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Research paper

Detergent and Soaps Adulteration Detection in the Milk Using Artificial Embedded Sensors

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Abstract

An absolute natural world mammals food is milk and is the only foodstuff that practically consists of almost all the nutrition is known to be necessary for individual personality. This research paper aims to play a good role in the rural source of revenue and livelihood improvement in emergent countries. In an insightful and sustainable way, through assisting the milk provider and consumer factions with harmless reasonably priced milk and dairy foodstuffs. The target of this research paper is to analyze and detection of frauds which are mixing the soapy and detergent materials to the milk for monetary benefits. It will be working on small-scale milk collection. For avoiding adulteration it is aimed to develop an artificial embedded system to discourage farmers and adulterator from adding soaps, detergents and shampoo substances to the milk and the payment scheme should be decided accordingly. An experiment was conducted for pure pasteurized cow milk of 3.5% fat under different temperature conditions on different days. There are 50 experiments with 10 different quantities of adulterants of shampoo, detergents and soaps were conducted. The conducted experimental results were tabulated and analyzed by statistical methods. These experimental results showing that there was no match of conductivity and pH values of the shampoo, detergents adulterated milk with standard pasteurized milk. This mismatch value indicates the presence of adulterants and experimental results show the mixing of detergents leads to the milk pH scale to base range and conductivity may be decreased or increased but never match with the standard pH and conductivity scale. For this reason, it is an efficient and effective method of detection of detergent based adulteration in milk and it is a low-cost design due to low-cost artificial embedded tongue system.

Keywords: *artificial tongue, milk adulteration, milk pH, milk conductivity;*

1. Introduction

Milk is an excellent preference of pale yellow semi-liquid as it not only re-hydrates the body, but offers a mass of essential nutrients and defends from the diseases at the same time. The natural milk has a pH of *approximately 6.5 to 6.7*, which looks like slightly acidic. Lactic acid present in the milk is a proton donor. Screening and verification of milk is an important part towards ensuring the safety of milk made available to consumers [1,2]. Shampoo, soaps, detergents said to be the most used adulterant in the milk [5,6]. Monetary rewards profited from the fractional or complete substitution of additional substances which are comparatively low-priced and readily available is the main encouraging feature behind this fraudulent practice [7,8,9]. These adulterants cause a high risk of health challenges, ranging from allergic reactions, infectious illness and metabolic diseases [10,11]. At present, lactometers [12,13] are using to measure the quality of milk which is sensible for only pure water dilutions more than 15% and is not suitable to detect other adulterants like soaps and detergents. Lactometer is very low cost but it can be inaccurate, influenced by temperature and fat[14,15]. Cryoscope can be used to find the amount of water added in the milk with respect to the freezing point. Milk and water have different freezing points; hence mixed water in milk can be identified by calculating the freezing point of the milk sample. Normally Water has a 0 °C freezing point, and standard milk has around -0.540 °C freezing point, because of dissolved substances. But it is costly equipment; therefore, small-scale diaries cannot be purchased and use it. In this research conductivity and pH based electronic tongues are used[16]. This technique is no doubt an effective taste measuring technique, capable of detecting soap, detergents, shampoo adulterated sample.

2. Materials and Methods

The block diagram of milk an adulterant analyzer and detector is as shown in fig.1. It mainly consists of two electronic tongues and data processing unit. A pH meter is one of the electronic tongues which depends mainly on the charges accumulation on the electrodes which forms the potential difference between two electrodes when they are immersed in a milk test sample.

In this one of the electrode cell is taken as a reference electrode cell which is a glass bulb electrode and is independent of the pH of the milk which is connected to another electrode called measuring electrode cell whose potential difference with respect to reference electrode is proportional to the hydrogen ion concentration (pH) of the milk.

The pH meter is a standard high input impedance voltmeter which is used to measure and display the pH value equivalent to the potential difference produced by the pH electrode cells.

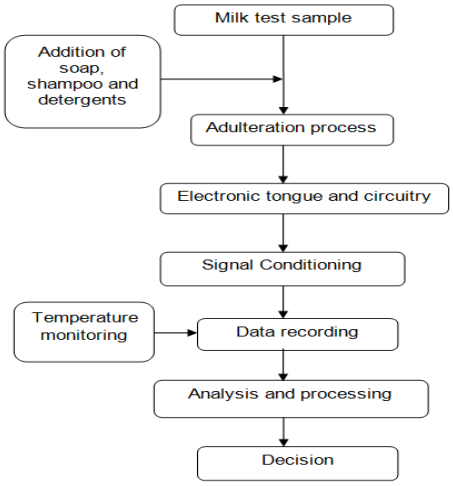

Fig. 1: The flow diagram of detection of Shampoo, detergent, and soap adulteration in milk.

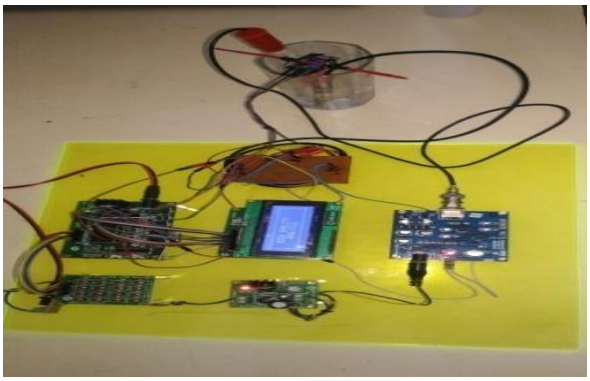

Fig. 2: An Experimental setup and conduction.

A conductivity cell is another type of electronic tongue which is used to measure the specific conductance of the liquid. The measurement begins by first performing the initial corrections of sensors, pH meter, and conductivity meter as follows,

1) The conductivity and pH meter should be placed in a dry environment.
2) If new glass electrodes are to be chosen it has to be soaked in hydrochloric acid around 4 hours before using the electrodes.
3) Care should be taken not to rub glass electrodes against the sides of beakers or other hard surfaces during storage or testing.
4) Make sure the level of saturated chlorides in the calomel electrode before performing pH and conductivity measurements. Then standardize the pH and conductivity meters.
5) First, clean the electrodes with distilled water and dried it smoothly with tissue paper.
6) Set the temperature of the meter using variable pot resistor and then standardize the meter with standard and chemically tested buffer solutions which are formed by standard buffer solution tablets which are commercially available in the market.
7) Distilled water is used to rinse the electrodes and dried it by tissue paper after every test.

The data acquisition consists of sensors, amplifiers, analog multiplexers, PIC16F877A microcontroller and serial interfacing. The voltage and specific conductance outputs from electronic tongues are connected to the operational amplifier and gain the amplifier are selected based on the sensitivity of the sensor. The amplified analog outputs from the sensors are connected to the multiplexer. The analog amplified outputs are converted into digital using standard analog to digital converters. The digital data is processed and analyzed by the microcontroller.

3. Results and Analytical Discussion

Performance Evaluation of Feature Extraction and Preprocessing

The standard pasteurized Nandini milk of 4.1% fat labeled on the milk packet was taken for the conduction experiment. Fig. 1 shows the voltage response obtained by the hydrogen ion concentration electrode cell due to adulteration of milk by soap, shampoo, detergent, and water. The adulterations of shampoo, soap, and detergent are usually based in the pH scale so the presence of these in the milk increases the pH value rapidly and pH value decreases very slowly when adding a water to the detergent adulterated milk.

Fig. 2 shows specific conductance response which is rapidly increasing with the addition of shampoo, soap and detergent substances but the addition of water rapidly decreases the conductivity. All these values are tabulated for further analysis. From these values, the relative response of pH and conductivity electrodes were calculated. The relative responses obtained from these sensors were called features and were used in the analysis to investigate the presence of adulterants.

Repetitive Analysis

Table1: Variation of conductivity and pH due to a mishmash of shampoo and dilutions in milk.

	pH	Conductivity mS	Adulterant Shampoo in milk (ml)	
50ml	6.52	5.0	0	
	6.81	5.4	1	
	7.12	5.8	2	
	7.25	6.1	3	
	7.37	6.6	4	
	7.52	7.0	5	
	7.72	7.6	6	Water (ml) 0
	7.75	6.8		2.5
	7.78	6.0		5
	7.81	5.4		7.5
	7.83	4.6		10
	7.86	3.8		15
	7.89	2.9		20

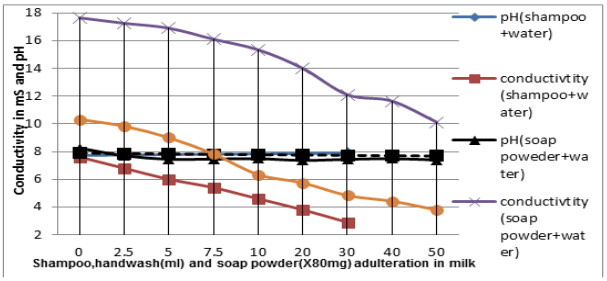

Fig. 3: Variation of conductivity and pH of milk due to the addition of detergents.

The voltage response and conductivity response obtained from repeated measurements on the same sample and different samples. The observation was supported by the correlation coefficient calculated on the feature series for the milk was represented in Table 1, Table 2 and Table 3. From these repetitive analyses, it is concluded that there is a drastic change or lot of variations will happen in the characteristics and properties of the milk due to adulteration materials like shampoo, soap, and detergents.

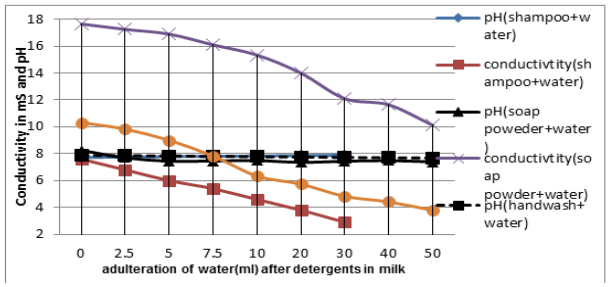

Fig. 4: Variation of pH and conductivity due to adulteration of water after detergents in the milk.

Table2: Variation of conductivity and pH due to a mishmash of detergent and dilutions in milk.

Milk quantity	pH	Conductivity mS	Adulterant Detergent powder in mg	
50ml	6.621	4.9	0	
	6.742	6.8	80	
	6.890	8.6	160	
	6.933	10.5	240	
	7.086	12.3	320	
	7.334	13.4	400	
	7.667	14.5	480	
	7.863	15.4	560	
	8.252	17.65	640	Water (ml) 0
	7.70	17.25		2.5
	7.441	16.9		5
	7.463	16.1		7.5
	7.487	15.34		10
	7.36	14.00		20
	7.442	12.1		30
	7.485	11.64		40
	7.394	10.12		50
	7.41	8.02		70

Table3: Variation of conductivity and pH due to a mishmash of handwash and dilutions in milk.

Milk quantity	pH	Conductivity mS	Adulterant handwash in ml	
50ml	6.62	5.0	0	
	7.16	6.61	1	
	7.36	7.72	2	
	7.59	8.90	3	
	7.80	9.94	4	
	7.89	10.32	5	Water (ml) 0
	7.85	9.83		2.5
	7.84	9.0		5
	7.80	7.83		7.5
	7.78	6.34		10
	7.75	5.74		15
	7.73	4.83		20
	7.70	4.42		25
	7.68	3.79		30

4. Conclusion

This paper has presented the analysis and development of artificial intelligence-based detergents and soapy materials detection in milk. It is observed from the results and analysis the pH and conductivity are rapidly varying with the addition of adulterants like detergents and soapy materials. From tables, it is observed that the pH and conductivity of the adulterated milk never resemble the standard milk pH and conductivity. Normally the pH and conductivity values of the standard milk are 6.5 to 6.8 and 4.8mS to 5.2mS respectively. If pH of the adulterated milk is matched with standard milk pH but the conductivity will never match the standard milk and if the conductivity of the adulterated milk is matched with standard milk conductivity but pH of adulterated will not match with the standard milk pH. The lactometer does not find any detergents and soapy materials are added to the milk. Formation of bubbles in the adulterated milk due to detergent materials gives the incorrect readings. Therefore this research work conducted experimental results have been shown to out-perform other existing analysis processes in terms of cost-effective and accuracy.

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