JAET

Journal homepage: http://jae-tech,com

Journal of Applied Engineering & Technology

ISSN : 2523-6032 ISSN-L : 2523-2924

Detection of Milk Impureness

Mahreen Bhanger[1*], Ammara Latif[1], Siraj Baloch[1], Aisha Baloch[2]

[1]Department of Electronic Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, 67480, Pakistan

[1]Department of Electronic Engineering, Mehran University of Engineering and Technology, Jamshoro, Sindh, Pakistan

*Corresponding Author

Abstract: Milk is an essential element of our daily diet. It provides many nutrients, including vitamins, minerals, protein, healthy fats, and antioxidants. It is very much essential to drink healthy milk. However, due to different aspects of our society, i.e., unhealthy environment, corruption, and lack of food security, we are consuming impure milk provided by dairy shops. Among the causes of small-scale dairy producers' difficulties in producing hygienic products are informal and unregulated marketing, handling, and processing of dairy products, lack of financial incentives for quality improvement, and insufficient knowledge and skills in hygienic practices. This impure milk produces adverse effects on our health and, worst cases. According to the World Food Organization report, 41% of health issues are due to impure milk in Pakistan. Unfortunately, there is no absolute or intelligent system to identify the Milk quality in Pakistan. In this work, an Intelligent Milk Quality Detection system is proposed. The project proposed an optical sensor based digital system that identifies milk quality. The optical signal is acquired from Milk and after that signal processing techniques will be applied to convert the signal to be classified for the machine learning approach. In addition to optical, the other sensors such as fat, protein, and water preserve sensors are used to get accurate results. The project will offer an intelligent and accurate system to detect the quality of milk that will acknowledge the best milk to be consumed by the public.

Keywords: Milk Impureness, Pureness Detection, Sensors, Internet of Things

1. Introduction

Milk is an essential element of our daily diet. It provides many nutrients, including vitamins, minerals, protein, healthy fats, and antioxidants [1]. It is very much essential to drink healthy milk. It is a rich source of protein, with just one cup containing 8 grams. Protein is required by the human body for a variety of critical processes, including growth and development, cellular repair, and immune system modulation [2]. Milk is a "complete protein," containing all nine essential amino acids required for the human body to operate properly. Milk has two major forms of protein: casein and whey protein. Both of these proteins are regarded to be of good grade [3]. Casein accounts for the majority of the protein in cow's and buffalo's milk, accounting for 70–80% of the total protein composition. Around 20% is whey [4]. Whey protein is a source of the branched-chain amino acids leucine, isoleucine, and valine, which have been related to a variety of health advantages. However, due to different aspects of our society i.e., unhealthy environment, corruption, and lack of food security, we consume impure milk provided by dairy shops [5]. Among the factors contributing to small-scale dairy producers' difficulties with hygienic product production are informal and

Corresponding author: 18es01@quest.edu.pk

unregulated marketing, handling, and processing of dairy products; a lack of financial incentives for quality improvement; and insufficient knowledge and skills in hygienic practices [6]. Among the factors contributing to small-scale dairy producers' difficulties with hygienic product production are informal and unregulated marketing, handling, and processing of dairy products; a lack of financial incentives for quality improvement; and insufficient knowledge and skills in hygienic practices [7]. This impure milk produces adverse effects on our health and in the worst case; it may cause severe issues with the digestive system and may cause food poising, stomach cramps, vomiting, and diarrhea as well [8]. Milk adulteration is a social problem. It exists both in the backward and advanced countries. Common adulterants in milk and its effect on human health are various types of adulterants are used in milk. Among them some kinds of adulterant and their impact on health of human body such as, Water, Urea, Hydrogen peroxide, Detergents, Starch, Carbonates and bicarbonates, Chlorine, Antibiotics, Whey / liquid whey, and many more [9]. According to the World Food Organization report, 41% of health issues are due to impure milk in Pakistan. Unfortunately, there is no absolute or intelligent system to identify the Milk quality in Pakistan [10]. Hence it is very important to test the purity of milk before consumption as synthetic milk and pure milk look the same and have a same taste.

It is critical to monitor the quality and adulteration of milk. Numerous current and novel techniques are employed to detect the presence of adulterants in milk, and the standard metrics for determining the milk's quality and adulterations include the quantity of water, fat, protein, and solid not fat (SNF), as well as the microbiological count [11].

The proposed Milk Quality Identifier works's benefits include the ability to intelligently and reliably identify impurities in milk that is free of debris and silt; free of off tastes and aberrant colour and odour; and low in bacterial count. The suggested approach will assist in identifying milk that is both safe and appropriate for its intended usage. The initiative will assist in achieving a high standard of quality; proper hygiene measures should be implemented across the dairy supply chain. In this work, an Intelligent Milk Quality Detection system is proposed. The work proposed a sensors-based digital system that identifies milk quality. The sensor signal is acquired from Milk and after that signal processing techniques will be applied to convert the signal to be classified. The work will offer an accurate system to detect the quality of milk that will acknowledge the best milk to be consumed by the public.

2. Background and Literature Review

Long before recorded history, milk was recognized as an excellent sustenance with unmatched nutritional value for sustaining human beings. It is considered a full meal because to the fact that it contains all of the necessary nutrients for all animals, including humans [11]. In its natural state, milk possesses the highest nutritional value. It more precisely satisfies the body's nutritional requirements than any other single food since it contains all of the nutritional components required to complete each physiological activity of the body system. Milk contains around 87.80 percent water, 3.20 percent protein, 3.50 percent fat, 4.80 percent lactose, and 0.70 percent minerals, according to Pehrsson [12], and 100g milk has approximately 66 kcal of calories. Historically, research shows that individuals who obtained the majority of their daily energy requirements from milk and milk products were more successful and capable of efficient governance, and these groups benefited from total immunity to a variety of nutritional illnesses [13]. On the other side, the world's poorest or least developed nations or areas lack access to milk, resulting in a large number of nutritionally deficient population [14]. Thus, continual monitoring of milk quality and adulteration is critical to resolving these issues. There are various current and novel ways for detecting the presence of adulterants in milk [15], and the standard metrics for determining the milk's quality and adulteration include the quantity of fat, protein, solid not fat (SNF), and microbiological count. Impurity analysis is completed as numerous tests were conducted to rule out the existence of impurities/adulteration. The tests were mostly titrations of the sample with various reagents. The presence of added sugar and starch was measured using the technique described by Karmaker et al in [16]. It is very important to check the pureness of milk at dairy shops while there is no such system that can be used in local areas [17]. Only industrial based techniques are used for the milk pureness detection and these techniques are not useful commercially. Here we are trying to design a system to detect milk pureness.

3. Research Methodology

The implementation of the work will be carried out as per the direction mentioned in the objectives and the flow diagram. In the first step, the optical transducer will expose pulse on milk to test impurity. After using phototransistor, the optical pulses reflected from milk will be collected as shown in Fig. 1.

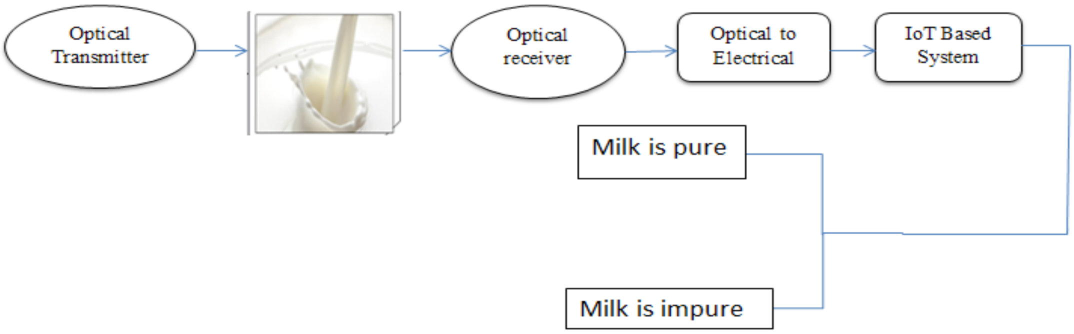

Fig. 1 – Design approach of Milk pureness detection system

The collected reflected optical pulses from milk and other data from different sensors will be processed using an Embedded system that will convert the signal into the digital signal and after that, the data will be given to a machine learning model for training the data. Finally, the AI-based system will collect the data from the optical sensor and train the system based on received real-time data along with detection and recognition of impurity of the milk. The implementation model is depicted in Fig. 1. The proposed system is based on three sub-systems. The first is the sensing system, second is the processing of data, and the last is the machine learning algorithm system. These sub-systems are shown in Fig. 2.

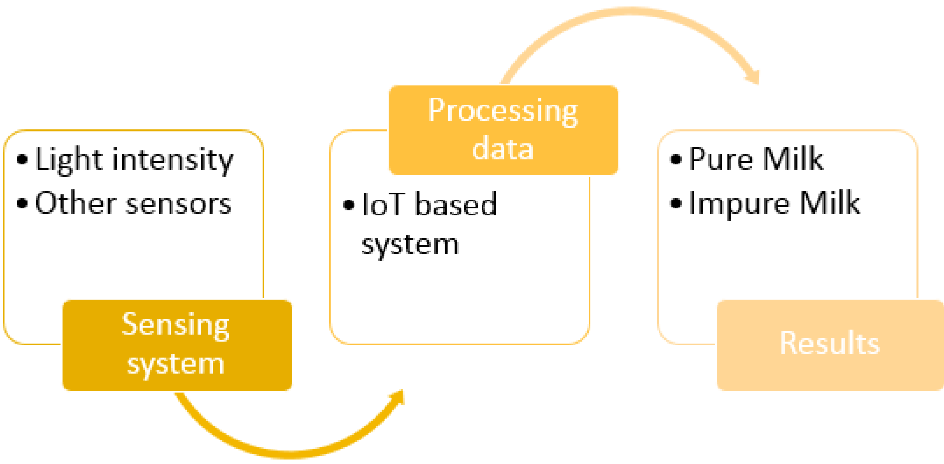

Fig. 2 – Sensing system and data processing

The sensing system is based on Optical Technology that measures the light intensity reflected from the milk that will be tested. The processing system is based on a data accusation system and a real-time system carrying and processing all the data from the sensing system. This transfers the data to an IoT system for classification and recognition of milk impurity. The last stage is based on the internet of things / IoT system output that will display that either milk is pure or impure by measuring the milk's fat. The hardware design is shown in Fig. 3

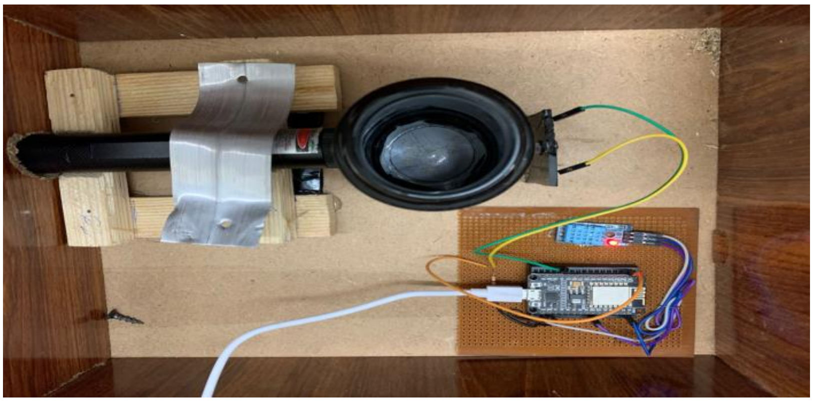

Fig. 3 – Hardware Design

The system is based on optical transmission and reception. The transmission of something is the passing or sending of it to a different person or place while the reception is to receive the passed or sent data from the sender. The optical transmitter in this case is a LASER light device that emits light by optical amplification using electromagnetic radiation that has been triggered to emit light. A laser emits coherent light, which distinguishes it from other light sources. The optical receiver is LDR which is photo resistor (also known as a light-dependent resistor, LDR, or photo-conductive cell) amd a passive component that decreases resistance with respect to receiving luminosity (light) on the component’s sensitive surface. The system design using, ESP8266 NODEMCU, DHT11 sensor is used to detect temperature and humidity of environment at which milk is going to be test. Light dependent resistor is used as a receiver that receive laser light and convert it into the electrical voltages and current. That electrical signal is given to the ESP8266 to process the data and generate LASER with a wavelength range of 400 to 700 nanometers is used. When a LASER light falls on liquids, it spreads or the light intensity of the LASER reaching the opposite side decreases, this Laser will be employed in our module to detect the fat content of the milk. Various solids have different levels of light intensity. LIGHT DEPENDENT RESISTOR (LDR) is used to observe the resistance changes when light shines on it. The resistance of the LDR can vary by many orders of magnitude, with the resistance decreasing as the amount of light rises. Light dependent resistors, LDRs, photoresistors, and even photocells, photocells, and photoconductors are all names for these electronic components. Other electronic components, such as photodiodes or phototransistors, can also be utilised, but LDRs or photo-resistors are especially useful in many electrical circuit designs. For variations in light level, they produce a considerable shift in resistance.

4. Results and Discussion

The work milk pureness detection system is delivered the prototype that identifies the milk quality as the final deliverable. The buffalo milk type data set is used for training and testing because buffalo milk has a larger total solids content than cow milk, resulting in a thicker product. Buffalo milk contains 100 times the fat of cow's milk, making it creamier and thicker. Buffalo milk can be naturally stored for a longer amount of time due to its high peroxidase activity (a family of enzymes that function as catalysts for processes). Buffalo milk is a better nutritious supplement for newborns because it includes more calcium, has a higher calcium-to-phosphorous ratio, and contains less sodium and potassium. Finally, the accuracy of the machine learning algorithm will be identified to find the quality of the milk by measuring its fat contains. Table 1 shows the average values of LDR readings that have taken experimentally.

Table 1 – Milk average value

S.no	Milk average value	
1.	Pure and fresh milk	7.12
2.	Pure stored milk	7.07
3.	50% impure milk	7.3
4.	60% impure milk	7.8
5.	75% impure milk	7.9

Table 1 shows the average values based on fat content in buffalo milk. When the LDR sensor gives the values in above range then the IoT based system will display results on the robot serial monitor accordingly. The readings that have been taken experimentally are given below with the graphic representation. Fig. 4 shows the relationship between LDR values and time readings have been observed. There are more fluctuations in pure and fresh milk than stored pure milk because environment pollution can affect fresh milk.

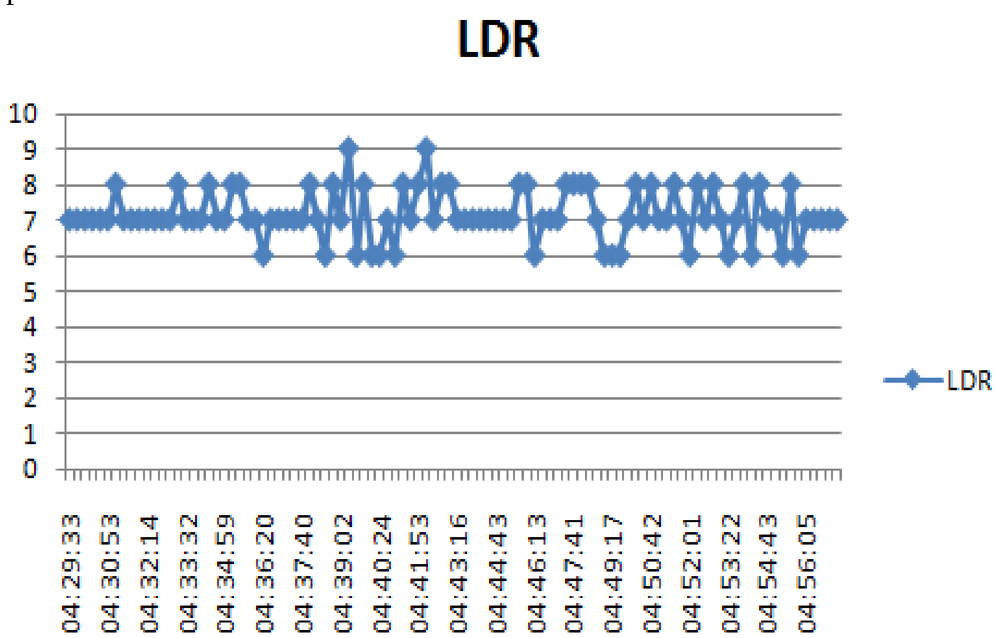

Fig. 4 – Fresh and Pure milk values

In the above graph time is on x-axis and ldr values are shown on y-axis. X-axis shows the total time in which ldr values are detected experimentally. In almost 25 minutes, we learned about the behavior of ldr for pure and fresh milk fat content. The 100% pure but stored milk (upto 8 hrs) in stored milk, fat and total protein contents and acidity values slightly increased. Cold storage of both kinds of milk increased the rennet coagulation time (RCT), curd tension and curd syneresis (extraction or expulsion of a liquid from a gel) values. Also, preservation of buffalo's and cow's milk at 4-5°C increased total viable bacterial (TVBC), lactic acid, psychrophilic bacteria, proteolytic (enzymes) and yeast counts. It is observed form the previous research that when the milk is stored in a refrigerator for time being, the density of milk is increased. So the graph shown below is displaying exact 7 values except one glitch value which is because of analog nature of sensor as shown in Fig. 5

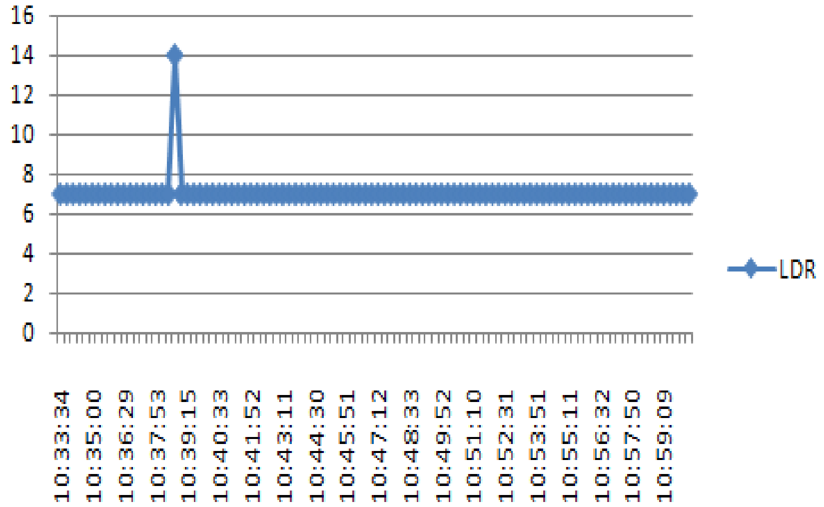

Fig. 5 – Pure but stored milk values

The time on x-axis does not affect ldr values, it only shows the period on which experiment is being performed. But the temperature and humidity may effect on sensor values. Also, environmental pollution may cause impurities in the milk, so the experiment area must be neat and clean for accurate readings. At 50% impure milk, as mentioned above, the average 50% impure milk values are 7.3. Since polluted water is added to the pure milk which is designed to increase the shelf life and quantity of milk and improve its taste. This is contaminants are damaging a key staple of diets, especially for infants. When the sensor senses the intensity of light passing through the 50% impure milk, ldr will give the result greater than or equal to the average value mentioned in Table 1. The graphic representation of impure milk is given below, indicating the values of ldr for impure milk and showing some glitch values because of some environmental distortions as shown in Fig. 6.

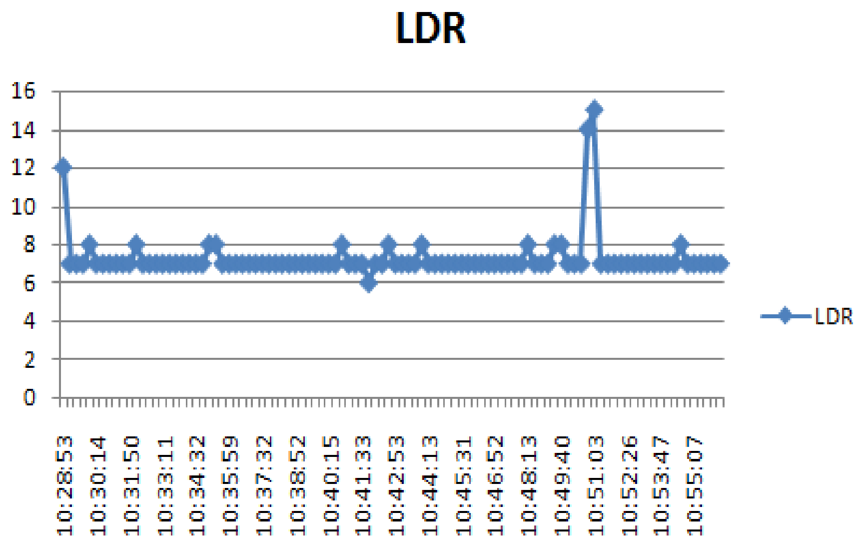

Fig. 6 – 50% impure milk values

Lower fat milk is made by removing the fat, not diluting the milk with water. Add ½ quart of water to ½ quart of milk and you've diluted the fat by half, but also all the other essential the nutrients, including calcium and vitamin D. "The milk also will taste watered down". In many areas of Pakistan, water is added to milk to increase the quantity of milk to fulfill the consumer's requirements because resources for producing and supplying pure milk are lesser while the consumer's demand is more than that. But impure milk has very adverse effects on human health, so it is very important to supply pure milk in less quantity. More impure milk means more health issues.

4.1 Effect of temperature (26°C) on 80% impure milk

As it is observed that high quantities of milk are sensitive to heat and tend to decrease their milk production. It is shown that all other conditions being approximately the same, the lower the environmental temperature within the observed limits, the higher the percentage of fat in milk. It is found that striking variations of the percentage of fat with season which is independent of the period of lactation or of the character of the diet suggests exercise and temperature as possible causes of this variation. The graph shows the variations in the temperature with the time passing, these variations in temperature values are effected on the milk which may be caused the variation in ldr values. With the constant temperature values, ldr values are also constant but some unwanted values are due to distortion of sensor. When the temperature increases that may cause the increment in ldr values, that is directly effected on the fat content of milk. The relation between fat of milk and temperature is inversely proportional. The temperature incresed the fat content in milk decreased. Below is the graphic representation of this relationship as shown on Fig. 7.

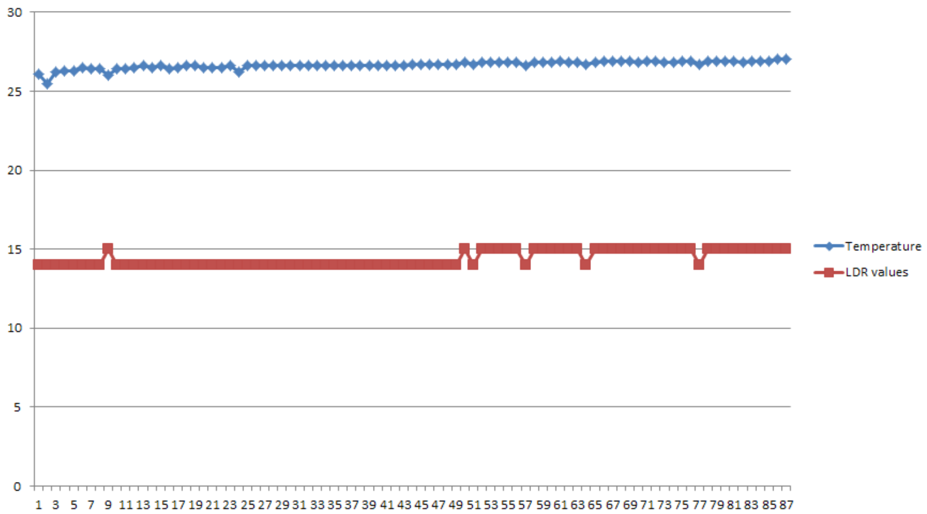

Fig. 7 – Effect Of (26OC) Temperature on Milk And Ldr Values

The table given below shows the experimental value of temperature and ldr. There is not that much effect of temperature on the ldr value if temperature increases in the floating points, but when these values go towards the precision, it may affect the ldr values.

5. Conclusion

In comparison to other traditional ways, this method is also accurate and precise, but the complete system must be closed space. This must be calibrated before use by using other established methods to determine the fat level. If the depositor deceives the machine by pouring things other than milk, such as honey, the device will not function properly until it is serviced. The system should be improved to segregate different fat content milks into distinct containers and detect the user who is attempting to tamper with the machine. This project proposes an Intelligent Milk Quality Detection using IoT based system. The project is offered an intelligent and accurate system to detect the quality of milk that will acknowledge the best milk to be consumed by the public in local areas or commercially. This system can be designed at a larger scale to detect other milk parameters.

Acknowledgement

The authors would like to thanks Department of Electronic Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Sindh, Pakistan for the support and encouragement in carrying this research work.

References

1. Haug, A., Høstmark, A. T., & Harstad, O. M. (2007). Bovine milk in human nutrition–a review. Lipids in health and disease, 6(1), 1-16.
2. Wu, Q., Mu, Q., Xia, Z., Min, J., & Wang, F. (2021, January). Manganese homeostasis at the host-pathogen interface and in the host immune system. In Seminars in Cell & Developmental Biology. Academic Press.
3. Huppertz, T., & Chia, L. W. (2021). Milk protein coagulation under gastric conditions: A review. International Dairy Journal, 113, 104882.
4. Shi, T., & Li, Y. (2021). Producing high Fischer ratio peptides from milk protein and its application in infant formula milk powder. Quality Assurance and Safety of Crops & Foods, 13(1), 49-58.
5. Liguori, J., Trübswasser, U., Pradeilles, R., Le Port, A., Landais, E., Talsma, E. F., ... & Holdsworth, M. (2022). How do food safety concerns affect consumer behaviors and diets in low-and middle-income countries? A systematic review. Global Food Security, 32, 100606.
6. Kapaj, A., & Deci, E. (2017). World milk production and socio-economic factors effecting its consumption. In Dairy in human health and disease across the lifespan (pp. 107-115). Academic Press.
7. Benkerroum, N., & Tamime, A. Y. (2004). Technology transfer of some Moroccan traditional dairy products (lben, jben and smen) to small industrial scale. Food Microbiology, 21(4), 399-413.
8. Ratnaike, R. N. (2003). Acute and chronic arsenic toxicity. Postgraduate medical journal, 79(933), 391-396.
9. Reddy, D. M., Venkatesh, K., & Reddy, C. V. S. (2017). Adulteration of milk and its detection: a review. International Journal of Chemical Studies, 5(4), 613-617.
10. Devendra, C. (2005, March). Small ruminants in Asia; Contribution to food security, poverty alleviation and opportunities for productivity enhancement. In Proceeding of international workshop on small ruminant production and development in South East Asia. MEKARN, Nong Lam, HCMC, Vietnam (pp. 19-32).
11. Nicolaou, N., Xu, Y., & Goodacre, R. (2010). Fourier transform infrared spectroscopy and multivariate analysis for the detection and quantification of different milk species. Journal of Dairy Science, 93(12), 5651-5660.
12. Hossain, T. J., Alam, M., & Sikdar, D. (2011). Chemical and microbiological quality assessment of raw and processed liquid market milks of Bangladesh. Tanim Jabid Hossain, Md. Khorshed Alam, & Dwaipayan Sikdar.(2011). Chemical and Microbiological Quality Assessment of Raw and Processed Liquid Market Milks of Bangladesh. Continental journal of food science and technology, 5(2), 6-17.
13. Pehrsson, P. R., Haytowitz, D. B., Holden, J. M., Perry, C. R., & Beckler, D. G. (2000). USDA's national food and nutrient analysis program: food sampling. Journal of food composition and analysis, 13(4), 379-389.

14. Power, O., Jakeman, P., & FitzGerald, R. J. (2013). Antioxidative peptides: enzymatic production, in vitro and in vivo antioxidant activity and potential applications of milk-derived antioxidative peptides. Amino acids, 44(3), 797-820.
15. McDermott, J. J., Staal, S. J., Freeman, H. A., Herrero, M., & Van de Steeg, J. A. (2010). Sustaining intensification of smallholder livestock systems in the tropics. Livestock science, 130(1-3), 95-109.
16. El Sheikha, A. F. (2019). DNAFoil: Novel technology for the rapid detection of food adulteration. Trends in Food Science & Technology, 86, 544-552.
17. Karmaker, A., Das, P. C., & Iqbal, A. (2020). Quality assessment of different commercial and local milk available in the local markets of selected area of Bangladesh. Journal of advanced veterinary and animal research, 7(1), 26.