MILK PURITY DETECTION SYSTEM

Bhushan Chaudhari*[1] , Nikita Deshmukh [2], Kumudini Bagul [3]
Divya Chaudhari[4], Rushikesh Yeole[5]

[1] *(Dept of Information Technology SVKM's IOT , Dhule India , chaudharibs@gmail.com*)*
[2345] *(Dept of Information Technology SVKM's IOT , Dhule India , nikitadeshmukh112002@gmail.com)*

Abstract
To ensure customer health and contentment, the quality and kind of milk are of the utmost significance. In this study, it describes a unique system for determining the type of milk and detecting its purity using sensor technologies and a mobile application called Blynk. With the help of our method, anyone may evaluate the milk they drink and verify its safety and authenticity. We outline the development of a low-cost sensor array that can analyze important milk characteristics like fat content, adulterants, ph. level, TDS level. In the dairy sector, it is crucial to guarantee the purity and quality of milk. We suggest a comprehensive solution that combines IoT sensors and the Blynk app to continuously monitor and categories milk quality. Data on numerous milk parameters, including fat content, TDS Level, ph. Value, and milk color, is collected by IoT sensors. All people can benefit from the system's affordable, automated, and effective solution. The results demonstrate the potential of IoT in revolutionizing dairy management practices with their encouraging accuracy rates.
The study focuses on the system's critical role in improving quality assurance, operational efficiency, and overall customer safety. Through a complete examination of the system's accuracy in detecting contaminants, the study reveals its efficacy in providing fast and reliable data, promoting proactive decision-making, and enabling preventive steps in the dairy business. The abstract acknowledges the inherent challenges and recommends future directions for improving the technology, scaling its implementation, and addressing regulatory concerns. This demonstrates the potential of the IoT-based milk purity monitoring technology to help shape a more resilient and trustworthy dairy sector. The findings highlight the system's promising contribution to sustaining milk product quality, encouraging consumer trust, and identifying areas for future research and development.
Keywords —: *IoT, Milk Purity Detection, Internet of Things, Blynk app, Food safety, Adulteration detection.*

I. Introduction

Milk plays a vital role in the diets of people all over the world because of its high nutritional value. It is becoming more difficult to verify the validity and quality of the milk that is sold in the market, though, as concerns about adulteration, contamination, and mislabeling gain traction. It is crucial to guarantee milk purity and accurately identify its sort in order to protect both the consumer's health and the dairy industry's reputation. A user-friendly Blynk smartphone app process and presents data gathered from the sensors, enabling customers to make educated decisions about the milk they buy. This study proves the viability and potential advantages of sensor-based milk quality evaluation, opening it up to a wide variety of users and enhancing customer satisfaction and food safety. Innovative technologies that make it simple and accurate for consumers to judge the quality and kind of milk are required to address these concerns. Traditional quality evaluation techniques frequently need specialized tools and knowledge, which makes them inaccessible to the general population. We suggest an advanced system that makes use of sensor technologies in conjunction with the Blynk mobile application to close this gap and provide customers with the power to make knowledgeable decisions. This technology offers an approach to milk type categorization and practical and user-friendly milk purity detection that is open to anyone.

This study focuses on creating a dependable sensor array that is affordable and capable of evaluating a variety of milk characteristics, including pollutants and fat content. The Blynk mobile app uses the gathered data to analyze and display it to users, giving them access to real-time details on the milk's origin and quality. In an era where food safety is a major concern, this technology has the potential to revolutionize how customers interact with their milk products by assuring transparency, safety, and authenticity. To make our sensor-based milk purity detection and categorization system available to everyone, this article outlines its design and implementation. With an emphasis on protecting food safety and boosting customer trust in the dairy business, we will examine the technical elements, usability, and advantages of this novel method to milk quality evaluation. We will also look at the technology's larger implications for improving accessibility and openness for everyone in the food supply and manufacturing chain. Historically, milk quality ratings have been difficult and impossible for average customers to get because they rely so much on laborious laboratory tests and expert opinions. Therefore, there is an urgent need for creative, economical, and user-friendly technologies that enable people to make wise choices regarding the milk they consume.

II. Literature Survey

The survey includes a thorough analysis of pertinent scholarly works, research articles, and industry reports. Through an examination of the many techniques and methods utilized in the creation of Internet of Things-enabled milk purity detection systems, this survey seeks to offer a comprehensive picture of the state of the industry at the moment.
The authors [1] have investigated the integration of Internet of Things (IOT) technologies for milk spectrum profiling within the context of Industry 4.0 applications in the dairy industry. The study's goal is to improve the efficiency, quality, and safety of milk production and processing by using IOT devices and advanced analytics to monitor and analyze the spectral properties of milk .The survey [2] describes the design and implementation of a real-time milk condition surveillance system with the goal of improving milk quality monitoring and control in the dairy industry. The system uses advanced sensor technologies, data analytics, and Internet of Things (IoT) connectivity to provide continuous, automated monitoring of multiple milk parameters .The research [3] describes a comprehensive Milk Quality Monitoring System (MQMS) based on Internet of Things (IoT) technology. The system is intended to continuously assess and ensure the quality of milk throughout the production and supply chain. By integrating advanced sensors and IoT devices, the MQMS provides real-time monitoring, data analytics, and decision support to dairy industry stakeholders The survey a Milk Products Monitoring System (MPMS) that uses an ARM processor to detect microbial activity in dairy products. The system combines advanced sensors with ARM-based processing capabilities to provide real-time monitoring, analysis, and alert mechanisms to ensure the safety and quality of milk products. The research describes [5] a Milk Adulteration Monitoring System (MAMS) that is intended to provide a comprehensive and reliable solution for detecting and preventing milk adulteration. The MAMS uses advanced sensing technologies and analytical methods to ensure the quality and safety of milk products in the dairy industry.
In [6]The design and implementation of an Internet of Things (IoT)-based Milk Analyzer using Arduino and Wi-Fi connectivity are described. The system is designed to provide real-time monitoring and analysis of milk quality parameters by combining advanced sensors and IoT technologies. The research describes the system architecture, sensor integration, data transmission via Wi-Fi, and experimental results that demonstrate the effectiveness of the IoT-based Milk Analyzer.[7] It provides an in-depth evaluation of an Internet of Things (IoT)-based model for detecting milk adulteration and assessing overall milk quality. The model relies on LabVIEW for data acquisition, processing, and analysis, as well as IoT technologies for real-time monitoring. The research presents [8] an innovative approach to milk quality monitoring using Edge-AI (Artificial Intelligence at the Edge). The system aims to provide real-time assessment and analysis of milk quality parameters by utilizing advanced sensors an innovative processing capabilities . Focuses on the detection of pathogenic bacteria in milk sample to ensure the safety and quality of dairy products. The study employs advanced microbiological and analytical techniques to monitor and identify pathogenic bacteria strains in milk. The research describes [10]a novel approach to on-chip detection and quantification of soap as an adulterant in milk using Electrical Impedance Spectroscopy (EIS). The study's goal is to create a rapid and sensitive on-chip system capable of detecting soap adulteration in milk samples and quantifying contamination levels. The review presents [11] a statistical study that focuses on the design and testing of a reliable system for detecting detergent and shampoo adulteration in milk. The study uses statistical methods to analyze data collected from a novel detection system, with the goal of identifying and quantifying the presence of adulterants. The research describes the research methodology, experimental setup, statistical analyses, and validation results, providing insight into the effectiveness of the proposed detection system. This research describes and evaluates the use of neural network technology for quality control in the milk packaging process [12] study focuses on using artificial intelligence, specifically neural networks, to improve the efficiency and accuracy of detecting packaging defects while also ensuring the overall quality of dairy packaging. The research [13] describes the design and implementation of a Milk Analysis Embedded System specifically for dairy farmers. The system combines advanced sensor technologies with embedded computing to provide on-site milk analysis capabilities, allowing farmers to assess the quality and composition of their milk production .The design and implementation of a low-cost Near-Infrared (NIR) Digital Photometer that uses In GaAs sensors to detect milk adulterations with water [14] study aims to provide a cost-effective solution for dairy industry stakeholders to identify and quantify water adulteration in milk using NIR technology.The research focuses [15] on the design and validation of a point-of-care sensor for the rapid and on-site detection of milk adulteration. The study aims to provide a portable, user-friendly, and cost-effective solution for detecting common adulterants in milk. The research describes the sensor's design, operating principles, experimental validation, and real-world applications, demonstrating its effectiveness in improving milk quality control.
The comprehensive review research in [16] surveys and analyzes the most recent techniques and methodologies for detecting quantitative adulteration in milk. The research [17] provides a comprehensive examination of quantitative adulteration detection methods in milk, with the goal of consolidating current knowledge, highlighting advancements, addressing challenges, and outlining future directions in the field. The research discusses a variety of techniques,

including spectroscopic methods, chromatography, sensor technologies, and molecular techniques, and provides insights into their applications in ensuring the quality of milk products. The researchers [18] have presented a focused investigation into the Limit of Detection (LOD) for five common adulterants in milk considering fat percentage variations. The study seeks to determine the lowest concentration at which adulterants can be reliably detected in milk samples with varying fat content. The research [19] describes the design and implementation of a comprehensive traceability system for milk samples using Radio-Frequency Identification (RFID) technology. The study aims to improve the transparency and efficiency of the milk supply chain by incorporating RFID tags into the production, processing, and distribution stages .The authors [20] have described the design and validation of a magnetic counter system for detecting Group B Streptococci (GBS) in milk samples. The research focuses on using magnetic-based techniques for sensitive and rapid detection of GBS, a pathogenic bacterium that has implications for milk quality and safety.

III. Methodology

The public's health is seriously endangered by adulteration and pollution, which also damage customer confidence. This paper provides a thorough methodology for a Milk Purity Detection System that makes use of the Internet of Things (IoT) to address these issues. Throughout the whole milk production and distribution chain, the integration of IoT technology guarantees a proactive approach to quality control and permits real-time monitoring.

A. Requirement Specification

Table 1 : Requirement Specification

Component Name	Detect
ESP 32	The ESP32 has integrated Bluetooth and Wi-Fi, making it simple to communicate and send data to other devices or a central server
TDS SENSOR	TDS testing can be a crucial factor in determining the purity and quality of milk.
Temperature sensor	Spoilage detection: Milk that exhibits unusual temperature fluctuations may be spoiled
PH sensor	The acidity or alkalinity of milk
Color sensor	Color of milk

Table 1 represents following component overview used in this research

1. ESP32:

A wide range of applications, including sensor-based systems like a milk purity detection system, may make use of the ESP32, a flexible microcontroller. The ESP32 in such a system may communicate with many sensors to track and evaluate milk quality. The following are the features and applications of an ESP32-based milk purity detecting system.

Figure 1: ESP32 DEVELOPING KIT

2. TDS Sensor:
The number of dissolved solids in milk may be measured using a TDS (Total Dissolved Solids) sensor in a milk purity monitoring system. Different organic and inorganic materials that are dissolved in a liquid are referred to as total dissolved
solids. TDS testing can be a crucial factor in determining the purity and quality of milk.

Figure 2: TDS SENSOR

3. Temperature Sensor:
For many reasons, a temperature sensor can be an essential part of a system used to assess milk quality.

Figure 3: TEMPERATURE SENSOR

4. PH Sensor:
The acidity or alkalinity of milk is measured using a pH sensor in a milk purity testing device. This is significant because there are variables that can affect milk's pH, and variations in pH can be a sign of contamination or spoiling.

Figure 4: PH sensor

5. Color Sensor:
A milk purity detection system may evaluate the color of milk using a color sensor, which can provide details about the milk's composition and any adulteration. The purpose of milk purity detection systems is to make sure that the milk being tested is free of contaminants and adulterants and satisfies certain quality criteria.

Figure 5: COLOR SENSOR

B . Algorithm for milk purity detection:
1. Initialize with:
-Install required libraries like (One Wire, Dallas Temperature Wi-Fi and Blynk)
- Define color sensor pins (S2, S3, sensorOut), pH sensor pins (pHSensorPin), and TDS sensor pins (TdsSensorPin).
2. Setup Function:
- Begin serial communication.
- Turn on Wi-Fi.
- Link to Blynk.
- Configure the pin modes and sensor resolutions.
3. Loop Function:
- Verify the Blynk connection.
- Calculate the pH, color values, temperature, and TDS.
- Determine pH://ph calculation
- Retrieve the analog value from the pH sensor.
- Convert an analog value to a voltage value.
- Determine the pH value based on the voltage.
- Sort pH into Base, Neutral, Acidic, or Unknown.
- Milk Color Classification: // Color Classification
- Retrieve the RGB values from the color sensor.
- Based on the RGB values, determine the milk type (Buffalo Milk, Cow Milk, Other Color Detected).
TDS calculation:
- Take TDS sensor readings and save them in a buffer.
- Determine the average voltage.
- Use temperature compensation.
- Using a formula, calculate the TDS value.
- Sort milk into categories based on TDS (Checking Results, Water, Pure Milk, Starch, Urea).
Blynk App:
- Blynk is updated with the pH, temperature, milk type, pH category, TDS value, and result.
Print Information:
- Print pertinent data to the serial monitor.
Wait three seconds.:
4. Function get Color Value:

- Get Color Value:
- Connect the S2 and S3 pins.
- Using the color sensor's pulse In, calculate frequency.
- Map frequency to a value between 0 and 255 based on the color range specified.

5. Connect Blynk Function:
- Connect to Blynk: - Check the Blynk connection and retry if necessary.

6. Algorithm End.

C. Equations and Expressions:

1. Calculation of pH:

The equation 1 describe A Ph sensor is used to determine the pH of the milk. The sensor's analog reading (Ph Value) is converted to voltage and then mapped to obtain the Ph value (Ph). The acidity or alkalinity of the milk is associated with different Ph ranges.

Ph Value = analog Read (Ph Sensor Pin)

*Volt = Ph Value *5.0 / 4095.0 …………(1)*

*Ph=5.0*Volt /3.3*

2.Calculation of TDS:

Equation 2 describe TDS (Total Dissolved Solids) in milk is calculated using temperature compensation. The compensation coefficient (CompensationCoefficient) compensates for temperature variations. The compensated voltage (Compensation Volt) is then used to calculate the TDS value (TDS Value) using a formula. TDS is a measure of impurities in milk.

*CompensationCoefficient = 1.0+0.02 *(Temperature - 25.00)*

CompensationVolt = CompensationCoefficientAverage Volt ………..(2)

3.Classification of Milk color:

Equation 3 describe the RGB values from the color sensor are used to determine the type of milk. If the RGB value conditions match predefined ranges, the milk is classified as "Buffalo Milk" or "Cow Milk." Otherwise, it is labeled "Other Color Detected."

Equation 3 : Redvalue =getColorvalue (S2, S3, R_Min, R_Max)……………(3)

Blue value = getColorvalue (S2, S3, B_Min, B_Max)

D System Architecture:

The Milk Purity Detection System employs a multi-sensor approach, including TDS (Total Dissolved Solids). Color, dissolved solids, and temperature sensors are used to assess the quality and purity of milk at various stages of processing. The TDS sensor is essential for measuring the concentration of dissolved solids provides information about the overall mineral content and potential adulteration. The color sensor analyzes visual aspects such as color consistency and texture, providing valuable information on the milk's physical properties. Meanwhile, the temperature sensor ensures that the milk processing adheres to specific temperature standards that are critical for quality maintenance. The integration of these sensors is managed through a centralized system architecture. Each sensor is strategically placed to contact milk samples at various stages of processing. The sensor data is collected and fed into a central processing unit, where it is analyzed by advanced algorithms The output of the TDS sensor contributes to the assessment of dissolved solids, whereas the data from the color sensor aids in identifying any deviations from standard visual characteristics. The temperature sensor ensures that the processing conditions remain within the desired range at the same time.

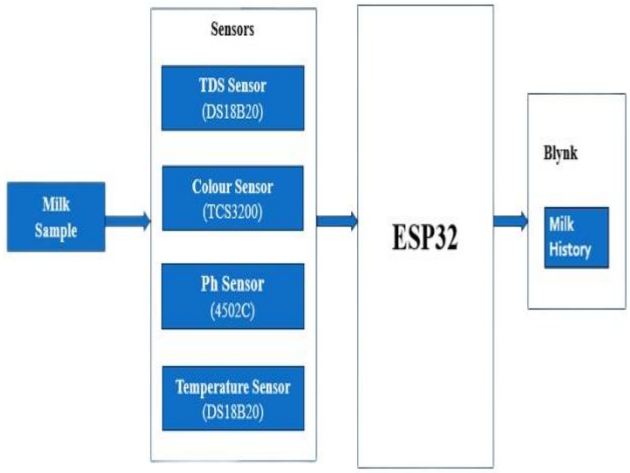

Figure 6: System Architecture

IV . Result and Analysis

The Milk Purity detecting system improves milk quality monitoring and assessment by incorporating a variety of sensors, an Arduino Uno board for data processing, and a Blynk app for easy visualization and control. This system is useful in industries and households where the quality of milk is critical.

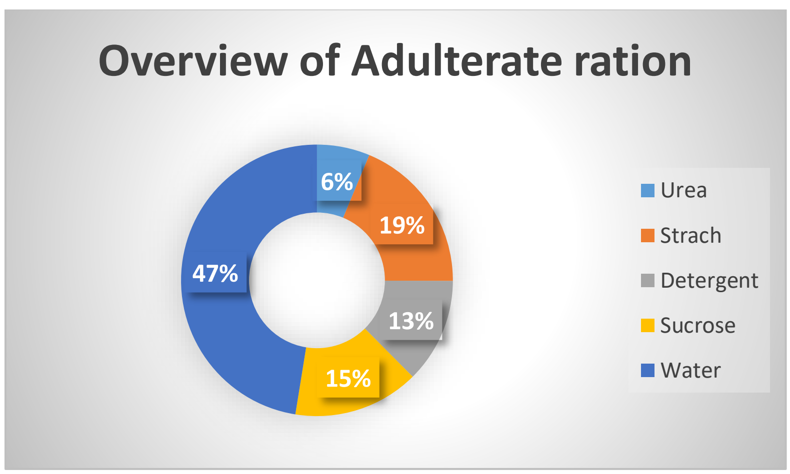

Figure 7: Overview of Adulterate ration

Table 2: Analysis of milk

Cattle	PH value	Temperature	Color
Cow	6.0-6.4	38°C	Off-white
Buffalo	6.7-6.9	40°C	White

Normal pH Range for Pure Milk: The pH of milk indicates whether it is acidic or alkaline. Pure milk's pH value typically falls within a specific range. Cow's milk and Buffaloes milk usually has a pH of 6.4 to 6.4 and 6.7 to 6.9. When milk is adulterated or contaminated with acidic or alkaline substances, the pH can change. Monitoring the pH value aids in detecting such changes, indicating potential adulteration.
Normal Temperature of milk: The recommended storage temperature for pure milk is typically between 32°F (0°C) and 40°F (4.4°C). Storing milk within this temperature range slows the growth of bacteria, extending the milk's shelf life and quality.
Natural Color of Pure Milk: Pure milk is typically white with creamy for cow milk and off-white for buffaloes' milk. Color deviations may indicate the presence of impurities or additives.
RGB values are used to classify milk into three types: buffalo milk, cow milk, and other color detected. This classification is based on predefined RGB value ranges for each type of milk. Any significant deviation from these ranges could indicate impurities or adulteration.

Figure 8: Interface

In Figure 8 When the Sensors are dipped into the powdered milk containing water the PH value, TDS meter and the temperature varies from different PH category as Basic and depicting the milk as adulterated with water.The PH value is 2.2 so it is showing Base as a category as the basic nature of the milk ranges from 0 to 6.5.

Figure 9: Proposed Model

An innovative IoT-based system has been developed, with pH sensors, TDS sensors, temperature sensors, and color sensors seamlessly integrated into an Arduino Uno board. This comprehensive system is used to test the quality of milk by immersing these sensors in impure milk samples. The collected data, which includes the pH category, milk type, temperature values .

V. Conclusion

The "Milk Purity Detection" system is a creative approach that uses a variety of sensors and the Internet of Things to address the urgent problem of adulterated milk. It uses various sensors to identify adulterants including urea and starch and the type of milk (goat, buffalo, or cow). These sensors include color, TDS (total dissolved solids), temperature, and pH sensors. The problem of guaranteeing milk purity for the typical consumer—who might not have access to laboratory testing—is addressed by this household-use method. Customers can simply keep an eye on important milk-related indicators by using a smartphone application. This flexible approach provides enhanced selectivity and reaction time over current techniques, enabling faster and more precise identification of adulterants and milk varieties.
The Internet of Things-based milk purity detection system is a promising technical innovation that not only maintains milk purity, but also has far-reaching consequences for the dairy industry's entire integrity and sustainability. As we move forward, we must continue to refine and advance such technology to meet the worldwide market's ever-increasing demand for safe and high-quality dairy products. The successful implementation of this system could act as a beacon for the dairy industry, demonstrating IoT's transformative capacity in ensuring the purity of our daily staple, milk. By embracing this technology, stakeholders can work towards a future in which milk quality is consistently maintained, consumer safety is prioritized, and the dairy supply chain operates efficiently and transparently. As we enhance and increase the capabilities of such technologies, the ideal of a safer, more reliable dairy sector becomes increasingly attainable.

References:

[1] Ali Yavari, Dimitrios Georgakopoulos, Himanshu Agrawal, Harindu Korala Prem Prakash Jayaraman, Josip Keratotic Milovic "Internet of Things Milk Spectrum Profiling for Industry 4.0 Dairy and Milk" 2021 IEEE 2nd International Conference on Mobile Networks and Wireless Communications (ICMNWC)

[2] Nayeem Abdullah, Ahnaf Shahriyar Chowdhury, Md.Mehedi Hossain "Real-Time Milk Condition Surveillance System" 2021 Conference on Information Communications Technology and Society.

[3] Kathiravan Pugazhenthi Anandhan Sengamalam Bharath Ganesan "Milk Quality Monitoring System using IoT" International Conference on Sustainable Computing and Smart Systems (ICSCSS 2023) IEEE Xplore.

[4] Dr.S.Asif Hussain Assistant, Dr.M.N.Giri , Chandra Shekar Ramaiah S. Mazhar Hussain "Milk products monitoring system with arm processor for early detection of microbial activity" 2019 3rd MEC International

Conference on Big Data and Smart City.

[5] Dr. M. Alagumeenaakshi , Ajitha S , Sathika J , Navaneethakrishnan R “Milk Adulteration Monitoring” 2021 International Conference on Advancements in Electrical Electronics, Communication, Computing and Automation (ICAECA) .

[6] G. Kalaiarasi K. Dinakaran ,J. Ashok , M. Kathirvelu , A. Anandkumar “IOT Based Milk Analyzer using Arduino with Wi-Fi” 2022 IEEE 2nd International Conference on Mobile Networks and Wireless Communications (ICMNWC).

[7] Medha Khenwar , Swati Vishnoi and Ankur Sisodia “An Assessment of Milk Adulteration IoT Based Model to Identify the Quality of Milk using Lab View” T–2022, IEEE Conference 11th International Conference on System Modeling & Advancement in Research Trends.

[8] Rahul Umesh Mhapsekar , Lizy Abraham, Norah O’Shea, Steven Davy “Edge-AI Implementation for Milk” 2022 IEEE Global Conference on Artificial Intelligence and Internet of Things (GCAIoT).

[9] Nikita Mittal, Alok Bharadwaj “Surveillance of Pathogenic Bacteria from Milk Samples” 2021 5th International Conference on Information Systems and Computer Networks (ISCON).

[10] Chirantan Das, Subhadip Chakraborty, Anupam Karmakar, Sanatan Chattopadhyay “On-chip Detection and Quantification of Soap as an Adulterant in Milk Employing Electrical Impedance Spectroscopy” India 2021 5th International Conference on Information Systems and Computer Networks (ISCON) GLA University, Mathura, India.

[11] Moupali Chakraborty, Dina Anna John and Karabi Biswas, “A Statistical Study of Detergent and Shampoo Adulterated Milk Detection System” T–2022, IEEE Conference 11th International Conference on System Modeling & Advancement in Research Trends.

[12] Marina S. Chvanova ,Ilya A. Bakalets “Neural network technology for quality control of the milk packaging process” 2022 6th Scientific School Dynamics of Complex Networks and their Application.

[13] Yadav S. N, Mrs.Kulkarni V.A. ,Gholap S. “Design of Milk Analysis Embedded System for Dairy Farmers” 2019, IEEE Conference on Advances in Technology and Engineering.

[14] Maurício Moreira, José Alexandre de França, Dari de Oliveira Toginho Filho, Vanerli Beloti, Alberto Koji Yamada, Maria Bernadete de M. França, and Lucas de Souza Ribeiro “A Low-Cost NIR Digital Photometer Based on In Ga As Sensors for the Detection of Milk Adulterations With Water IEEE Sensors Journal, May 15, 2019.

[15] Subhashis Patari Micro, Nano Bio-Fluidics Group, “A point of care sensor for milk adulteration detection” 2021 IEEE Sensors Journal.

[16] Sowmya Natarajan , Vijayakumar Ponusamy “A Review on Quantitative Adulteration Detection in Milk”2021 Smart Technologies, Communication and Robotics.

[17] Maurício Moreira, José Alexandre de França, Dari de Oliveira Toginho Filho, Vanerli Beloti, Alberto Koji Yamada, Maria Bernadete de M. França, and Lucas de Souza Ribeiro “A Low-Cost NIR Digital Photometer Based on In GaAs Sensors for the Detection of Milk Adulterations with Water”IEEE Sensors Journal, 2019.

[18] Moupali Chakraborty, Student Member, IEEE, and Karabi Biswas, Member, IEEE “Limit of Detection for Five Common Adulterants in Milk: A Study With Different Fat Percent”, IEEE Sensors Journal , 2018.

[19] Eng. Jesús Carreño Laguna, Dr. Andrés García Higuera, Eng. Roberto Zangróniz Cantabrana, Eng. Javier de las Morenas “Comprehensive traceability system of milk samples using RFID” India International Conference on Sustainable Computing and Smart Systems (ICSCSS 2022).

[20] Carla Margarida Duarte, Ana Carolina Fernandes, Arroyo Cardoso, Ricardo Bexiga, Susana Freitas Cardoso and Paulo J. P. Freitas “Magnetic Counter for Group B Streptococci Detection in Milk” IEEE Transactions On Magnetics, 2019.