral pH environments (pH 6.5-7.5), while acidic conditions (pH < 4.5) inhibit their growth. By adjusting the pH, food processors can enhance food safety and prevent spoilage.

Preservation: Acidic conditions help preserve foods by inhibiting microbial activity. Fermented foods, pickles, and certain beverages have low pH levels, which prolong their shelf life and maintain their safety.

Texture and Consistency: pH affects the texture of food products. For example, in dairy processing, the pH level influences the coagulation of milk proteins, which is critical for cheese and yogurt production. Proper pH control ensures the desired texture and consistency.

Flavor and Color: The pH level can impact the flavor and color of food. Acidic conditions can enhance tartness and preserve natural colors, while alkaline conditions might lead to undesirable color changes and off-flavors.

Chemical Reactions: pH plays a vital role in various chemical reactions during food processing, such as enzymatic activity and Maillard browning. Controlling pH helps optimize these reactions to achieve the desired product attributes.

The lactose sugar in milk is converted into Lactic Acid by Lactic bacteria which lowers the pH level of milk, with the passage of time the Lactic acid level increases and a stage come when pH level decreases to such a level so that the Lactic acid provides help in growth of bad bacteria which causes spoilage of milk. The normal standardized pH of fresh milk is about 6.5-6.7 as shown in figure 1.2, it may increase or decrease with the type of impurity added to it but if a sample of fresh milk is kept at room temperature its pH gradually decreases with the passage of time, milk is getting sour.

The pH of milk is an important indicator of its freshness and quality. Milk typically has a slightly acidic pH, usually ranging from 6.5 to 6.7. However, this pH level can change over time due to various factors, such as microbial activity, storage conditions, and processing methods. Understanding the pH trend of milk is crucial for ensuring its safety and suitability for consumption.

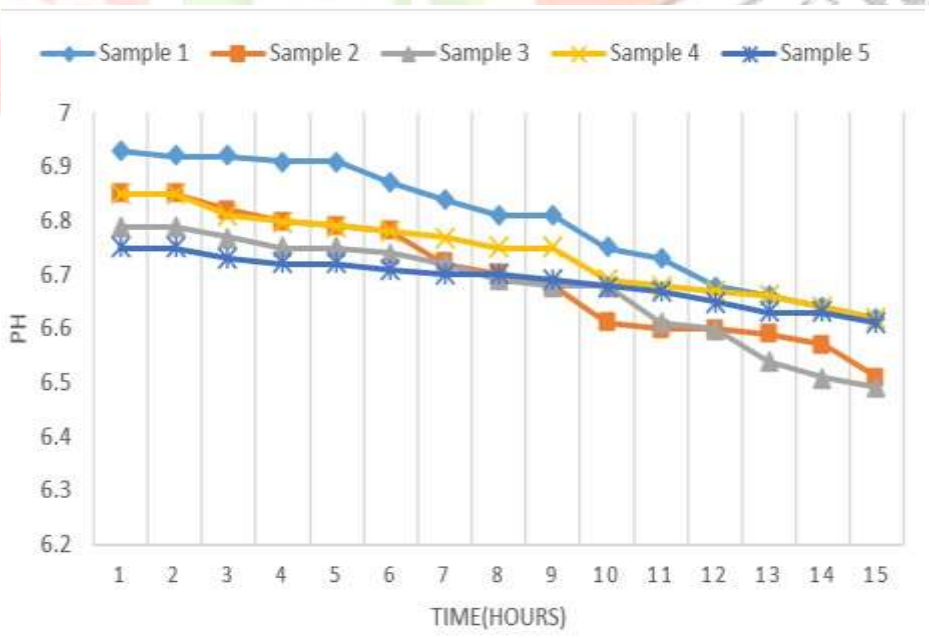

Fig 1.2: pH Trend of Milk Samples

B. pH Trend of Yogurt

The normal standardized pH of fresh yogurt is about 4.4, it may increase or decrease with the type and quantity of bacteria added to it at time of its production, if a sample of fresh yogurt is kept at room temperature its pH gradually decreases with the passage of time, yogurt is getting sour. Figure 1.3 shows the trend of 5 samples of yogurt and the pH level with the passage of time.

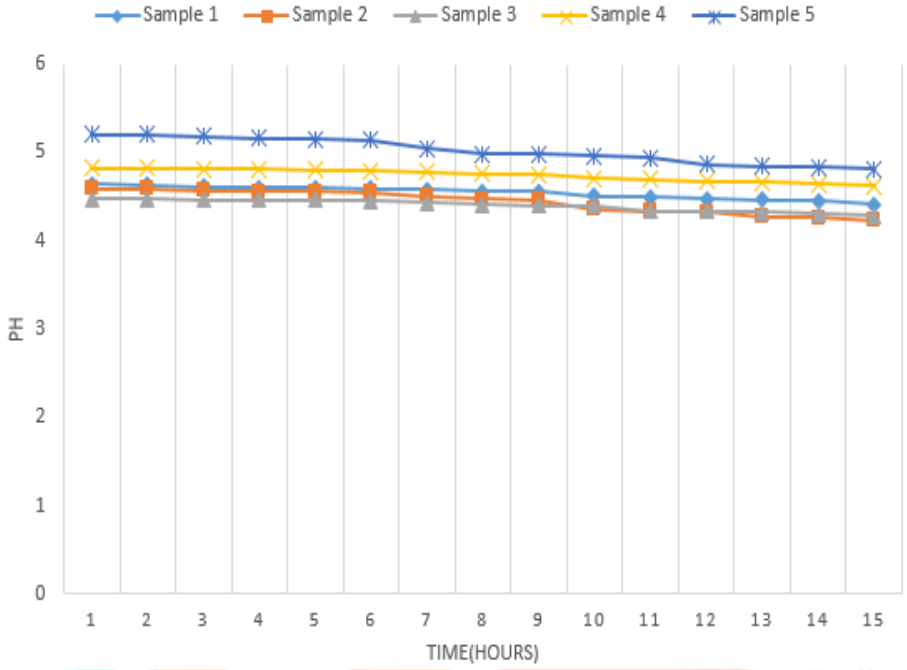

Fig 1.3: pH Trend of Yogurt Samples

C. Moisture Trend of Chicken

The moisture contents in meet items is one of the important property which ensures freshness, if a sample of fresh piece of chicken is kept at room temperature its moisture level gradually decreases with the passage of time, and chicken pieces will get dry and smelly with production of different organisms which causes chemical changes and results in spoilage of meat. Figure 1.4 shows the trend of 5 samples of chicken and the moisture level with the passage of time.

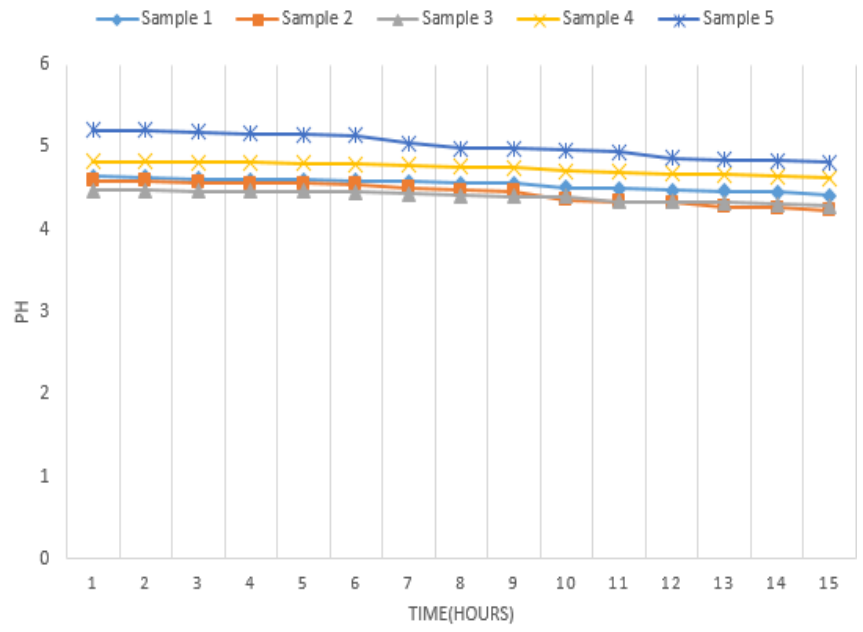

Fig 1.3: pH Trend of Yogurt Samples.

D. Moisture Trend of Chicken

The moisture contents in meet items is one of the important property which ensures freshness, if a sample of fresh piece of chicken is kept at room temperature its moisture level gradually decreases with the passage of time, and chicken pieces will get dry and smelly with production of different organisms which causes chemical changes and results in spoilage of meat. Figure 1.4 shows the trend of 5 samples of chicken and the moisture level with the passage of time.

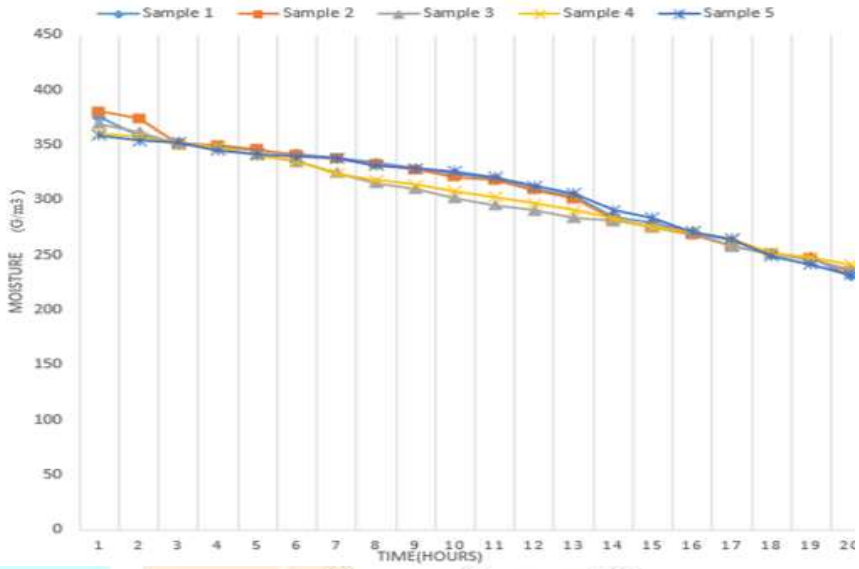

Fig 1.4: Moisture Contents in Chicken with Time

D. Moisture Trend of Beef

The moisture in meat is one of the main properties which ensures freshness, if a sample of fresh piece of beef is kept at room temperature its moisture level gradually decreases with the passage of time, and beef will get dry and dry as moistures contents decreases. Figure 1.5 shows the trend of 5 samples of Beef and the trend of moisture level with the passage of time. The moisture content in beef will determine whether the beef is in good condition or stale. Beef is preserved in refrigerator to maintain the moisture content. If the beef is placed at room temperature & as the time passes by the moisture content in beef will decrease which results in Stale beef.so thereby moisture content will determine if the beef is good or stale.

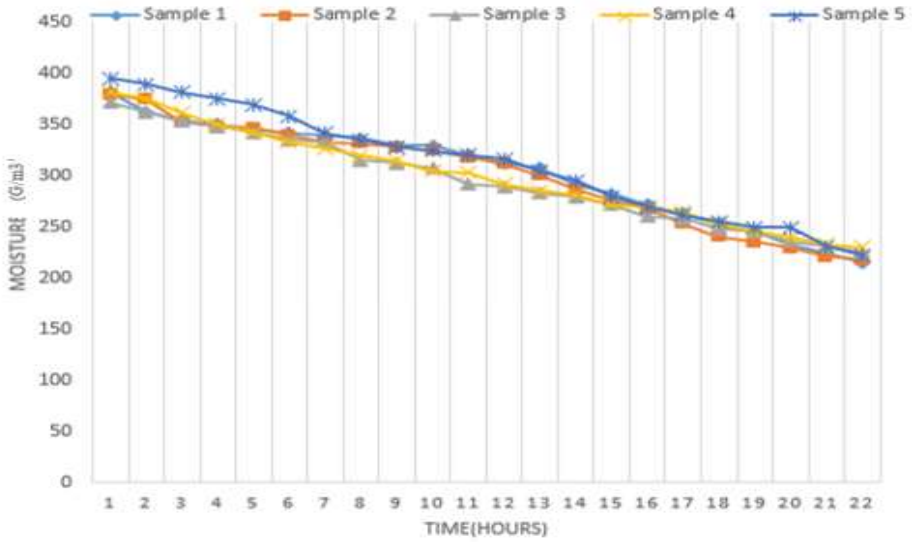

Fig 1.5: Moisture Contents in Beef Samples with Time

E. Ethanol Trend in Banana

Ethanol is a naturally occurring substance also called Alcohol. Ethanol plumes can be used for artificial ripening of fruit. Fruit ripening is associated with changes in color, taste, sugar, and ethanol content. When fruit like banana starts ripening its chemical properties change and produces ethanol in a small amount. This amount increases with time. The MQ3 gas sensor is used to detect the production and concentration of ethanol in banana. MQ3 alcohol sensor is used to detect the presence of ethanol, where the sensitive material used for this sensor is SnO2, whose conductivity is lower in clean air as shown in figure 1.6. Its conductivity increases as the concentration of ethanol gases increases. It has a high sensitivity to alcohol and has good resistance to

disturbances due to smoke, vapor, and gasoline. This module provides both digital and analog outputs. It has high sensitivity and fast response time. The sensor provides an analog resistive output based on alcohol concentration. MQ-3 is an analog as well as a digital sensor. The presence of ethanol vapors in food is a sign of decay. So, by the MQ3 sensor, it can be detected if food has started decaying.

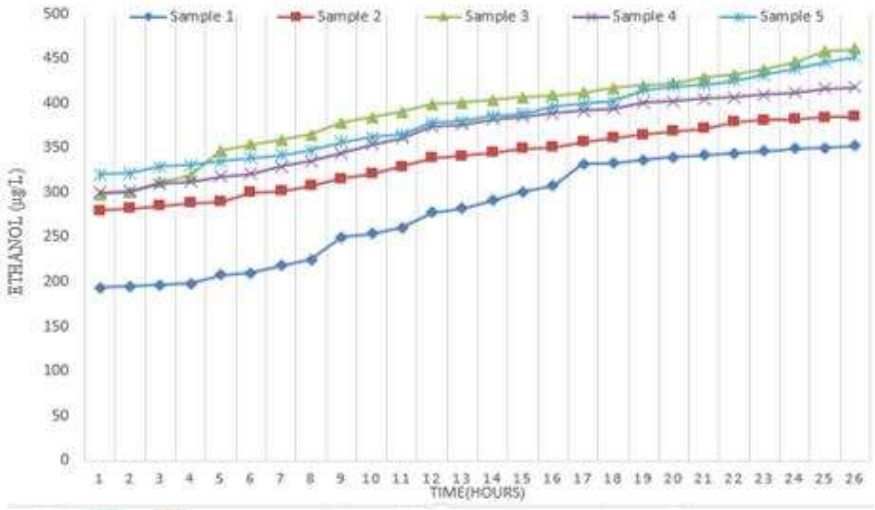

Fig 1.6: Ethanol Level of Banana Samples with Time.

V. CONCLUSION

The proposed system gives information about the contaminated contents present in the food. This system is developed for the people so that they can identify the quality of food. The sensors like the PH sensor, gas sensor, temperature sensor are interfaced with Arduino microcontroller and the obtained value is displayed on the LCD screen. This result helps to determine whether the quality of food is good or bad. This system can be used in various applications such as in restaurants, households and even in small scale industries. It gives a convenient way to find the amount of contamination in food. Without any human intervention, this system maintains and regulates the surveillance of the food system. The diseases due to the spoilage of food can be overcome up to great extent.

VI. FUTURE SCOPE

Centralized Server: An embedded system can be installed in it which can send data back to a centralized server where it can be used for different research purposes and user can see history of data.

Artificial Neural Network: For further improvement in results, they can add an Artificial Neural Network in the server which can read data and send the results to the terminal devices which can use this data for devising the better results in future about the food spoilage.

Product Label Reading from Hand-Held Objects for Blind Persons can be added, designing a system for blind persons to recognize the handheld objects or products.

In this system, they may design and develop a system to find products or objects with voice announcements.

The system can be upgraded by using an upcoming and updated sensor such as nutrients sensor.

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