Detection of Sub-Clinical Mastitis Using Prototype Electronic -Nose

Anand M J, V.Sridhar, Ramasamy Ravi

Abstract— Nowadays, traditional testing methods and expensive import detection devices restrict the requirements of fresh milk from agriculture, which is contrary to the improvement of fresh milk quality. The main illness of dairy livestock is mastitis. There are two types of mastitis. One is a clinical and another sub-clinical. Clinical mastitis is easily detected by its medical signs and the quality of milk but sub-clinical mastitis shows no pain. The other hand subcategory mulch results in more financial loss compared to the experimental form. It can be diagnosed with a variety of medical research, and the somatic Cell Count (SCC) is acknowledged as a major indicator. However, the SCC's decision with traditional methods is time consuming and laborious. So the quick field detection technique is a powerful tool to reduce this field. The proposed system is a MSP430 based monitoring unit. The volatility of volatile organic compounds (VOCs) in raw milk headspaces vary drastically when contaminated with bacterial metabolism. The key focus on the ability of the electronic nose (e-nose) system with TGS sensor to break the milks to a limit value with somatic cell counts (SCC). Milk samples are stored from dairy farms. The cow's milk enters the food chain by accidentally mixed milk in sub-clinical mastectomy, causing a threat to human health, such as diarrhea, tuberculosis, scarlet fever, and Q-fever. Major component analysis (PCA) was used to describe the difference between non-mastitis (N-M) / mastitis (M) patterns in conformity with sensor reactions

Keywords: Electronic nose, Sub-Clinical mastitis, MSP430, principal component analysis

I. INTRODUCTION

India is the first country in milk production and milk production in India is a classic example of mass production rather than mass production. Changes in human food consumption patterns, fruits, vegetables, demand for milk and milk products, meat, poultry and fisheries are increasing in recent years. In different dietary areas, growth in the dairy sector is appreciably [12]. The growth rate in milk production in India is substantially above the world average of 1.5 percent (3.6 percent). However, by 2030 total milk demand is 200 million tonnes, with an annual increase of about 4 million tonnes over the next two decades based on income, population, urban development and cost elasticity parameters. Decades. At the existing growth rate in milk production, supplies will decline in the next ten years. Among the many barriers to achieving production goals,

mastitis continues to be a challenging disruption because of the productivity of about 30% in affected quarters and about 15% of cattle production. [18] Dairy animals are considered to be one of the major economic disorders that can cause massive economic losses to the country. [19] In India, economic losses have risen 115 times over the past five decades due to the urinary tract. Lack of awareness, delays in sub-clinical mastitis detection, lack of markers for later detection, unhealthy milking practices, diverse production systems.

When white blood cells (lucocytes) are released to the mammary gland, inflammation occurs in response to bacteria that usually attack on a tetric canal. Milking tissue and various vessels are damaged due to the bacteria released from bacteria throughout the mammary gland. mastitis can occur as a result of chemical, mechanical or heat injury. It can be distinguished by a variety of clinical research and the physical cell count (SCC) is considered an important indicator. However, SCC's decision with conventional methods is time consuming and laborious.

The electronic nose represents the ultimate attempt to smell human-independent value. The disease can be identified by abnormalities in the ulcers such as swelling, heat, redness, hardness, or pain (if clinical). Other indications of inflammation include abnormalities in milk, such as water appearance, layers, or clots. When subclinical mastitis is infected, no visible signs of cow infections or abnormalities can be shown

It is unknown whether mastitis milk can be detected using gas-sensor array technology, but volatile substances are likely to be produced in milk as dramatic changes occur in milk composition at harmful time. However, the recognition and quantity of such substances are unknown to our knowledge. Therefore, this technology is to evaluate if it can be used to separate mastitis and healthy milk within dairy cows.

Pattern recognition techniques are used to analyze electronic nose data. Statistical packages are useful for general statistical methods, such as major unit analysis (PCA) and linear discrimination analysis (LDA).

II. LITERATURE SURVEY

Mastitis is one of the costly diseases in dairy animals and causing severe losses to the dairy industry. The losses due to mastitis are not only economic but issues like animal health and welfare, quality of milk, antibiotic usage and the image

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Anand M J, Research scholar, PES College of Engineering,Mandya, Karnataka, India (Email: ana_mys@yahoo.com)

Dr.V.Sridhar, Professor Emeritus, NMIT, Bangalore, Karnataka, India (Email: venusridhar@yahoo.com)

Dr.Ramasamy Ravi, Assistant Professor of Food Science, Department of Agricultural and Environmental Sciences , Tennessee State University, USA (Email: rravi@TNstate.edu)

of the dairy sector are also important reasons to focus on mastitis control programme. Mastitis causes a great deal of loss or reduction of productivity to influence the quality and quantity of milk and to culling of animals at annual acceptable age.

[1] Mastitis is most common and repeated disease in dairy cattle, due to which an economic losses in the quantity and quality of milk produced. The prevention of mastitis is done by a small training from veterinarians to workers which can reduce the consequence of sub and clinical mastitis.[2] The government of india drive to economic growth and to improve the quality of life of people. This leads to a development of technologies that can solve the problem. raw milk as different infective bacteria , if such milk is consumed it will affect an illness, so real time monitoring is required .which will detect the bacteria and send a data in real time. [3] Now a day we have a milking machine in the market, but the system is only meant to milking system must also contain the automatic in line measure the milk parameter lie amount of milk in each cow, fat contains and SCC (Somatic cell count).[4] The clinical mastitis can be detected easily, but clinical mastitis is complex and expensive in same time. The mastitis can be detected by using SCC count and level of conduction in the milk and using VOC components in the milk. [5] The aim to evaluate a clinical mastitis and their duration of treatment. The repeated accurance of mastitis to a same cow is evaluated by using episode.[6] The detection of the mastitis can be done, like CMT test are time consuming and laborious, so the ability of electronic nose has fast response and easy to use , in this we use 12 MOS sensor and discriminate milk with an analysis technique called ANN (Artificial Neural Network).[7] The milk production as increased in recent year and India is one of it the milk production has given profits to both formers and dairy forms. The formers who lives away from his form cattle – shed and the milk is collected by the workers, there is need of a system to monitor milk quality and quantity. So in this we used a GSM modem to measure volume and fat and mastitis detection using electrical conductivity. [8] Bovine mastitis is high incidence worldwide and become very costly to dairy industries. But bovine mastitis is getting spread by bio-film formation. We can say it is the advantage to the mastitis pathogens. [9] In mastitis they are 2 types of the Sub-clinical mastitis and clinical mastitis .clinical are visible to eyes and but sub-clinical must under a same test. CMT (California Mastitis Test) is one of it much faster than the SCC count and reliable.

[10] A traditional testing methods are old for testing milk which more time and they instruments are expensive. But we have ARM based monitoring unit which monitors the unwanted concentration of VOC's present in the headspace of raw milk. TGS gas sensor is used to detect VOC components.[11] The rear udder quarters had a higher risk of CM (Clinical Mastitis) incidence compared to front udder quarters. In this paper they go through clinical mastitis there symptoms in udder and milk and there aim to study to identify risk factors for CM in high producing dairy herds.[12] India ranks 1st in the world in milk production and it was not a simple task to increase milk production from 17 million tons in 1950-1951 to 127.3 million tons in 2011-12. At 2030, 200 million tons assumptions about the income. But in the huge required mastitis become a one of the major risk factor to the dairy industries. [13] In this paper, mastitis is characterized by physical chemical and bacteriological change in the milk and pathological changes in the milk and pathological changes in the glandular tissue of the udder and affects the quality and quantity of milk.If the mastitis milk s consumed, human get affects by a several disease like tuberculosis, sore- throat, Q-fever, etc... [14] When cows on dairy form are milked with an automatic milking system and clinical mastitis can't be detected without sensors.

The sensor based evaluation as a three factors

1) Time 2) Performance 3)Real-time analysis

This paper they used different detection methods EC, Color, SCC, Homogeneity(visual change in milk and udder).The effect of subclinical mastitis on milk composition in dairy cows.

III. MATERIALS AND METHODS

In order to use the sensors for the detection of gas concentration, they first need to be conditioned for certain period of time. This period for each sensor may vary as per the data sheets. This is because TGS is not selective i.e. it will react with wide range of gases. Hence it is very important that no gases are present during conditioning so that a true "base reading" in air is obtained. For conditioning, the basic measuring circuit of each sensor ie., TGS 2602, TGS 822, TGS 813 are first constructed as per specification mentioned in the data sheet.

Table 1 Specification of sensors

Sensors	Conditioning period	Specification
TGS 2602	More than 5 Days	V_C=5V, V_H=5V, R_L= 1KΩ(pot)
TGS 813	More than 5 Days	V_C=12V, V_H=5V, R_L= 1KΩ(pot)
TGS 822	More than 5 Days	V_C=12V, V_H=5V, R_L= 1KΩ(pot)

Fix the value of RL by varying potentiometer to get constant sensor output. Set the pH meter to standard range with the help of pH4, pH7 and pH9 solution in order to get the exact pH value of milk. Once pH meter standardization over, can be use measure the pH of milk. Since the sensor reading directly proportional to the room temperature, measure the room temperature with the help of temperature sensor before starting experimentation. Chemicals subjected to different volumes like 5ml, 10ml, and 15ml according to volume of milk. When all the prerequisites are successfully completed, sensor array is exposed to air and the baseline voltage is noted down. Take 100ml of MILK samples for the experimentation. Once the sensor array is subjected to raw milk, it is left for few minutes for the analyses to get adsorbed on the sensors then, corresponding voltage values are interfaced using data acquisition software and values are tabulated

Fig 1: shows the circuit setup along with the working interface for milk samples

3.1 Detection of Sub-Clinical Mastitis in Milk

Quality control tests for milk are very important to assure mastitis free milk for consumption. Mastitis of milk reduces the quality of milk and can even make it hazardous. Mastitis can cause the health issue like tuberculosis, scarlet fever and Q fever. The major bacteria cause the mastitis is Escherichia (E.) Coli, Streptococcus (Str.) dysgalactiae, Streptococcus (Str.) aureus etc…

Table 2: Volatile metabolite Content in raw and Mastitis Milk

Sl. No.	**Substance**	**Raw Milk (mg/L)**	**Mastitis Milk (mg/L)**
1	Ethanol	1.7	100
2	Acetic Acid	1.8	95
3	Acetaldehyde	3.2	124

3.2 Interfacing with MSP430:

Connect the sensor output pins to the analog ports of MSP430.Provide the proper power supplies like Vs, GND for the MSP430.Connect the PH meter and temperature sensor to rest of the analog pots of MSP430.Write the code to display all the sensor responses using Energia software. Set the threshold value for the freshness of bread and normal milk in a code to classify bread and milk samples Run the Energia software. Observe these responses on serial monitor and compare it with the voltmeter readings. Store the results in excel sheet for the further analysis.

Table 3: Major pathogens that cause Mastitis and large Volatile metabolite detect in pathogens

Pathogens	**Type Of Mastitis**	**Health Issue**	**VOC**
Escherichia (E.) Coli	Clinical	Diarrhea	Acetic Acid
Streptococcus(Str.) dysgalactiae	Sub-Clinical	Q-Fever	Ethanol
Streptococcus(Str.) aureus	Sub-Clinical	Human Skin	Acetaldehyde

3.3 Steps for classification of milk sample

Write a code of PCA and LDA in mat lab for the sensor readings Plot the PCA graph for different sensor readings of normal milk and mastitis milk. Since LDA is use used for differentiation of two classes, LDA code written in such a way that to classify the sensor responses as normal milk and mastitis milk.

IV. RESULTS AND DISCUSSION

4.1 Sensor response

Natural milk from cow is taken and it is differentiated into 5 samples of volume 100ml each. The prepared samples are subjected to sensor array to note down the sensor output voltage. Successive repetitions of this exercise make the sensor output voltage to constant out of all the samples. Table 5.1 shows the baseline voltage reference for which sensors are conditioned for the period of 15 to 20 days. By taking baseline sensor output voltage reference while doing experimentation need to make sure that once the sensor array subjected to milk samples the again it kept opening air at normal room temperature, in this condition sensor should standardized to baseline voltage as shown in Table 4

Table 4: Base line readings

Base line readings		
TGS2602-Acetaldehyde	**TGS822-Ethanol**	**TGS813-Acetic acid**
0.024	0.042	0.36
0.023	0.041	0.37
0.023	0.041	0.37

Below table5 shows the sensor response for the natural milk. The outputs of sensors are in terms of voltages and in the table the average of 10 repetitions of each sample are listed.

Table 5: sensor response for natural milk

Natural milk sample readings		
TGS2602-Acetaldehyde	**TGS822-Ethanol**	**TGS813-Acetic acid**
0.044	0.058	0.039
0.045	0.062	0.04
0.046	0.061	0.04
0.045	0.059	0.041

Below Figure 2 shows the sensor response for all samples with successive repetitions. The graph is plotted in such a way to get a smooth curve by taking voltage in y-axis and the number of repetitions in x-axis. As mention above table 5 the contents of ethanol and acetic acid is lower than the acetaldehyde, which can see in graph. i.e. TGS822 used to detect ethanol, TGS2602 is use to detect acetaldehyde and TGS813 to acetic acid.

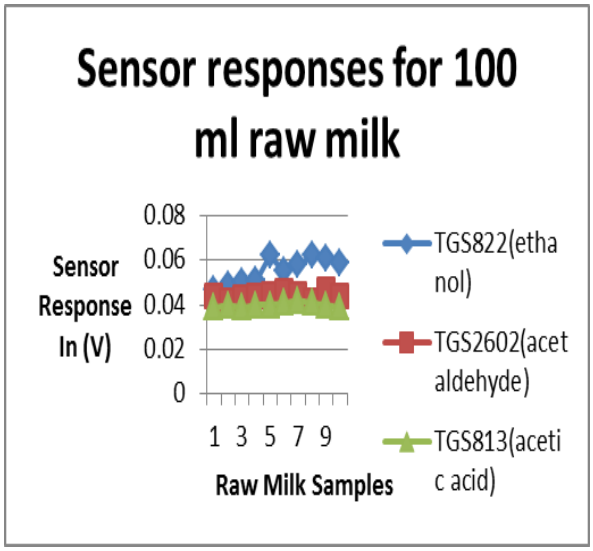

Figure 2: sensor response for natural milk

For the detection of adulterated milk, the threshold value fixed by comparing it with natural milk sensor response and to verify the volume of chemicals inside the milk, specified amount of chemicals added to the milk and sensor response are noted. Once the analysis done the threshold for each sensor is specified according to chemical response.

MSP430 microcontroller interfaced to sensor array gives the VOC's for corresponding chemicals present in milk and bread samples. Once the program is compiled and uploaded serial monitor window will open and the Wi-Fi module will generates the IP address, when this IP address accessed through any of the Browser HTML page regarding testing of Adulterants detection Bread Freshness Detection will open. The generation of IP address by Wi-Fi module interconnected with the MSP430. While this process MSP430 and the system which access the same IP address should connected to a same router which labelled in the program.

Figure 3: Mastitis Detection Testing page

Program for the mastitis detection written in such a way that the clear distinguish between the different pathogens are present and the approximate volume of the chemical present in the milk also displayed in the screen. These testing pages are shown in Figure 3 and Figure4

Figure 4: Detection of Particular Mastitis

According to the above table the threshold values fixed for the identification of mastitis milk samples and the same is dumped to MSP430 microprocessor in order to use it as IOT. Once the results are obtained the data is imposed to PCA and LDA and the classification of sensor response achieved. Below Figure 5 shows the PCA and LDA classification of the natural and mastitis milk sample.

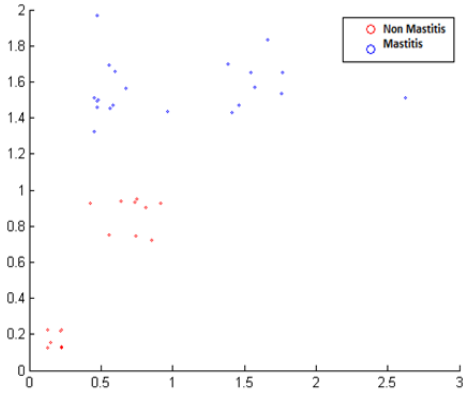

Figure 5: LDA for milk samples

Figure5 shows the Projection of good milk and Mastitis milk with acetaldehyde, acetic acid and ethanol on both Eigen vector (Red and Blue plot) are matches with the values obtained by mathematical calculations. Fig.5 LDA plot showing discrimination of milk samples with various mastitis at various regions. Discrimination of various milk samples cannot possible in this case. It is clear that Linear discrimination analysis can be better analyzed for various samples only for the differentiation of two classes with Eigen values.

V. CONCLUSION

The detection of mastitis using gas sensor done. E-nose system can be used to classify milk samples based on their headspace volatile measurements. Applying PCA and LDA improved the classification results. Thus, it will be possible to evaluate the quality parameters of biological materials in shorter times. It will also enable us to test this system in other disciplines such as waste management, air quality, and etc.

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