Assessment of market milk adulteration in Tiruchirapalli city of Tamil Nadu

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Abstract: A study was conducted to analyze the market milk samples sold in Tiruchirapalli city of Tamil Nadu for the presence of adulterants. A total of 110 milk samples, 10 from the organized brands, 50 from local vendors and 50 from tea and coffee shops were collected. The present study revealed the presence of starch in 02 milk samples (1.82%) and that to from organized brands were detected. Further, the presence of neutralizers, detergents and sodium chloride were found in 36 samples (32.73%), 21 milk samples (19.09%) and 33 milk samples (30%) respectively. The skimmed milk powder was detected in all the ten organized brands. The milk samples obtained from local vendors, tea and coffee shop were negative for skimmed milk powder. The study also revealed the presence of sugar in 45 milk samples (40.91%), hydrogen peroxide in 03 samples (2.73%) and pond water/nitrate in 20 milk samples (18.18%) respectively. In addition, the study revealed that none of the samples collected were found positive for the presence of alizarin, formalin, urea, glucose/dextrose, cellulose, maltodextrin, protein and boric acid.

Keywords: Adulterants, Detection methods, Market milk, Tiruchirapalli city

Introduction

India has emerged as the largest milk producer and consumer in the world with an annual production of more than 187.7 million

tones, giving a per capita availability of 394 gm per day (NDDB, 2019). India's milk production today accounts for 22.3% of the total world output and 40% of the Asia's total production.

Milk in its natural form has high food value. It supplies nutrients like proteins, fat, carbohydrates, vitamins and minerals in moderate amounts in an easily digestible form. Nutritional values and other health benefits have made milk and dairy products to be extensively consumed by large segments of the population during all stages of development and life including childhood, adolescence, pregnancy and the elderly. Adulteration can be defined as the inclusion in foods of constituents whose presence is prohibited by regulation, custom and practice or "making impure by adding inferior, alien or less desirable materials or elements" (Sonal et al. 2013).

The addition of adulterants to food to increase attractiveness and value is often referred to as "economic-adulteration". Milk may be adulterated on purpose and mostly motivated by economic greed, or accidentally during production or processing. The driving force behind most adulteration is to maximize revenues by using (partially) either a cheap ingredient as a substitute for a more expensive one, or (partially) removing the valued component in the hope that the altered product is undetected by the final user. Adulteration is an act of intentionally debasing the quality of food offered for sale either by admixture or substitution of inferior substances or by the removal of some valuable ingredients as per Food and Drug Administration (1995).

In the National Survey on Milk adulteration (2011) conducted by the Food Safety and Standards of Authority of India (FSSAI) to ascertain the quality of milk throughout the country, 68.4% samples were found to be non-conforming to Food Safety and Standards Regulations, 2011. The FSSAI latest report of October 2019 on National Milk Safety and Quality Survey which was conducted during 2018 reveals that milk in India is largely safe, even though quality issue persists. The survey found that less than 10% of milk samples had contaminants coming mainly from feeds and improper farming practices (FSSAI, 2019).

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The proposed study on adulteration of milk will bring about more awareness to the general public about the malpractices or negligence in milk production. Added to that it will establish its importance in formulating future food safety measures thus will address the health concern of the Tiruchirapalli city in particular and the state of Tamil Nadu in general with the following objectives. Collection of milk samples from organized brands, local vendors, tea and coffee shops from different areas in Tiruchirapalli city of Tamil Nadu. The collected milk samples were tested for the presence of different adulterants, viz., alizarin, formalin, urea, starch, neutralizers, detergent, sodium chloride, skim milk powder, sugar, glucose, hydrogen peroxide, cellulose, maltose, ammonium sulphate, protein, boric acid, pond water / nitrate.

Materials and Methods

Collection of milk samples

Tiruchirapalli city is located at the centre of Tamil Nadu, gets most of the milk supply from the surrounding villages, private dairies and cooperative milk union. The city comprise of four zones containing 65 wards. The market milk samples were collected randomly from all the four zones. A total of 110 milk samples, 10 from the organized brands, 50 from local vendors and 50 from tea and coffee shops were collected aseptically and were transported in an icebox at a suitable temperature range (0-4°C) to the laboratory within two hours. The collected milk samples were

analyzed in Veterinary University Training and Research Centre, Tiruchirapalli.

Adul-teration testing using milk kit

The kit for adulteration testing of milk was obtained from Himedia, Mumbai. The kit was designed for the detection of common seventeen milk adulterants in the milk sample (Bhanu et al. 2014). It was available in two parts, the Part A of the kit- K088A consisting of reagents for detection of 11 adulterants namely Alizarin, Formalin, Urea, Starch, Neutralizers, Detergents, Sodium chloride, Skim Milk powder, Sugars, Glucose/Dextrose and Hydrogen Peroxide. The Part B of the kit-K088B consisting of reagents for detection of 6 adulterants namely Cellulose, Maltodextrin / Maltose, Ammonium Sulphate, Proteins, Boric Acid and Pond Water/Nitrate. The kit was utilized for testing 50 samples each and was simple to carryout tests at field level and results could have been obtained rapidly. By observing colour changes we could decide the presence or absence of different adulterants (Table 1 and Fig. 1).

Results and Discussion

The market milk samples collected from organised brands, local vendors, tea and coffee shops from Tiruchirapalli city of Tamil Nadu were analysed for seventeen different adulterants and the results are presented in Table 2

Table 1 Detection of adulterants in market milk

S. No.	Adulterant	Presence	Absence
1.	Alizarin (Acidity and Heat stability)	Acidic-Reddish orange- pH 5.8 Alkaline- Reddish violet- pH 7.8	Normal milk- Red- pH 6.8
2.	Formalin	Purple / Violet colour ring	Brownish yellow coloured ring
3.	Urea	Yellow colour	Off white to slight yellow colour
4.	Starch	Blue colour	Off white to cream colour
5.	Neutralizers (Sodium bicarbonate, Sodium carbonate, Sodium hydroxide and Calcium hydroxide)	Reddish pink	Light orange
6.	Detergents (Washing powder, Shampoo)	Blue Slate Grey (Shampoo)	Grayish blue
7.	Sodium chloride	Yellow	Brick red
8.	Skim milk powder	Bluish	Greenish
9.	Sugar (sucrose)	Brick red	Pale yellow
10.	Glucose / Dextrose	Bluish green	Light green
11.	Hydrogen peroxide	Bluish grey	White to light grey
12.	Cellulose	Moss green	Yellow
13.	Maltodextrin /Maltose	Brown	Golden yellow
14.	Ammonium sulphate	Teal blue (Cons d" 0.5%) Alabaster (Cons > 0.5%)	Wheat colour
15.	Proteins	Pink	Colourless
16.	Boric acid	Reddish orange	Turmeric yellow
17.	Pond water / Nitrate	Pink magneta	White to off white

Fig. 1 Test results of milk samples for urea, starch, neutralizer, detergents, sodium chloride, sugar, cellulose and nitrate

Alizarin (acidity and heat stability)

None of the milk sample was found positive for Alizarin. Acidity is a measure of freshness and bacterial activity in milk. Among 110 milk samples tested, 71 samples had pH in normal range, 36 had acidic side and 03 in alkaline side. Most of the milk samples collected from the local milk vendors, tea and coffee shops showed acidic pH. Lack of refrigeration leads to microbial fermentation of milk sugar might be the reason for higher acidity in these samples.

Formalin

Addition of formalin even at low concentration in milk inhibit proliferation of bacteria and help in keeping quality of milk for longer period (Bansal and Singhal, 1991). None of the milk sample was detected for presence of formalin in present study; indicate the lack of awareness of milk sellers about the use formalin for increasing keeping quality of milk. In contrast, Arora et al. (2004), Sanjeevani et al. (2011) and Abbas et al. (2013) reported the presence of formalin in milk samples at the level of 0.4 %, 12 % and 28.33% in market milk samples tested in Delhi, Nanded town in Maharashtra and Peshawar in Pakistan respectively.

Urea

Urea is usually added to milk to elevate nitrogen content and mimic a high protein concentration. Addition of water in milk leads to disappearance of foamy appearance of milk. Urea is being used to restore the milky appearance. Urea is an end product of nitrogen metabolism and a normal constituent of milk. It is usually found between 180 and 400 ppm and constitutes about 55 % of the non-protein nitrogen compounds (Paradkar et al. 2000). The

cut-off concentration for urea in milk is normally set at 700 ppm (Nikoleli et al. 2010). The presence of urea in milk above this limit could cause severe health problems for humans such as indigestion, acidity, ulcers, etc. (Trivedi et al. 2009). The present study revealed that none of the milk sample was found positive for urea. Abbas et al. (2013) reported that none of the milk sample collected from Peshawar district, Pakistan was positive for urea. In contrast, detection of urea adulteration reported by Nirwal et al. (2013) in different regions of Dehradun in Uttarakhand and Deepti (2014) in Akola city of Maharashtra state.

Starch

Starch is usually added to synthetic milk to improve its appearance, mainly viscosity, to compensate the effect of water adulteration. Starch improves the value of total solids up to the level acceptable by the consumers (El-Loly et al. 2013). Among 110 milk samples tested, two samples (1.82%) were positive for starch. Ahmad (2009) collected three hundred milk samples from three different localities in Sudan and observed for adulteration with starch that 35.5 % of samples were found adulterated with starch. Abbas et al. (2013) detected 26.66 % of milk samples adulterated with starch in Peshawar district, Pakistan. However Islam et al. (2013); Nirwal et al. (2013), El-Loly (2013), Hossain (2013) and Deepti (2014) reported that none of the milk sample was positive for starch.

Neutralizers

Neutralizers are adulterated with milk to mask the acidity and to improve the apparent quality. There were 36 samples (32.73%) out of 110 were found to be positive for neutralizers in the present study. Bhanu et al. (2014) reported presence of neutralizers in 15

Table 2 Incidences of adulteration in market milk sold in Tiruchirappalli city of Tamil Nadu

S. No.	Source of milk sample	Alizarin	Formalin	Urea	Starch	Neutralizer	Detergent	Sodium chloride	Skimmed milk powder	Sugar	Glucose/dextrose	Hydrogen peroxide	Cellulose	Maltodextrin	Ammonium sulphate	Protein	Boric acid	Pond water/nitrate
1	Organized brands n=10	0	0	0	2(20%)	5(50%)	0	0	10(100%)	0	0	3(30%)	0	0	0	0	0	0
2	Local vendors n=50	0	0	0	0	10(20%)	11(22%)	12(24%)	0	22(44%)	0	0	0	0	0	0	0	7(14%)
3	Tea and coffee shops n=50	0	0	0	0	21(42%)	10(20%)	21(42%)	0	23(46%)	0	0	0	0	0	0	0	13(26%)
	Number of positive samples (n=110)	0	0	0	02(1.82%)	36(32.73%)	21(19.09%)	33(30%)	10(9.09%)	45(40.91%)	0	03(2.73%)	0	0	0	0	0	20(18.18%)

% of market milk sold in Chennai. Deepti (2014) reported presence of neutralizers in one out of ten milk samples of different company pouch in Akola city of Maharashtra state.

Detergents

Detergents are either deliberately added to improve the appearance of milk or it may get in to milk due to improper rinsing of milk utensils after detergent wash. Out of 110 milk samples twenty-one (19.09%) was positive for detergent test in this study. As per National Survey on Milk Adulteration 2011, 8.4 % of milk samples collected throughout India was found adulterated with detergent (FSSAI Report, 2011). Similarly, Nirwal et al. (2013) reported positive results for detergent in milk quality analysis in Dehradun. In contrast, Abbas et al. (2013) reported that none of the milk sample tested was positive for detergent in Peshawar district, Pakistan.

Sodium chloride

Sodium chloride or salt are added to milk to mask higher water content. Total of 33 milk samples (30%) out of 110 tested were positive for sodium chloride. Similarly, Arora et al. (2004) observed that in all the collected milk samples from organized and unorganized sector 0.6% samples were positive for sodium chloride detection test. Abbas et al. (2013) reported 16.66 % positive results for sodium chloride test in milk samples collected from Peshawar district, Pakistan. Deepti (2014) reported very high positive results for sodium chloride in five out of ten milk samples tested in Akola city. Nirwal et al. (2013) reported 51% positive samples for sodium chloride in Dehradun.

Skim milk powder

Skim milk powder is added to milk to improve the solid not fat content of milk and/or mask the added water. In present study 10 samples (9.09%) out of 110 were positive for skim milk powder test. As per National Survey on Milk Adulteration 2011, there were 548 milk samples out of 1791 *ie.* 44.69 % positive for skim milk powder adulteration (FSSAI Report, 2011). Similarly, Deepti (2014) reported 20 % positive result for skim milk powder adulteration. Nirwal et al. (2013) reported that 58 % of milk they tested was positive for skim milk powder adulteration. But in true sense, presence of skim milk powder should not be considered as an adulterant as it is produced from milk only.

Sugar

Sugar usually added to improve the solid not fat content of milk and/or to mask the added water. There were 45 milk samples (40.91%) out of 110 collected in this study were found to be positive for added sugar. Abbas et al. (2013) reported 18.33 % sugar adulteration in milk samples collected in Peshawar district, Pakistan. Lateef et al. (2009) reported very high *i.e.* 93.33 % cane sugar adulteration in milk. Deepti (2014) detected 3 milk samples

with sugar out of 10 samples. Nirwal et al. (2013) observed 20 % milk adulteration with sugar during summer, 12 % in rainy and 3 % in winter season.

Glucose / Dextrose

Glucose or Dextrose is added to milk to enhance Solid Not Fat (SNF) portion of milk. The present study revealed that none of the milk sample was found positive for presence of glucose or dextrose. In contrast to this, National Survey on Milk Adulteration (2011) revealed that 477 milk samples out of 1791 were adulterated with glucose (Anonymous, 2011). In an assessment of adulteration in skimmed milk samples of Akola city, out of 8 milk samples there were 3 samples with glucose adulteration (Deepti, 2014). In a milk quality analysis in Dehradun conducted by Nirwal et al. (2013), 80 % of milk samples were found to be adulterated with glucose.

Hydrogen peroxide

To increase the shelf life of raw milk hydrogen peroxide is added. This unethical activity is usually adopted in summer season when the environment temperature is very high, to prevent the spoilage milk during transport (Tipu et al. 2007). The present study revealed that 03 milk samples (2.73%) out of 110 were found to be adulterated with hydrogen peroxide. There were 23.5% pasteurized milk samples and 5.58% raw milk samples found positive for hydrogen peroxide. (Wangala and Wafula, 2007). In contrast, none of the milk sample was found positive for hydrogen peroxide reported by Mishra et al. (1977), Patel (1979), Karpude et al. (1987), Rao et al. (2002), Abbas et al. (2013), Deepti (2014). Reason for the absence of Hydrogen peroxide adulteration may be that it is not easily and cheaply available in the open market.

Cellulose

The present study revealed the absence of cellulose in all the 110 milk samples analyzed. Similarly, Deepti (2014) also reported that, none of the skim milk samples analyzed for adulteration from Akola city was positive for cellulose test. Absence of cellulose in any of the milk samples could be due to unawareness of cellulose among milk vendors.

Maltodextrin / Maltose

Out of 110 milk samples tested, no one was found positive for Maltodextrin / maltose. This was in agreement with Deepti (2014). The reason may be that Maltodextrin / maltose is not available cheaply in the open market.

Ammonium Sulphate

The milk vendors may add ammonium sulphate to milk in order to increase the lactometer reading by maintaining the density of

milk. None of the milk sample in this experiment was adulterated with Ammonium Sulphate.

Proteins

The presence of protein milk samples vary between 3.0 and 4.1 %. The present study revealed that none of the milk sample was deviated from the normal range which in turn ruled out the addition of extraneous protein in the tested milk samples. In contrast, Deepti (2014) reported three skim milk samples were found above normal range of protein and none below the normal range in Akola city of Maharashtra state.

Boric acid

Out of 110 milk samples analyzed, Boric acid was not detected in any of the milk samples in this study. The result was in agreement with that of Nirwal et al. (2013) and Deepti (2014). In contrast, Abbas et al. (2013) reported 11.67 % of milk samples adulterated with Boric acid in Peshawar in Pakistan.

Pond water / Nitrate

Twenty milk samples (18.18%) out of 110 were found positive for pond water / nitrate in this study. This may be due to addition of raw water in milk samples to increase the volume by local vendors, tea and coffee shops. Deepti (2014) reported presence of one sample with pond water / nitrate out of ten samples tested in Akola city of Maharashtra state.

Conclusions

Adulteration is an act of intentionally debasing the quality of food offered for sale either by admixture or substitution of inferior substances or by the removal of some valuable ingredients. The driving force behind most adulteration is to maximize revenues by using (partially) either a cheap ingredient as a substitute for a more expensive one, or (partially) removing the valued component in the hope that the altered product is undetected by the final user. The market milk samples of Tiruchirapalli city in Tamil Nadu were analyzed for the presence of adulterants. The study revealed that nearly 41% of market milk samples were adulterated with any one of the adulterants tested. The adulteration was found to be more in milk samples collected from tea and coffee shops than those from organised brands. The present study on adulteration of market milk will bring about more awareness to the general public about the malpractices or negligence in milk production, processing and distribution to public. Added to that it will establish its importance in formulating future food safety measures which in turn address the health concern of the Tiruchirapalli city in particular and the state of Tamil Nadu in general.

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