

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.704.054>

Chromogenic Method for the Instant Detection of Adulterants in Milk

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ABSTRACT

Keywords

Milk Adulteration,
Instant detection,
Chromogenic,
Rapid method

Article Info

Accepted:
07 March 2018
Available Online:
10 April 2018

India is the world's largest country with 164 million tons of milk production in year of 2016-17. As the population increase, the consumption of milk and milk product is also increased. Today India facing major problem in field of dairy sector is adulteration malpractice of milk and milk products. Common milk adulterants like nitrate, sodium chloride, formalin, urea, starch etc. have been mixed with milk for cost cutting purpose. Detection of milk adulterant at entry level is very huge challenge. Traditional instrumental based technique is available to detect the milk adulterant but it is costly and time consuming. In this article we have developed very easy to handle, cheap, very sensitive, portable, accurate, rapid, reliable and it does not require any type of instrument and expert personnel to handle instrument. This technique enables the instant detection of different adulterant from the group of sodium chloride, pond water and formalin. Presence of sodium chloride, pond water and formalin can be confirm by changing color from radish maroon to yellow, white to blue and white to purple respectively. We have developed vial based detection method for the rapid detection of different adulterants in milk sample.

Introduction

India is the world's largest producer and consumer of milk. According to an estimate by Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, Government of India, all India milk production was 164million tons in 2016-17. According to the survey of FSSAI, 68.4 % of milk is found to be adulterated in India. Milk is an important source of nutrient required for growth in infants and children and for maintenance of health in adults. Milk is a perfect food, readily digested and absorbed. It is a sole natural food for infants and children.

It is chiefly a valuable source of good quality protein, fat, carbohydrates, vitamins and minerals. Protein in diet, supply the amino acids required for growth of infants and children. It is also required for maintenance of tissues in adults. Milk contains more than 100 substances that are either in solution suspension or emulsion in water, the important being casein - the major protein of milk, lactose - milk sugar, whey and mineral salts.

From past few years with the increase of living standard of people and advance technology, there is significantly increased in milk and milk product consumption. Though it

is very common in dairy industry to adulterating milk and other dairy product for the cost-cutting purpose or increase the life of dairy product. Addition of such adulterant in milk decrease the nutrient value, its quality and flavor and may also cause harm full effect on human health. Now a day the trend of adulterating the milk and other dairy product is increase day by day in metro cities of India and also in developing countries.

Milk can be adulterated by two way i) Synthetic milk: synthetic milk is prepare by dissolving or mixing the water with sodium chloride, Pond water, formalin etc. to get more income. Synthetic milk doesn't have any potential value instead it has very harm full effect on human health. ii) In second type the milk is adulterated by mixing the natural milk with urea, boric acid, hydrogen peroxide, starch, neutralizer to maintain its viscosity. Sodium chloride is the one of the mostly used adulterant. It used to increase the fat percentage in milk and to maintain the white color of synthetic milk. It may cause the swollen tongue, nausea, diarrhea, abdominal cramps etc.

Pond water is heavier than the normal water. Normally the pond water contain the nitrate in dissolve form which is comes from agriculture fertilizer. Consumption of pond water contaminated milk can cause the methemoglobinemia, or "blue baby" disease in which nitrate react with oxyhemoglobin and then converted into the methemoglobinemia which cannot carry the oxygen. Methemoglobinemia can cause the infant to develop a blue coloration of their mucous membranes and possibly digestive and respiratory problems.

Formalin is about 40% aqueous solution of formaldehyde and has chemical formula HCHO which is potentially hazardous toxic substance. Formalin can provide long term

freshness of milk or it can be used as a milk preservatives. It can also disrupt the optic nerves and may cause the blindness. Long term consumption of milk containing the adulteration of formalin can cause the various health hazardous effects.

Milk is a complex mixture and a liquid food, which can easily be adulterated. Detection of adulteration in milk is huge challenge at the entry level. For the detection of adulterant in milk, sophisticated laboratory and instrument are available but it is costly, time consuming, and it also need an expert personnel to handle the instrument and for analysis too.

So, there is need to develop such a technique for the instant detection of adulteration in milk which is portable, accurate, cheap, rapid and reliable. We have developed very sensitive and vial based technique for the instant detection of different milk adulterants on field level. This vial based technique is very sensitive, portable, accurate, cheap, rapid, reliable and require very small amount of milk sample as well as reagent for the detection purpose. Most important object of these methods is it does not require any type of instrument and expert personnel to handle that instrument. In this article we explore the different method for the instant detection of different milk adulterant.

Materials and Methods

Detection of sodium chloride in milk

Material

All chemical was used as a received. Silver nitrate (AgNO_3) was purchased from Loba Chemie laboratories, Mumbai, India. Potassium chromate was purchased from S.D Fine Chem Pvt. Ltd. Mumbai, India. HPLC grade water was procuring from Hi Media Pvt. Ltd. Mumbai, India.

Reagent preparation

0.339 gm silver nitrate was dissolve in 20 ml of HPLC grade water (AgNO₃ form white precipitation in tap water). Dissolve the 2 gm of potassium chromate in 20 ml of HPLC grade water.

Detection procedure

Keep out the vial containing reagent at room temperature rest it for 2 minutes. Take few ml of adulterated milk in clean vessels add two-three drop of vial containing reagent in milk. Immediately color changes confirm the presence of sodium chloride in milk.

Detection of pond water (nitrate) in Milk

Material

Diphenyle amine was purchased from LobaChemePvt. Ltd. Mumbai. Concentrated H₂SO₄ was procured from Merc Specialties Pvt. Ltd. Mumbai, India.

Reagent preparation

Reagent was prepared by dissolving the 0.4 gm diphenyl amine in 20 ml conc. H₂SO₄.

Detection procedure

Take 2-3 ml of milk sample in sterile vial. Add two-three drop of reagent along the side of vial. Observed the color change. Color change of milk indicate the presence of nitrate in milk. Pure milk will not develop any color.

Detection of formalin in milk

Reagent preparation

Schiff's reagent was procure form LobaChemie Ltd. Mumbai.

Detection procedure

Take 4-5 ml of milk sample in sterile vial. Add few drop of Schiff's reagent in milk containing vial. The color change was observed. The color change of milk confirms the presence of formalin in given sample.

Results and Discussion

There are various methods available for the detection of different milk adulterant in milk. Every developed method having its own demerits. Instant detection of milk adulteration by vial based method is developed in our laboratory. These all the test give positive/negative result within a few second.

Detection of sodium chloride in milk

Presence of sodium chloride in milk sample is confirmed by changing the color (Fig. 1) of milk from radish maroon to yellow indicate the presence of sodium chloride in milk sample. The minimum detection limit of this test is 0.5 %.

Detection of pond water

Sodium and potassium nitrates are oxidizing agents and hence act as preservative. Pond water also contains appreciable quantities of nitrates and such water is usually admixed with milk by rural milk producers or vendors. The presence of pond water (nitrate) in milk sample can be confirmed by changing the color (Fig. 2) of vial containing milk from white to blue indicate the presence of pond water (nitrate) in milk. Minimum detection limit for this test is 0.1%.

Detection of formalin in milk

Presence of formalin can be confirmed by changing the color (Fig. 3) of vial containing milk from white to purple indicates the

presence of formalin in milk sample. Milk being a complete natural food has lot of nutritional as well as economical value.

The major problem in the milk supplied by milkman system in India, from the customer point of view, is its poor quality and dirty adulteration. Several studies has focused on the outdated adulterant detection method in

raw milk, which is consider to be very time consuming, costly, instrumental based and can't be afford by common man. Our innovative technique i.e. vial based is very help full to the common man, apart from this our newly developed technique is very safe to use, non-instrumental based, portable, accurate, cheap, instantaneous and can be used by the common man at home and field level.

Fig.1 Schematic representation for the detection of sodium chloride in milk. Pure milk will not give any color changes while adulterated milk with sodium chloride will give color changes

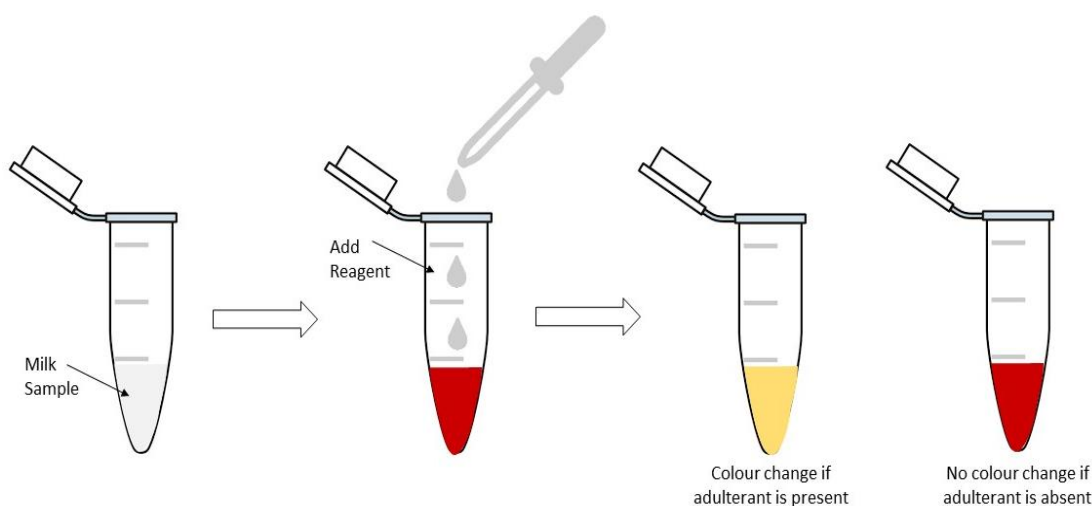


Fig.2 Schematic representation for the detection of Pond water by vial based method. Pure milk will remain white while adulterated with pond water (nitrate) will give color change from white to blue

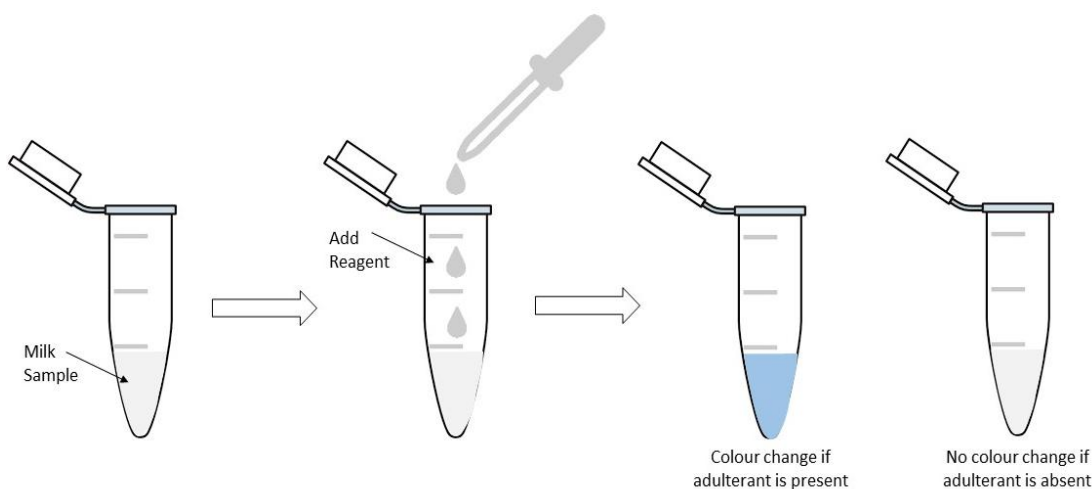
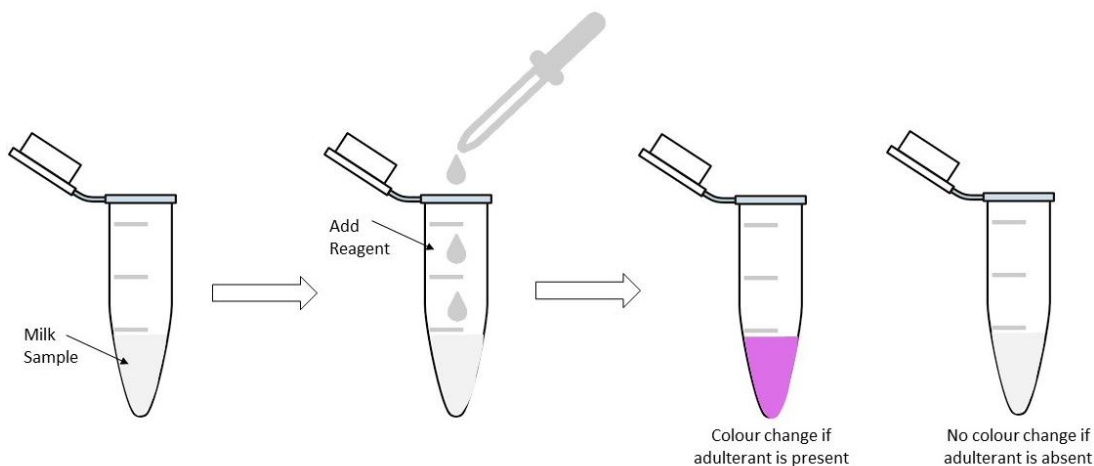


Fig.3 Schematic representation for the detection of formalin by vial based method. Pure milk will turn to pink in color while adulterated with formalin will give color change from white to purple



Sodium chloride containing milk can cause the irritation of the gastrointestinal tract, vomiting, hypernatremia, respiratory distress. Ananya Debnath *et al.*, (2015) have developed traditional chemical based technique for the detection of sodium chloride in milk. Their developed technique was test tube based and is not easy to handle while our modified technique is vial based and easy to handle. Vial based technique is better in cost, durability and portable compare to traditional method.

Pond water also contains appreciable quantities of nitrates and such water is usually admixed with milk by rural milk producers or vendors. Pond water mixing in milk indicates the possible presence of other more serious residential or agricultural contaminants, such as bacteria or pesticides. Mohitkamthania *et al.*, (2014) had developed technique for the detection of pond water in milk. Result of our technique is at par with them and technique is better in handling.

Formalin is a cadaverous chemical. It is flammable, highly reactive with many substances. Formalin is potent carcinogenic

and its elevated dose can cause the diarrhea, vomiting, increased body temperatures, shallow respiration, weak irregular pulse, unconsciousness, blindness and gastrointestinal disturbance. FSSAI (2015) has developed formalin detection test. Our modified technique is at par with the technique described by FSSAI.

From the above result it is conclude that detection of milk adulterant like sodium chloride, pond water and formalin can be done instantly. Above described method i.e. vial based is very effective and useful in such area where there is no milk testing facility is available and it is also very simple to handle. This method can be useful in the interior village and suburban area of India where people don't have any information regarding the milk adulteration. This technique can be used by uneducated people. Vial based detection of different adulterants is very effective and accurate compare to other traditional instrumental based technique, one can used our developed technique at home level. Our developed technique can stop the entry of adulterated milk in milk village cooperatives. In a country such as India where

milk and milk products play an important role in different foodstuffs, this analysis carried out should bring more awareness to the general public about the malpractices or negligence in milk production.

Acknowledgement

We would like to appreciate and acknowledge the financial assistance of Department of Biotechnology, Ministry of Science and Technology, New Delhi, Government of India.

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How to cite this article:

Rakesh B. Kabariya and Vimal M. Ramani. 2018. Chromogenic Method for the Instant Detection of Adulterants in Milk. *Int.J.Curr.Microbiol.App.Sci.* 7(04): 467-472.
doi: <https://doi.org/10.20546/ijcmas.2018.704.054>