STUDIES ON ADULTERATION OF MILK AND ITS PUBLIC HEALTH IMPORTANCE IN HIMACHAL PRADESH

THESIS

By

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Submitted to

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CERTIFICATE – I

This is to certify that the thesis entitled "**Studies on Adulteration of Milk and its Public Health Importance in Himachal Pradesh**" submitted in partial fulfillment of the requirements for the award of the degree of **Master of Veterinary Science** in the discipline of **Veterinary Public Health** of CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur is a bonafide research work carried out by **Tanu Palsra (V-2016-30-025)** daughter of Smt. Bhawna Devi and Shri Gopal Dass under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

Dr. S.K. Khurana
(Major Advisor)

Place: Palampur

Date:

CERTIFICATE – II

This is to certify that the thesis entitled "**Studies on Adulteration of Milk and its Public Health Importance in Himachal Pradesh**" submitted by **Tanu Palsra (V-2016-30-025)** daughter of **Shri Gopal Dass** to the CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur in partial fulfillment of the requirements for the degree of **Master of Veterinary Science** in the discipline of **Veterinary Public Health** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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Place: Palampur _____

Date: *(Tanu Palsra)*

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ABBREVIATIONS USED

ABBREVIATION	MEANING
%	Per cent
ALZ	Alizarin
AMS	Ammonium Sulphate
BA	Boric Acid
C°	Centigrade
CLR	Corrected Lactometer Reading
CLS	Cellulose reagent
DET	Detergent reagent
EMA	Economically Motivated Adulteration
et. al.	Et alia (and others)
etc.	et cetera (other things)
F	Fahrenheit degree
FDA	Food and Drug Administration
Fig.	Figure
FM	Formalin
FSSAI	Food Safety and Standards Authority of India
g	Gram (s)
GIT	Gastro intestinal tract

GL	Glucose
HP	Hydrogen Peroxide
i.e.	id est (that is)
ICMR	Indian Council of Medical Research
MD	Maltodextrin
MDL	Minimum Detection Limit
mins	Minutes
Ml	Milliliter
N	Neutralizer Reagent
NCL	Sodium Chloride
NDDB	National Dairy Development Board
OLR	Observed Lactometer Reading
ppm	Parts per million
PW	Pond Water
SKM	Skim Milk Powder
SNF	Solid not Fat
ST	Starch
TS	Total Solid
U	Urea Reagent
UHT	Ultra-High Temperature

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Abstract

The present study was conducted to assess the milk quality with reference to adulteration and its importance on consumers' health in different areas of Himachal Pradesh. Total 200 raw milk samples were collected directly from consumers. Milk analysis was done firstly to assess the physico-chemical quality attributes and further qualitative analyses of adulterants. The specific gravity of milk samples ranges from 1.010-1.032 with an average value 1.022±0.005. The fat percentage ranges from 1.0-9.2 with an average value 3.5±0.10, SNF ranges from 3.6-12.8 with an average value 7.01±0.10 and Total Solid ranges from 4.6-19.2 with an average value 10.54±0.17. Total 74% milk samples in case of specific gravity, 69.5% samples for fat percentage, 82.5% samples for SNF, and 73.5% milk samples for TS were less than the minimum prescribed standards of FSSAI for specific gravity, fat, SNF, and TS for cow milk in Himachal Pradesh. Further zone-wise determination of physico-chemical parameter of milk samples revealed that there was no significant difference ($p>0.05$) in specific gravity and %SNF content between Zone I and Zone II whereas, there was significant difference ($p<0.05$) of Zone III with Zone I and Zone II. No significant difference was observed between Zone I, Zone II, and Zone III in case of fat% and TS. All these samples were analysed for presence of adulterants by using a standard milk adulteration kit. Tests included were alizarin test, urea test, starch test, salt test, skim milk powder test, glucose test, formalin test, sugar test (sucrose), neutralizers test, detergent test, hydrogen peroxide test, maltose test, ammonium sulphate test, boric acid test, nitrate/ pond water test. Assessment of adulteration depicted that water was the most common adulterant (74%) found in the milk samples followed by salt (18%), alizarin (13.5%), skim milk powder (9.5%), detergent (3%), sucrose (1.5%), glucose (1%), formalin (1%), and neutralizers (1%). Other tests performed were negative in all milk samples. None of the individual sample was found positive for all the synthetic ingredients (urea, detergent or soap, sodium hydroxide, vegetable oil, and salt) required for production of synthetic milk. From survey study it could be concluded that majority of the respondents had low awareness towards disease transmission through milk, government regulations against milk adulteration and proper reporting system. Majority of respondents preferred the method of assessment of adulteration was through visual appearance, taste, touch and they perceived that adulterated milk had no harmful effect on their health.

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Tanu Palsra (Student)

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Head of Department

CHAPTER-1

INTRODUCTION

Milk is considered as the most perfect food for nourishment of mankind. It is of big value in promoting growth and development of children. It is readily digested and absorbed thus is especially important for infants, nursing women, children and elderly people. Milk in its natural form is a unique food for the nourishment of human being from long back as it supplies nutrients like proteins, fat, carbohydrates, vitamins and minerals in moderate amounts in an easily digestible form than any other single food (Neumann et al. 2002). Besides its general need for human health, milk protein supplies those animo acid which are needed for proper growth of adults and infants (Espinosa et al. 1992). India is the largest producer of milk in the world with estimation production of 165.4 million tonnes during 2016-17 (NDDB 2017), with annual growth rate of 6.28% as per capita availability of milk is around 355 grams per day as compared to world average that is 299 grams per day. Despite being the largest producer of milk in the world the act of internationally debasing the quality of milk has emerged as one of the major problems to India's dairy industry. Milk is one of the products which can be adulterated in many ways affecting the quality of further dairy products. Addition of milk with a low value ingredient (watering of milk, addition of whey, etc.) also known as "economic adulteration" has been often practiced (Kumar et al. 1984)

Economically Motivated Adulteration (EMA) is defined as "the fraudulent, intentional substitution or addition of a substance in a product for the purpose of increasing the apparent value of the product or reducing the cost of its production" (FDA 2009). As per FDA, dairy products stand on the second most reported category of adulterated food products among all scholarly records of adulterated foods (Moore et al. 2012). Adulteration may be intentional or unintentional, the former is a wilful act on the part of adulterator who intended to increase the margin of profit. On the other hand, adulteration may be incidental contamination, which is usually due to ignorance or negligence (Kamthania et al. 2014). When consumers buy milk, they have the right to assume that it will be pure and unadulterated. But unfortunately, this is not always the case as there is rapid growth of population, scattered colonisation and urbanisation, milk consumption is increased but not the milk supply (Awan et al. 2014). The

extensive consumption of milk and dairy products makes these food stuffs targets for potential adulteration with financial gains for unscrupulous producers (Nicolaou et al. 2011). Despite the laws governing the quality and sale of milk existing in India for decades, the adulteration of milk has not been checked completely (Nirwal et al. 2013). Adulteration of milk is of great importance for financial and potentially health reasons. Consumers are deceived into consuming a product whose chemical composition is altered and paying for a product of inferior quality. It is equally important for the consumer to know the common adulterants and their effects on health. Milk is produced throughout the year. However, milk production is greatly reduced during summer months due to heat stress and scarcity of fodder (Kandpal et al. 2012). Milk is transported from point of production to cities mainly through middlemen such milk is watered/ skimmed to increase profit. The nature of adulterants generally encountered in milk are addition of water, removal of fat, addition of skim milk powder, reconstituted milk, thickening agents such as starch, flour, glucose, urea, salt, chlorine and preservatives such as neutralizers which usually consists of sodium bicarbonate, sodium hydroxide, calcium hydroxide, formalin and hydrogen peroxide (Varley 1969).

Adulteration of food products specially milk is a major problem and may lead to severe health problems. Here are a few examples of what adulterants can be added to milk in order to maintain its freshness and market value which in turn is harmful to the consumer leaving them clueless of what direct effect these adulterants have on them. Water is an adulterant in milk which is often added to increase the volume of milk which in turn decreases the nutritive value of milk which if contaminated poses a health risk especially to infants and children (CSE 2006). Detergents cause gastro–intestinal complications. Urea is added to milk to provide whiteness, increase the consistency of milk and for leveling the contents of solid-not-fat (SNF) as are present in natural milk. The presence of urea in milk overburdens the kidneys as they have to filter out more urea content from the body (Kandpal et al. 2012). Gastrointestinal problems like gastric ulcer, colon ulcer, diarrhea, and electrolytes disturbance may be caused by carbonates in milk (Beall and Scofield 1995). Weakening, sensory disturbances and loss of acquired speech may be developed by presence of ammonia in milk. Blood pH and acid base balance in the body may be disturbed by the presence of chlorides in milk (Hu and Murphy 2004). Damages of liver and lung tissues and increasing of total oxidant capacity by formalin was stated by Aydin et al. (2015). Hydrogen Peroxide is also added to milk to prolong its

freshness, but peroxides damage the gastro intestinal cells which can lead to gastritis and inflammation of the intestine (Singuluri and Sukumaran 2014). High amount of starch addition in milk may cause diarrhea due to the effects of undigested starch in colon. Its accumulation in body may prove fatal for the diabetic patients (Afzal et al. 2011). Salts in adulterated milk can cause critical illnesses like heart disease, problems of kidney, raised blood pressure, gastro-intestinal disturbance and allergies in human being (Kharat and Arak 2013).

According to National Survey on Milk Adulteration conducted by FSSAI (India) in 2011, water was the most common adulterant followed by detergent in milk. A survey by FSSAI in 2012, 68% milk samples was found to be adulterated in which 31 % were from rural areas. Of these 16.7 % were packet or branded milk and rest were loose milk samples from dairies. In the urban areas, 68.9 % milk was found to be adulterated with water, detergent, urea and skim milk powder. Adulteration of milk is one of the challenging problem that the dairy sector of India is facing now days, which not only causing major economic losses for the dairy industries but is health threatening for consumers.

The honourable high courts and supreme court of India have taken very tough stands on milk adulterations due to rampant prevalent practices of adulteration in most of the states. Himachal Pradesh is not exceptional to this according to recent reports of government authority. In FSSAI survey in 2011, 59% samples from Himachal Pradesh were found to be non-conforming to food safety and standards regulations. Despite the strict laws and regulations, the sale of adulterated milk has not been checked completely. Further, scanty research data about the milk quality in Himachal Pradesh leads to design the present study to assess the milk quality with reference to adulteration and its significance on consumers' health with following objectives.

Objectives of the Investigation

1. To assess the quality of market milk from various places in Himachal Pradesh.
2. To find out the public health importance of adulterated milk.

CHAPTER-2

REVIEW OF LITERATURE

2.1 Milk Adulteration in General

Milk is defined as the whole, fresh, clean, lacteal secretion obtained by complete milking of one or more healthy animals excluding that obtained within fifteen days before or five days after calving or such periods as may be necessary to render milk practically colostrum free and containing the minimum prescribed percentage of milk fat and solids not fat so as to confirm legal standards or other requirements (FSSAI 2006).

Milk is the heterogeneous product and an almost complete and well-balanced food for the newly born infant (Abdelfatah 2015; Jafarpour 1970). It is a necessary item of daily diet (Farkye 2003; Javaid et al. 2009). It contains abundant nutrient such as protein, fat, carbohydrate, vitamin and minerals so considered as ideal food for both infants and adults. Unfortunately, milk is being very easily adulterated throughout the world (Azad and Ahmed 2016).

Historical evidence indicates that the nations which used to obtain highest calories from milk and milk products were more civilized and capable of having sound administration and such societies enjoy almost complete freedom from nutritional disease. In contrast, the poorly or underdeveloped areas of the world have a primitive or non-existent milk supply and have numerous inhabitants suffering from nutritional deficiency, especially infants and children (Hoppe et al. 2006)

Developing countries are at higher risk due to lack of monitoring and policies (Reddy et al. 2017). Adulteration of milk is one of the most serious issues that the dairy sector of India is facing today, which not only causes major economic losses for the processing industry, but also a major health risk for the consumers.

Milk 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 (FDA 1995). Adulteration is practiced either to substitute cheaper ingredients or to

impress the buyer to think the product is more valuable or of better quality (Kandpal et al. 2012). Adulteration of milk depends on the associated factors i.e. demand and supply gap, perishable nature of milk, spoiled socio-economic structure, degraded moral of society, unorganised condition of dairy industry, low purchasing power of customer, lack of strict and effective regulatory system and lack of suitable, rapid and sure tests (Srivastava 2010; Kamthania et al. 2014). To face this shortage of milk supply i.e. to meet demand of milk and to keep milk temporarily fresh, some of the milk suppliers usually adopt adulterating practices to prevent the financial losses due to spoilage of milk during its transportation sale (Naz 2000).

Suppliers of milk appear to have found three ways to increase their margin from the sale of milk: (i) dilution (ii) extraction of valuable components i.e., milk fat removed as cream and (iii) a combination of (i) and (ii) with the addition of cheap (and sometimes potentially harmful) bulking additives, such as low-quality flour, to bring the total solids to a level which is acceptable to consumers. Some of the adulterants and malpractices results in public health concern and malnutrition (Faraz et al. 2013).

Milk adulteration is done either by dilution of milk by water or by addition of synthetic milk. Synthetic milk is produced by blending urea, cooking oil, detergent, caustic soda, sugar, salt and skimmed milk powder in order to make more profit (Bansal and Bansal 1997). It does not contain natural milk and hence it is devoid of essential nutrients. Further natural milk is adulterated by diluting with water and addition of substances such as urea, fat, sugar, neutralizers, salt, hydrogen peroxide etc. to maintain desired viscosity and specific gravity of milk (Varley 1969).

2.2 Physico-chemical Properties of milk

2.2.1 Fat

Shojaei and Yadollahi (2008) analysed raw, pasteurized and UHT milk samples from milk shops of Shahrekord, Iran, and reported that the fat content was 2.6%, 2% and 2.8% for raw, pasteurized and UHT milk respectively.

Javaid et al. (2009) analysed milk samples from direct seller, milk collection center, milk vendor shop, hotel and dairy farm respectively, and reported fat values of 5.2%, 5.41%, 5.13%, 5.54% and 6.51%.

Mansour et al. (2012) analysed 260 raw bulk milk samples from Assiut Governorate, Egypt and reported that the fat percentage of cow and buffalo milks were 3.6% and 6.2 % from dairy farms, 2.8% and 5% from dairy shops and 2.6% and 4.5% from street vendor milk.

Khalid et al. (2013) reported that the fat percentage in the milk samples from urban, peri urban and rural areas in and around Faisalabad were 4.83%, 3.88% and 3.53% respectively.

Awan et al. (2014) tested tetra pack milk samples from local markets in Multan city and reported that fat percentage ranged from 2 to 3.2%. Soomro et al. (2014) reported the fat content of 7.3%, 4.88%, 3.34% and 3.18% in the milk samples of milk producers, milk vendors, dairy shops and milk collectors respectively.

Bendale et al. (2015) analysed branded pouch cow milk samples sold in Thane city and reported that the fat content ranged between 1.4 to 3.9%.

Indumathi and Obula Reddy (2015) reported that the fat percentage was 3.42%, 3.24%, 3.18% and 3.18% in samples from milk producers, milk collectors, milk vendors and retails shops respectively.

Ramya et al. (2016) reported that fat content was 6.25%, 5.54%, 5.37% and 4.91% in milk samples collected from dairy farms, chilling centres, dairy shops and street vendors respectively in and around Proddatur, Andhra Pradesh.

2.2.2 SNF

Shojaei and Yadollahi (2008) tested raw, pasteurized and UHT milk samples from milk shops of Shahrekord, and reported that the SNF contents was 7.71%, 7.5% and 8.3% for Raw, Pasteurized and UHT milk respectively.

Javaid et al. (2009) reported SNF contents were 8.25%, 8.81%, 8.06%, 8.51% and 9.79% in the milk samples from direct seller, milk collection center, milk vendor shop, hotel and dairy farm samples respectively.

Mansour et al. (2012) tested 260 raw bulk milk samples from Assiut Governorate, Egypt and reported that the SNF% of cow milk was 8.8 from dairy farms, 7.5% dairy shops and 6.9% street vendors milk.

Khalid et al. (2013) reported that the SNF percentage in the milk samples from urban, peri urban and rural areas in and around Faisalabad were 9.78%, 8.62% and 7.79% respectively.

Soomro et al. (2014) reported the SNF content of 9.09%, 7.65%, 7.17% and 7.79% in the milk samples of milk producers, milk vendors, dairy shops and milk collectors respectively.

Bendale et al. (2015) tested branded pouch cow milk samples sold in Thane city and reported that the SNF contents of 6.13 to 8.88 % where in water adulteration was clearly indicated.

Indumathi and Obula Reddy (2015) reported that the SNF percentage was 8.19%, 7.62%, 7.23% and 7.31% in samples from milk producers, milk collectors, milk vendors and retails shops respectively.

Ramya et al. (2016) reported that the SNF content was 10.3%, 9.1%, 8.8% and 8.6 % in milk samples collected from dairy farms, chilling centres, dairy shops and street vendors respectively in and around Proddatur, Andhra Pradesh.

2.2.3 Specific Gravity

Shojaei and Yadollahi (2008) analysed raw, pasteurized and UHT milk samples from milk shops of Shahrekord, and reported that the specific gravity was 1.030, 1.033 and 1.029 for raw, pasteurized and UHT milk respectively.

Lateef et al. (2009) have shown that the value was 1.02+0.01 for milk marketed at the canteens of various hospitals located in the city of Faisalabad, Pakistan.

Mansour et al. (2012) analysed 260 raw bulk milk samples from Assiut Governorate, Egypt and reported that the specific gravity of cow milk was 1.032 from dairy farms, 1.027 from dairy shops and 1.024 from street vendors milk respectively.

Faraz et al. (2013) analysed 50 milk samples from the canteens of educational institutes and public places located in Faisalabad and reported that the average specific gravity was 1.01, which was lower than that of normal specific gravity.

Neeta et al. (2014) reported that the specific gravity of milk samples collected from 250 households in Belgaum District was 1.026, which was less than the specifications. Awan et al. (2014) analysed tetra pack milk samples from local markets in Multan city and reported that the specific gravity values ranged from 1.382 to 1.389, which were higher than normal values.

Indumathi and Obula Reddy (2015) reported that the specific gravity was 1.023, and 1.012 in samples from milk producers and milk collectors respectively.

Bari et al. (2015) analysed 30 milk samples collected from five different bazaars Tangail town, Santosh Bazaar, Porabari Bazaar, Boilla Bazaar, Bajitpur Bazaar) of Tangail district of Bangladesh reported that mean specific gravity was 1.021, 1.020, 1.019, 1.019 and 1.020 respectively.

Ramya et al. (2016) reported that the specific gravity was 1.031, 1.031, 1.031 and 1.027 in milk samples collected from dairy farms, chilling centres, dairy shops and street vendors respectively in and around Proddatur, Andhra Pradesh.

2.3 Adulteration of milk

2.3.1 Water

Water is most common adulterant added in the milk for economic purpose when water is added to milk it decreases nutritional value of milk and compensates for density. According to National Survey on Milk Adulteration conducted by FSSAI (India) in 2011, water is the most common adulterant followed by detergent in milk.

Water is used as adulterant in milk, due to the convenience of its mixing to increase the volume and also to neutralize the developed acidity of fluid milk for prolonged shelf life. 100% of raw milk samples collected from different points of Barisal district of Bangladesh were adulterated with water (Chanda et al. 2012).

Adam (2009) reported that more than 95% of the total examined random samples in Sudan were adulterated with water.

Kandpal et al. (2012) estimated the quality of raw milk using milk adulteration testing kit at HIHT, Dehradun and reported that 80% of milk samples were adulterated with water.

Faraz et al. (2013) investigated non-processed milk samples and found that 97% and 93% of samples collected from educational institutes and public places were adulterated with water.

Shaikh et al. (2013b) examined market milk samples from different sale points of Hyderabad city, Tandojam, Pakistan and its surrounding areas and reported that 100 % samples

were adulterated with extraneous water compared to whole buffalo milk from dairy farm taken as control.

Barham et al. (2014) reported the various adulterants in the market milk sold in central zone of Sindh province a total of 300 milk samples were collected. Among all 300 milk samples water (79.3%) was common adulterant found in majority of milk.

Soomro et al. (2014) reported that 80% milk samples from milk producers, 75% from milk collectors, 95% from milk vendors and 100% from dairy shops were adulterated with water and the level of water added was 5.55, 3.70, 5.55 and 6.94% respectively.

Indumathi and Obula Reddy (2015) observed highest percent of milk samples adulterated with water (14.88%) from milk vendors, followed by 14.01% from retail shops, 10.36% from milk collectors and least 3.58% from milk producers.

Debnath et al. (2015) tested milk samples from Kolkata and its sub urban areas and reported that 64.52% and 47.06% of fresh milk and pasteurized milk respectively were adulterated with varied percent of water.

Swathi et al. (2015) examined 50 milk samples from local vendors in and around Greater Hyderabad Municipal Corporation, Telangana state and reported that 100% of samples were adulterated with water.

2.3.2 Alizarine test

Swetha et al. (2014) examined 92 pasteurized milk samples in and around Tirupati to detect the quality of milk by conducting alizarine test and reported that 61.96, 28.26 and 9.78% of samples were normal, alkaline and acidic in nature respectively.

Singh et al. (2015) examined milk samples procured from Delhi and reported that samples showed varying degree of alkalinity.

Geeta et al. (2015) collected samples from Secunderabad city and reported that 60% of the samples were of poor quality based on alizarine test.

2.3.3 Synthetic milk constituents

Synthetic milk is an excellent imitation of natural milk. Milk fat is mimicked by vegetable oil, the nitrogen component in milk is mimicked by urea, and detergents are added to

make it frothy. Synthetic milk is prepared by mixing urea, caustic soda, refined oil and common detergents (Bhatt et al. 2008). Urea is added to milk to provide whiteness, increase the consistency of milk and for levelling the contents of Solid-Not-Fat (SNF) as are present in the natural milk (Kandpal et al. 2012). Detergents are added to emulsify and dissolve the oil in water giving the frothy solution, and the characteristic white colour. Caustic soda is added as neutralizer (Kandpal et al. 2012).

Kandpal et al. (2012) examined 60 milk samples from Deharadun and reported that all (100%) the milk samples including double toned milk showed presence of detergents and urea irrespective of the source of milk.

FSSAI (2012) report revealed that 60 % and 44% milk samples were positive for urea and detergents respectively. Faraz et al. (2013) examined milk samples collected from canteens of educational institutes and public places and reported that 63% and 87% samples were positive for urea and no sample was positive for detergent and oil.

Nirwal et al. (2013) reported that 35% of raw milk samples collected from different regions of Dehradun were positive for urea.

Swetha et al. (2014) examined 92 pasteurized milk samples in and around Tirupati and reported that 1.08% and 14.13% samples were positive for urea and detergent.

Vegetable fat was detected in 10.7% of samples from Central Zone of Sindh, Pakistan, (Barham et al. 2014c) and 10% of samples from Mirpurkhas, (Barham et al. 2014b) areas of Pakistan.

Ayza and Yilma (2014) tested fresh whole or raw milk samples from Boditti town and its surroundings of South Ethiopia and reported that fat was removed from 30% of the samples and 80.8% of these milk samples were positive for vegetable oil.

An incidence of 10, 0 and 6% of samples from Mirpurkhas, Pakistan (Barham et al. 2014b), 10.7, 30.3 and 8.3% samples from central Zone of Sindh (Barham et al. 2014c) and 15, 41 and 13% samples from Hyderabad, (Barham et al. 2014a) from Pakistan were reported positive for soap, detergents and ammonium sulphate.

Singuluri and Sukumaran (2014) examined 50 milk samples in and around Hyderabad city, India and reported that 60% and 44% of samples were positive for urea and detergents respectively.

Debnath et al. (2015) reported that vanaspathi was found in 83.87% of fresh milk samples, whereas none of the pasteurized milk samples were positive for vanaspathi.

Bendale et al. (2015) tested branded pouch cow milk samples sold in Thane city and reported that all the samples were negative for urea adulteration. The incidence of detergents in raw milk samples from Coastal area of Sindh, Pakistan was 25% (Barham et al. 2015).

Makadiya and Pandey (2015) analysed buffalo milk samples collected from in and around Gandhinagar, Gujarat and reported that 96% and 100% of samples were positive for ammonium sulphate and urea respectively and no sample was positive for anionic detergent.

Indumathi and Obula Reddy (2015) reported that urea was found in 4% samples from milk collectors and milk vendors and 8% from retail shops, whereas none of the samples were positive from milk producers. They also reported that detergent was found in 4, 4, 8 and 24% of the samples from milk producers, milk collectors, milk vendors and retail shops respectively.

Ramya et al. (2015) examined 50 milk samples in and around Proddatur of Andhra Pradesh and reported 10% and 24% of samples were positive for detergents and urea respectively.

Swathi et al. (2015) examined milk samples from local vendors in and around Greater Hyderabad Municipal Corporation and reported that 10% of samples were positive for detergents.

2.3.4 Preservatives

To increase the shelf life of liquid milk, preservative like formalin and hydrogen peroxide are added unscrupulously to milk which may prove hazardous to human health. At ambient temperature the mesophilic microflora of milk grows and multiplies at faster rate increasing the titratable acidity. Higher acidity milk cannot withstand heat treatment and graded as substandard quality. To counter this the affluent people will add preservatives, which will inhibit the microbial growth and increase the shelf life of milk and avoid financial loses with added advantage for transportation to distant areas (Sinha 2012).

As per FSSAI milk should not contain any added preservative and such milk cannot be sold in the market (FSSAI 2006). A positive relationship between day temperature and intensity of using chemicals as preservatives is normally observed, as high temperature increases multiplication of microbes and increase the acidity and making the milk unacceptable, there by the middle men prefer to add preservatives to counter this effect (Chanda et al. 2012).

Lateef et al. (2009) and Khan et al. (1999) examined milk samples supplied to canteens of various hospitals in Faisalabad city, Pakistan and reported that most of the milk samples studied in Pakistan were positive for formalin and benzoic acid.

Kandpal et al. (2012) examined 60 milk samples from Dehradun and reported that all the milk samples from different sources were negative for preservatives like hydrogen peroxide and sodium chloride.

Mansour et al. (2012) reported that 3.3% of milk samples from dairy farms were positive for formalin and hydrogen peroxide. Milk from dairy shops revealed 3.3%, 5% and 12.5% positive for hydrogen peroxide, boric acid and carbonates respectively, whereas 5 and 10 % milk samples from street vendors were positive for boric acid and carbonates.

Chanda et al. (2012) examined milk samples from Karapure and Shaestabad of Barishal district, Bangladesh and reported that 10% of samples are positive for formalin and all the samples are negative for hydrogen peroxide.

Faraz et al. (2013) examined milk samples collected from canteens of educational institutes and public places in Faisalabad and reported that 23% and 27% samples respectively were adulterated with formalin and 3% milk samples collected from canteens of public places were adulterated with hydrogen peroxide.

Shaikh et al. (2013a) reported that Hydrogen Peroxide was detected in 40% of milk samples collected from Hyderabad city, Pakistan and only 10% of milk samples of peripheral surrounding areas of Hyderabad city and in another study, they found that 75 and 65% of milk samples in city and from outskirts of Hyderabad respectively were positive for formalin, whereas boric acid was not found in the milk samples from both the areas.

Awan et al. (2014) examined milk samples from Multan, Pakistan and reported that all UHT treated milk samples were positive for formalin and benzoic acid and negative for salicylic acid and boric acid.

Nirwal et al. (2013) reported that 51% of raw milk samples collected from different regions of Dehradun were positive for salts and all the samples were negative for formalin, salicylic acid and boric acid.

An incidence of 15%, 20%, 4%, 4% and 19% of samples from Hyderabad, (Barham et al. 2014a), 12%, 14%, 8.3%, 1.3% and 14% of samples from Central Zone of Sindh, (Barham et al. 2014c) and 13%, 11%, 8%, 0 and 0 from Mirpurkhas, (Barham et al. 2014b) from Pakistan were positive for hydrogen peroxide, formalin, boric acid, salicylic acid and sodium chloride respectively.

Singuluri and Sukumaran (2014) conducted survey of 50 raw cow milk samples and found that 16 samples (32%) were contaminated hydrogen peroxide and formalin.

Swetha et al. (2014) examined 92 pasteurized milk samples in and around Tirupati and reported that 3.3% and 2.2% of samples were positive for hydrogen peroxide and formalin respectively.

Debnath et al. (2015) examined raw milk samples in Kolkata and reported that all samples were negative for formaldehyde and salicylic acid.

Indumathi and Obula Reddy (2015) reported that all the milk samples collected from Chittoor district, Andhra Pradesh were negative for hydrogen peroxide and formaldehyde.

Makadiya and Pandey (2015) analysed buffalo milk samples collected from in and around of Gandhinagar, Gujarat and reported that none of the samples was positive for hydrogen peroxide, boric acid, formalin and salicylic acid.

Ramya et al. (2015) examined 50 milk samples in and around Proddatur, Andhra Pradesh and reported that 26% and 12% of samples were adulterated with hydrogen peroxide and formalin respectively.

Razzagh et al. (2015) examined raw milk samples of East Azerbaijan province, Iran and reported that all the samples were negative for hydrogen peroxide and formalin.

2.3.5 Neutralizers and Salts

Neutralizers are added to milk to reduce the acidity. If the time between milking and receiving to the consumer elapses long time, naturally the acidity is increased due to microbial actions and make the milk unsuitable for processing. Neutralizers such as carbonates, bicarbonates and various alkalis are generally used to mask the pH and acidity values of badly preserved milk passing it off as fresh milk (Faraz et al. 2013).

Kandpal et al. (2012) examined 60 milk samples from Deharadun and reported that all the milk samples from different sources were negative for neutralizers.

Chanda et al. (2012) examined milk samples from Karapure and Shaestabad of Barishal district, Bangladesh and reported that 20% of milk samples are positive for sodium bicarbonate.

Awan et al. (2014) examined milk samples from Multan, Pakistan and reported that all UHT treated milk samples were positive for alkalinity, that indirectly reflects addition of neutralizers.

Swetha et al. (2014) examined 92 pasteurized milk samples in and around Tirupati and reported that 28.26 and 8.7% of samples were positive for salt and neutralizers respectively.

Singuluri and Sukumaran (2014) conducted survey of 50 raw cow milk samples and found that 13 samples (26%) and 41 samples (82%) were contaminated with neutralizers and salt respectively.

An incidence of 11% milk samples positive for caustic soda from Hyderabad, (Barham et al. 2014a), 14% from Central Zone of Sindh, (Barham et al. 2014c) and 18% from Coastal area of Sindh, Pakistan (Barham et al. 2015) were reported.

Singh et al. (2015) examined milk samples procured from Delhi and reported that 73.3% samples were adulterated with neutralizers.

Bendale et al. (2015) tested branded pouch cow milk samples sold in Thane city and reported that 4 (36.3%) samples out of 11 samples were found to be positive for neutralizers and no sample was positive for salt and nitrates.

Indumathi and Obula Reddy (2015) reported that 20% and 12% milk samples collected from in and around Chittoor, Andhra Pradesh, collected from retail shops and milk vendors

were positive for neutralizers, sodium chloride was found in 28%, 16% and 12% of milk samples collected from retail shops, milk vendors, milk collectors, whereas samples from milk producers were negative.

Barham et al. (2015) examined milk samples from Coastal area of Sindh, Pakistan and reported that 17% of samples were adulterated with salt. Addition of salt in 8% samples in summer, 4% in rainy and 3% in winter season was reported by Wadekar et al. (2001).

Ramya et al. (2015) examined 50 milk samples in and around Proddatur, Andhra Pradesh and reported that 6% and 54% of samples were positive for neutralizers and sodium chloride respectively.

Razzagh et al. (2015) examined raw milk samples of East Azerbaijan province, Iran and reported that 11.6% and 10% of samples were positive for carbonate and salt respectively.

Makadiya and Pandey (2015) analysed buffalo milk samples collected from in and around of Gandhinagar, Gujarat and reported that 14 (46.66%) samples out of 30 were positive for sodium chloride and none of the sample was positive for nitrates and chlorates.

2.3.6 Thickening agents

Viscosity of milk can be changed by skimming or addition of water. Thickening agents like starch, sugar, skim milk powder etc. are added to the milk to mask water adulteration in milk and increase solids content and viscosity. Sugar is added to increase specific gravity, viscosity and also increases the sweetness of milk, which was decreased due to water adulteration (Faraz et al. 2013; Lateef et al. 2009).

Wadekar et al. (2011) reported that 20%, 12% and 3% of the milk samples from Latur, Maharashtra were adulterated with sugar in summer, rainy and winter seasons respectively.

Chanda et al. (2012) examined milk samples from Karapure and Shaestabad of Barishal district, Bangladesh and reported that 26%, 14% and 12% of milk samples were positive for cane sugar, powdered milk and starch respectively.

FSSAI (2012) report revealed that 44.7% milk samples collected from various parts of the country were positive for skimmed milk powder, whereas 38.9% samples were positive for glucose.

Nirwal et al. (2013) examined milk samples from Dehradun for the presence of adulterants and reported that 80% and 58% of the samples were positive for glucose and skim milk powder and none of the samples were positive for starch.

Shaikh et al. (2013a) examined milk samples collected from Hyderabad city, of Pakistan and its surroundings areas and reported that starch was detected in 30% milk samples from city and 15% of the samples for surrounding areas, whereas 60 and 45% samples adulterated with cane sugar from city and surrounding areas respectively.

Faraz et al. (2013) examined milk samples collected in Faisalabad and reported that 87% and 97% samples from educational institutes and public places respectively were adulterated with cane sugar.

Awan et al. (2014) examined milk samples from Multan, Pakistan and reported that all UHT treated milk samples were positive for cane sugar and glucose and negative for skim milk powder.

Barham et al. (2014a) examined milk samples from Hyderabad Pakistan and reported that 19, 27, 31, 10, 3, 9, 24% of milk samples were positive for skim milk powder, starch, cane sugar, glucose, sorbitol, arrow root and rice flour respectively.

Singuluri and Sukumaran (2014) examined 50 milk samples from Hyderabad city and reported that 22% and 80% of samples were adulterated with sucrose and skim milk powder respectively and none of the samples were positive for starch and glucose.

Swetha et al. (2014) examined 92 pasteurized milk samples in and around Tirupati and reported that 18.48% and 1.09% of samples were positive for skim milk powder and glucose respectively, whereas none of the sample was positive for starch and sucrose.

Debnath et al. (2015) analysed raw milk samples from Kolkata for adulterants and reported that 29.03%, 45.16% and 19.35% samples were positive for starch, skim milk powder and cane sugar respectively. All the pasteurized milk samples were negative for starch and glucose, but 52.94, 41.18 and 64.7% samples were positive for cane sugar, ammonium sulphate and skim milk powder respectively.

Bendale et al. (2015) tested branded pouch cow milk samples sold in Thane city and reported that all the samples were negative for starch, glucose and sugar. Razzagh et al. (2015)

examined raw milk samples of East Azerbaijan province, Iran and reported that 5% of samples were adulterated with whey.

Geeta et al. (2015) examined milk samples from Secunderabad city and reported that 4.5%, 46.6%, 20%, 33.3% and 33.3% of samples were adulterated with starch, sugar, glucose, skim milk powder, and maltose respectively.

Barham et al. (2015) examined milk samples from Coastal area of Sindh, Pakistan and reported that 14% and 22% of samples were adulterated with cane sugar and rice flour respectively.

Indumathi and Obula Reddy (2015) reported that starch was found in 12 % and 16% milk samples collected from milk vendors and retail shops respectively. They also reported that 16%, 24% and 20% samples from milk collectors, vendors and dairy shops were positive for skim milk powder. Adulteration of sugar in milk was highest (24 %) with retail shops followed by 20% from milk vendors, 16% from milk collectors and least 8% from milk producers.

Makadiya and Pandey (2015) analysed buffalo milk samples collected from in and around of Gandhinagar Gujarat and reported that 30% and 50% of samples were adulterated with glucose and sucrose respectively.

Ramya et al. (2015) examined 50 milk samples in and around Proddatur, Andhra Pradesh and reported that 8%, 10%, 40% and 2% of samples were adulterated with starch, glucose, sucrose and skim milk powder respectively.

Swathi et al. (2015) examined milk samples from local vendors in and around greater Hyderabad Municipal Corporation and reported that 60% of samples were positive for starch.

Singh et al. (2015) examined milk samples procured from Delhi and reported that all the samples tested were negative for glucose and starch, whereas cane sugar (Sucrose) and maltose were present in all the collected samples and also reported that 10% samples were adulterated with skimmed milk powder.

2.4 Public Health Significance

Adulteration of food products specially milk is a major problem and may lead to severe health problems. Adulteration of milk with water, preservatives, thickening agents, neutralizers,

synthetic milk constituents etc. will have different public health problems, which vary from gastrointestinal disturbances to even fatality (Kandpal et al. 2012).

2.4.1 Water

Water is the chief adulterant used in milk. If the milk used in the adulteration is contaminated with water it will lead to the harmful diseases like cholera, typhoid, shigella, polio, meningitis, and hepatitis A and E (CSE 2006).

2.4.2 Neutralizers

Neutralizer**s** are added to mask the developed acidity or bitter taste in synthetic milk. Among these neutralizers the most common is sodium hydroxide which can be very harmful if ingested. Its ingestion may result in a burning sensation, abdominal pain, shock or collapse. Sodium carbonate also referred as soda ash or washing soda can cause severe health hazards if ingested. Sodium carbonate on ingestion may cause irritation along the digestive tract or stomach linings and may cause vomiting. Its ingestion may also cause diarrhea which may further result in frequent, loose bowel movements. Carbonate in milk may produce gastrointestinal problems including gastric ulcer, diarrhoea, colon ulcer and electrolytes disturbance (Barham et al. 2014c).

Rideout et al. (2008) reported that high amounts of carbonates and bicarbonates disrupts hormone signals that regulate development and reproduction. Levels of carbonates and bicarbonates in milk samples gives higher alkalinity, which cause milk alkali syndrome resulting in systemic alkalosis, renal failure, high blood pressure, hypertension, cardiac failure and oedema (Troy 2005).

2.4.3 Formalin

Mansour et al. (2012) reported that formalin in milk causes vomiting, diarrhoea and abdominal pain, larger doses may cause decreased body temp, shallow respiration, weak irregular pulse and unconsciousness. Formalin is added to milk as preservative but may cause vomiting, diarrhoea, abdominal pain, increased body temperatures, shallow respiration, weak irregular pulse, unconsciousness, blindness and it is also a potent carcinogen (Gwin et al. 2009). The addition of formalin as adulterant in milk causes vomiting, diarrhoea, and abdominal pain.

It also leads to decrease in body temperature, shallow respiration, weak irregular pulse and unconscious (Afzal et al. 2011). It also causes blindness by damaging optic nerve and it is carcinogenic in nature. (Gwin et al. 2009; Barham et al. 2014c and Debnath et al. 2015).

2.4.4 Hydrogen peroxide

Hydrogen Peroxide is also added to milk to prolong its freshness, but peroxides damage the gastro intestinal cells which can lead to gastritis and inflammation of the intestine. Hydrogen peroxide adulteration disturbs the antioxidants activity in the body that causes disturbance in natural immunity, which leads to increase aging (Clare et al. 2003). It also causes disruption of hormones, which are important for development and reproduction (Rideout et al. 2008). Hydrogen peroxide damages the stomach cells, which can lead to gastritis and inflammation of intestine and bloody diarrhoea (Murthy et al. 1981; Gwin et al. 2009). This also disturbs the antioxidants in body, and natural immunity hence increasing the ageing. (Barham et al. 2014c).

2.4.5 Starch

Starch is added in synthetic as well as natural milk to adjust or to increase the consistency and viscosity. Rideout et al. (2008) mentioned that higher amount of starch may cause diarrhoea due to the effects of undigested starch in colon. Its accumulation in the body may prove very fatal for the diabetic patients. Debnath et al. (2015) reported that starch causes diarrhoea and other disturbances in the colon.

2.4.6 Urea

Presence of urea in milk overburdens the kidney as they have to do more work to throw out urea contents from the body. This may lead to renal failure in some cases. It also results in swollen limbs and impaired vision. Besides, urea is also harmful for the heart and liver (Kandpal et al. 2012). Urea causes pain in lower abdomen, irregular heartbeat, muscle cramps, numbness and weakness in hands and feet, chills and shivering fever. Urea also causes increase in bleeding from uterus and appearance of unnecessary hairs on face especially of women and children (Baumgartner et al. 2005).

2.4.7 Detergents

Detergents are added in synthetic milk preparation to develop froth and their emulsification action. Most of the detergent contains dioxane which is carcinogenic in nature and can cause cancer on consumption (Mudgil and Barak 2013). The Indian Council of Medical Research in one of its reports, states detergents cause food poisoning and gastrointestinal complications. Its high alkaline level can also damage body tissue and destroy proteins (ICMR 1993).

2.4.8 Salt

Sodium chloride is added in milk to mask the higher water content. Use of sodium chloride as a thickening agent is common. It may have added to milk to increase the lactometer reading, solid not fat (SNF) content of the milk (FSSAI 2014). Animal physiology and health also affect the mineral content of the milk. It has been reported that high level of sodium chloride in milk could affect the acid base balance in body and may develop regression loss of acquired immunity, kidney problems, speech and sensory disturbances (Ayub et al. 2007). Salt in adulterated milk can cause critical illnesses like heart disease, problems of kidney, raised blood pressure, gastro-intestinal disturbance and allergies in human being (Kharat and Arak 2013).

2.4.9 Boric acid

Boric Acid causes nausea, vomiting, diarrhoea, kidney damage, acute failure of circulatory system and even death (See et al. 2010; Barham et al. 2014).

CHAPTER- 3

MATERIALS AND METHODS

3.1 Collection of milk samples

Total 200 raw market milk samples were directly collected from the consumers in 100 ml screw capped clean and sterilized plastic bottles from different places of Himachal Pradesh. Each bottle was coded and subjected to laboratory techniques in an isothermal box to access the quality and adulterants present in milk. The collected samples were analysed for specific gravity, fat, solid not fat and total solids by set laboratory procedure. While the adulteration tests were done by using a standard milk adulteration kit manufactured by HIMEDIA laboratories, Mumbai, India. HiMedia Adulteration Testing Kit protocol (HiMedia, Mumbai, India) as per the instructions given in the kit manual. Further the samples data were analysed according to agro-climatic zones of Himachal Pradesh. The samples were collected from three zones Zone I, Zone II, Zone III except Zone IV which included very high hilly areas of Himachal Pradesh and it was difficult to cover that area during study period. Further data was also collected from total 40 (20 negative and 20 positive samples) respondents in order to assess the perception of consumers towards public health importance of adulterated milk. Semi-structured interview schedule/ questionnaires were prepared and administered to total 40 consumers to collect the required information. The data was coded, edited, tabulated and statistically analysed.

3.2 Chemicals, kits and other equipment used

A standard Milk adulteration kit consisting of A and B manufactured by Himedia laboratories, was used for detection of adulterants, neutralizers, preservatives and thickening

agents. Kit part A (K088A) was used for detection of alizarin, formalin, urea, starch, neutralizers, detergents, sodium chloride, skim milk powder, sucrose, glucose (dextrose) and hydrogen peroxide. Kit part B (K088 B) was used for detection of cellulose, maltose, ammonium sulphate, boric acid and pond water. Other chemicals and equipment used were lactometer jar, lactometer and dairy thermometer for estimation of specific gravity and for fat estimation Gerber's butyrometer, milk pipette, sulphuric acid 90%, isoamyl alcohol, rubber stopper, key, test tube stands were used. Water bath, spirit lamp, and different glasswares (Borosil) were used in the study. All the glassware was thoroughly washed with labolene, properly rinsed with distilled water and dried in hot air oven. Before use, these glasswares were again rinsed with organic solvents to make them free from residual contamination, if any.

3.3 Estimation of Specific Gravity, Fat, SNF and TS

3.3.1 Specific gravity

Lactometer was used for rapid determination of specific gravity. The method was based on law of floatation which states that when a solid was immersed in a liquid. It was subject to upward thrust equal to the weight of the liquid displaced by the body and acting in upward direction.

The milk sample was mixed and was poured into lactometer jar upto 2/3 of its capacity. Lactometer was gently inserted into the cylinder without touching the sides and allowed to float freely. Lactometer reading called OLR i.e. Observed Lactometer Reading was taken from the top of the meniscus within 30 seconds. The temperature of the milk was recorded**.** Corrected Lactometer Reading (CLR) was determined by following formula

CLR= OLR +0.5± 0.1(Temperature difference) that means add 0.1 to OLR for every 1° above 84°F or subtract 0.1 from OLR for every 1° below 84°F. Finally, specific gravity of milk was calculated by following formula

Specific gravity= 1+ corrected lactometer reading/ 1000

3.3.1 Fat

Fat is the most important constituent of milk as it is used as a basis for fixing the purchase and sale price of milk. It helps to detect adulteration like watering and skimming of milk.

To determine the fat level in milk by Gerber method, the milk was mixed with sulphuric acid and iso-amyl alcohol in a special Gerber tube, permitting dissolution of the protein and release of fat. The tubes were centrifuged and the fat rising into the calibrated part of the tube was measured as a percentage of the fat content of the milk sample. 10 ml of sulphuric acid was measured into a butyrometer tube without wetting the neck of the tube. Milk sample was mixed thoroughly and 10.75 ml of milk was delivered into butyrometer with the help of milk pipette slowly through the sides without allowing it to mix with the acid. 1 ml of isoamyl alcohol was added into the butyrometer with the tilt measure, butyrometer was closed with the help of rubber stopper using a key. Tightened the stopper and mixed the contents by shaking the butyrometer at a 45 degree. The butyrometer was placed in the Gerber's centrifuge for 3-5 minutes. The scale reading was noted corresponding to the lowest point of the fat meniscus and the surface of separation of the fat and acid.

3.3.3 SNF and TS

The amount of total solid in milk vary with considerable limit and is greatly influenced by factors affecting animal health and nutrition apart from species, age, breed, etc. Determination of total percentage of solids considered in conjugation with specific gravity and fat content is of special value for the purpose of detecting adulteration of milk especially of nature of skimming/ watering or both. Total solids minus milk fat are taken in account while establishing legal standards and pricing of milk.

Solids not fat content was calculated using modified Richmond's formula.

%SNF = CLR/4 + 0.22F + 0.72 where F is the Fat content in milk.

TS**%=**Fat%+ SNF%

3.4 Detection of Adulterants in milk

3.4.1 Water

Adulteration of milk with water was checked by lactometer reading. The raw milk was poured into a (100 ml) measuring cylinder and a lactometer was dropped in the milk to slowly sink down. Further, the lactometer reading was taken and recorded in lactometer degree (°L). If the reading was below the standard then it was considered to be adulterated with water **(**Bari et al. 2015)

3.4.2 Percent added water:

Addition of water decrease the milk solids-not-fat contents specially proteins So, calculation of added water percentage relies on determination of milk solids-not-fat (Moore et al., 2012 and Santos et al. 2013). Percent added water calculated by using the following formula by Indumathi and Obula Reddy (2015)

$$\% \text{ Added water } = \frac{\text{Standard SNF} - \text{Sample SNF}}{\text{Standard SNF}} \times 100$$

Further the percentage of added water was summarised into three categories.

Range of percentage of added water in milk	
Category	**Range**
Low	5-25
Medium	25-50
High	>50

3.5 Other adulterants detected by using HiMedia kit

3.5.1 Alizarin

1 ml of milk sample was taken in a test tube and 1 ml of reagent ALZ was added and color change of milk was observed. Red color indicates normal milk, reddish orange color indicates acidic and reddish violet color indicates alkaline milk.

3.5.2 Formalin

2 ml of milk sample was taken in a test tube and 2 drops of Reagent FM-I was added and mixed well. Then 1ml of Reagent FM-2 was added from the sides of the test tube slowly. The colour change of ring formed at the junction in milk was observed. Purple or violet coloured ring indicates the presence of formalin and brownish yellow coloured ring indicates absence of formalin.

*MDL: 0.05 ppm

3.5.3 Urea

2 ml of milk sample was taken in a test tube and 1 ml of reagent U was added. The colour change of milk was observed. Off white to slight yellow colour indicates absence of urea

and yellow colour indicates the presence of urea. Intensity of yellow colour depends on the amount of urea present in the sample.

*MDL: 0.5%

3.5.4 Starch

2ml of milk sample was taken in a test tube, boiled and cooled 5 drops of reagent ST was added and colour change of milk was observed. Blue colour indicates the presence of starch and off white to cream color indicates absence of starch.

*MDL: 0.1%

3.5.5 Neutralizers

1.0 ml of milk sample was taken in a test tube, 1ml of reagent N-1 and 3 drops of reagent N-2 were added. The colour change of milk was observed. Absence and presence of neutralizers was indicated by light orange and reddish pink colour respectively.

*MDL: 0.05%

3.5.6 Detergents/ Shampoo

2.0 ml of milk sample was taken in a test tube and 2 drops of reagent DET was added. The colour change of milk was observed, greyish blue color indicates absence of detergent blue and slate grey color indicates presence of detergent and shampoo respectively.

*MDL: 0.2%

3.5.7 Sodium Chloride

1.0 ml of milk sample was taken in a test tube. 1 ml of reagent NCL-1 and 3 drops of NCL-2 were added. The colour change of milk was observed. Absence and presence of sodium chloride was indicated by brick red and yellow colour respectively.

*MDL: 0.1%

3.5.8 Skim Milk Powder

2.0 ml of milk sample was taken in a test tube. 1 ml each of reagent SKM-1 and SKM-2 were added. The contents were mixed thoroughly, kept in boiling water bath for 15 mins and cooled. The colour change of milk was observed. Absence and presence of skim milk powder was indicated by greenish and bluish colour respectively. Intensity of blue color depends on the amount of SKM in the sample.

*MDL: 2.0%

3.5.9 Sugar (Sucrose)

2.0 ml of milk sample was taken in a test tube and 1 ml of reagent SGR-1 and 1 spoonful reagent SGR-2 were added and boiled for 1 min. The colour change of milk was observed. Absence and presence of sugar was indicated by pale yellow and brick red colour respectively.

*MDL: 0.5%

3.5.10 Glucose

1.0 ml of milk sample was taken in a test tube and 1 ml each of reagent GL-1 and GL-2 were added. Boiled in boiling water bath for 5 min and cooled. The colour change of milk was observed. Absence and presence of glucose was indicated by light green and bluish green colour respectively.

*MDL: 1.0%

3.5.11 Hydrogen peroxide

5 ml of milk sample was taken in a test tube and 1 small spoonful (0.300g) of reagent HP was added and after 5 min, the colour change of milk was observed. Absence and presence of hydrogen peroxide was indicated by white to light grey and bluish grey colour respectively.

*MDL: 0.05ppm

3.5.12 Cellulose

1.0 ml of milk sample was taken in a test tube and 10 drops of reagent CLS was added and mixed well. After 10 min the colour change of milk was observed. Absence and presence of cellulose was indicated by yellow and moss green colour respectively.

*MDL: 2.0%

3.5.13 Maltodextrin/ Maltose

5 ml of milk sample was taken in a test tube and 5 drops each of reagent MD-1 and MD-2 were added carefully without disturbing. Colour change of the ring on the top layer of milk was observed. Absence and presence of maltose was indicated by golden yellow and brown colour respectively.

*****MDL: 0.2%

3.5.14 Ammonium sulphate

1 ml of boiled and cooled milk sample was taken in a test tube. 6 drops each of reagent AMS-1, AMS-2 and AMS-3 were added and mixed well. The mixture was kept in boiling water bath for 2 min and cooled. After 10 min observed colour change. Absence and presence of ammonium sulphate was indicated by wheat and teal blue colour respectively.

*MDL: 0.25%

3.5.15 Boric Acid

5 ml of milk sample was taken in a test tube and 1ml of reagent BA-1 was added then test strip reagent BA-2 is dipped and dried. The colour change of strip was observed. Absence and presence of boric acid was indicated by turmeric yellow strip and reddish orange strip respectively**.**

*****MDL: 0.1%

3.5.16 Pond Water/ Nitrate

2ml of sample was taken in a test tube one small spoon full of reagent PW-1 and 6 drops of reagent PW-2 was added, mixed well. One small spoon full of reagent PW-3 was added, mixed thoroughly and color change was observed. White to off white color indicates absence of pond water and pink magenta color indicates presence of pond water.

*MDL: 20ppm

CHAPTER- 4

RESULTS AND DISCUSSION

A total of 200 raw market milk samples collected directly from the consumers from different places of the Himachal Pradesh were analysed for the physico-chemical quality and qualitative detection of adulterants. All tests were carried out at room temperature. The physico-chemical parameters of market milk samples (table 4.1) and zone-wise distribution of samples were summarised (table 4.2). Different adulterants in market milk samples (table 4.3) and according to zone-wise were summarised (table 4.4).

4.1 Specific gravity, Fat, Solid Not Fat, Total Solid

4.1.1 Specific gravity

The specific gravity of milk samples ranged from 1.010-1.032 with an average value 1.022±0.07 which was less than the minimum prescribed standards of FSSAI i.e. 1.028 for cow milk in Himachal Pradesh (table 4.1.1). Out of 200 samples 148 (74%) samples were found below the standards indicating dilution with water and skimming practices. The mean specific gravity of Zone I and Zone II was equal 1.021±0.00, and in case of Zone III it was 1.024±0.00. No significant difference ($p>0.05$) was observed between Zone I and Zone II whereas, there was significant difference ($p<0.05$) of Zone III with Zone I and Zone II (table 4.1.2). The number of samples which were below milk quality standards in case of Zone I (n=62) was 50 (80.6%), in case of Zone II (n=70) was 54 (77.1%), and in case of Zone III (n=68) was 44(64.7%). Other thickening agents salt, skim milk powder, sucrose and glucose which were present in some of the samples tested might also affect the specific gravity by

increasing the viscosity of milk. Earlier study conducted by Bari et al. (2015) in Tangail District of Bangladesh reported that the mean specific gravity of raw milk samples was ranged from 1.019 to 1.021. Shaker et al. (2015) reported that specific gravity of the milk samples obtained from dairy shops, street vendors and farmer's houses ranged from 1.013 to 1.038, 1.013 to 1.033 and 1.015 to 1.046 with an average of 1.025, 1.025 and 1.027, respectively. Faraz et al. (2013) reported that average specific gravity was 1.01+0.00, from various canteens of educational institutes and public places, respectively.

4.1.2 FAT

The fat percentage of milk samples ranged from 1.0-9.2 with wide variations. However, an average value 3.5±0.10 which were just matching the minimum prescribed FSSAI standards i.e. 3.5 for cow milk in Himachal Pradesh (table 4.1.1). Out of 200 samples 139 (69.5%) samples were found below the standards. Similarly mean value of fat percentage in Zone I, II, and III were 3.3±0.19, 3.67±0.18, and 3.53±0.17 respectively. The number of samples which were below milk quality standards for fat in Zone I, 47(75.8%), in Zone II, 50(71.4%), and in Zone III, 42 (61.7%). No significant ($p<0.05$) difference was observed between Zone I, Zone II, and Zone III (table 4.1.2). The lower fat content of market milk samples might be due to water adulteration which reduces the fat content of milk samples and also due to the skimming of the fat from milk samples showed its direct correlation with lowered specific gravity (74%) of tested milk samples in present study. In one of the study similar findings were reported by Rahman et al. (2017) for market raw milk. Other factors which might influence the fat percentage could be breed, interval of milking, lactation number, stage of lactation, month of year and Age. The average fat value of present study was comparable with the study of Indumathi and Obula Reddy (2015) which reported that the fat percentage was 3.42, 3.24, 3.18 and 3.18 in samples from milk producers, milk collectors, milk vendors and retails shops respectively. Lower fat percentage was reported by Faraz et al. (2013) in milk samples collected from canteens of various educational institutes and public places. The study conducted by Shaker et al. (2015) reported that the fat % in dairy shops and street vendors examined milk samples ranged from 1.2 to 8.7 % and 1.0 to 5.3 % with averages of 4.0 and 3.7 % respectively.

4.1.3 Solid Not Fat

The solid not fat percentage of milk samples ranged from 3.6-12.8 with an average value 7.01 ±0.10 which was also less than the minimum prescribed standards of FSSAI i.e. 8.5 for cow milk in Himachal Pradesh (table 4.1.1). Out of 200 samples 165 (82.5%) were found below the standards. The mean value of %SNF in case of Zone I was 6.7±0.18, in case of Zone II was 6.8±0.19, and in case of Zone III 7.52±0.16 (table 4.1.2). No significant difference ($p>0.05$) was observed between Zone I and Zone II whereas, there was significant difference ($p<0.01$) of Zone III with Zone I and of Zone III with Zone II ($p<0.05$). The number of samples which were below milk quality standards for fat in case of Zone I was 56 (90.3%) in case of Zone II was 59(84.2%) and in case of Zone III was 50 (73.5%). Addition of water decreases the milk solids-not-fat contents of milk showed its positive correlation with lowered specific gravity of milk samples (74%) in present study. Similar results were reported by Moore et al. (2012) and Santos et al. (2013). SNF content of the milk samples was also influenced by thickening agents, SKM, etc., which were found in analysed milk samples in the present study. Other factors which could affect the SNF content of milk, consists of protein, lactose and mineral, might vary with changes in the diet but to a lesser degree than the fat content. Specific factors that have been reported to affect SNF production include nutrition, genetics, disease, stage of lactation and season of year (Harris and Bachman 2003).

In present study the average SNF was 7.01% which was lower than the SNF content of 9.78 and 10.3% in buffalo milk reported by Khalid et al. (2013) and Ramya et al. (2016). Indumathi and Obula Reddy (2015) reported that milk samples collected from milk collecters and milk vendors were 7.62 and 7.23 respectively. Whereas Lateef et al. (2009) observed lower content of solid not fat i.e. 4.98±0.26 per cent in milk supplied to canteens of various Hospitals in Faisalabad city. Faraz et al. (2013) reported mean values for SNF contents were 5.10+0.17, 4.77+0.58 and ranged from 4.55 to 5.52 and 3.69 to 6.75 from various canteens of educational institutes and public places, respectively, which was lower than present study.

4.1.4 Total solids

The total solids percentage of milk samples ranged from 4.6-19.2 with an average value 10.54±0.17 which was also less than the prescribed standards of FSSAI i.e. 12.00 for cow milk in Himachal Pradesh (table 4.1.1). 73.5% samples were below the standards. The mean value of %TS in case of Zone I was 10.0±0.30, in case of Zone II was 10.4±0.32, and in

case of Zone III 11.06±0.27 (table 4.1.2). No significant difference ($p<0.05$) was observed between Zone I, Zone II, and Zone III. The number of samples which were below milk quality standards for TS in case of Zone I was 51 (82.2%) in case of Zone II was 53(75.7%) and in case of Zone III was 48(70.5%). When water was removed from milk the remaining constituents were called total solid. Total solid of milk comprises the fat, protein, lactose and minerals. Adulteration of milk with water and also skimming of milk might resulted in lowering of total solids. It showed its correlation with lowered specific gravity and fat percentage in present study. Similar interpretation was reported by Fahmid et al. (2016). Other factors which affect amount of total solid in milk vary with considerable limit and were greatly influenced by factors affecting animal health and nutrition apart from species, age, breed, etc. The results of present study were comparable with the results of Indumathi and Obula Reddy (2015) who reported that milk samples collected from milk producers, milk collector, milk vendors were 11.61, 10.84, 10.39 and 10.44 respectively. Whereas Lateef et al. (2009) observed lower observations for total solids 6.54±0.20, similarly Faraz et al. (2013) observed mean values for total solids were 7.18+0.27, 6.17+0.68 and ranged from 6.41 to 7.96 and 4.77 to 8.52 from various canteens of educational institutes and public places, respectively.

Table 4.1.1: Determination of Physico-chemical parameters of Market milk samples (n=200)

Parameters	Range	Average ± SE	Below standards	FSSAI standards for market milk (min)
Specific gravity	1.010-1.032	1.022±0.005	148 (74%)	1.028
Fat	1.0-9.2	3.5±0.10	139 (69.5%)	3.50
SNF	3.6-12.8	7.01±0.10	165 (82.5%)	8.50
TS	4.6-19.2	10.54±0.17	147 (73.5%)	12.00

Fig: 4.1.1 Percent samples with below milk quality standards

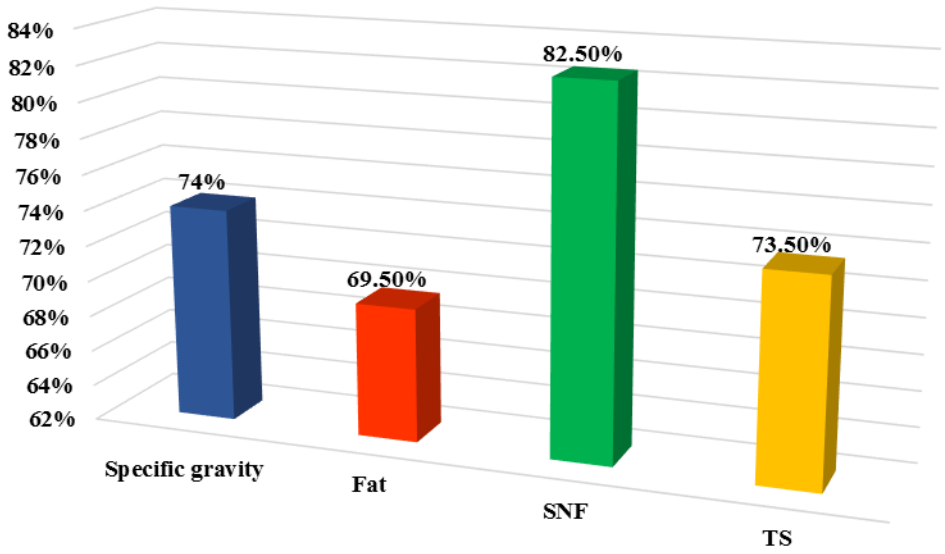
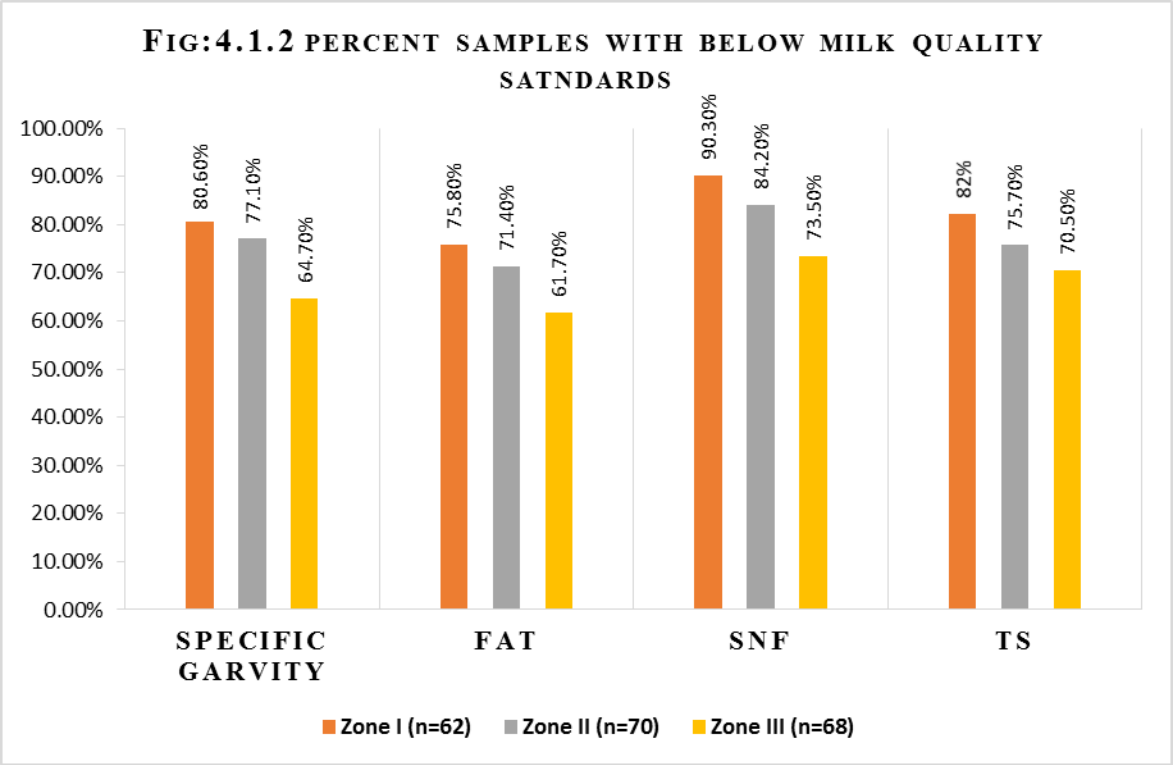


Table 4.1.2: Zone-wise determination of Physico-chemical parameters of Market milk samples (n=200)

	Zone I (n=62)		**Zone II (n=70)**		**ZONE III (n=68)**	
Parameters	Average±SE	Below standard	Average±SE	Below standard	Average±SE	Below standard
Specific Gravity	1.021±0.00[a]	50 (80.6%)	1.021±0.00[a]	54(77.1%)	1.024±0.00[b]	44(64.7%)
Fat	3.3±0.19[a]	47(75.8%)	3.67±0.18[a]	50(71.4%)	3.53±0.17[a]	42(61.7%)
SNF	6.7±0.18[a]	56 (90.3%)	6.8±0.19[a]	59(84.2%)	7.52±0.16[b]	50(73.5%)
TS	10.0±0.30[a]	51 (82.2%)	10.4±0.32[a]	53(75.7%)	11.06±0.27[a]	48(70.5%)

Values with different superscripts within the row differ significantly ($p<0.05$)



4.2 Detection of different Adulterants in market milk samples

4.2.1 Water

The present study revealed the most common adulterant in milk samples was water. Out of 200 milk sample studied, 148 (74%) milk samples were adulterated with water as also indicted by lowered specific gravity, fat percentage, SNF and TS content of analysed milk samples. Further in case of Zone I (n=62) 80.6% samples, in case of Zone II (n=70) 77.1% samples, and in case of Zone III (n=68) 64.7% samples were adulterated with water. This might be due to the easy availability of water and convenience of its mixing to increase the volume. This finding was comparable with the findings of Barham et al. (2014), Kandpal et al. (2012) Neeta et al. (2014), and Beniwal and Khetarpaul (1999) who found 79.3, 80, 68, 70% of samples positive for water. Whereas higher level of percentage of milk adulterated with water was reported by Chanda et al. (2012), and Shaikh et al. (2013) found 100% of milk samples adulterated with water, while Faraz et al. (2013) found 97% and 93% samples from

educational institutions (EI) and public places (PP) in the Faisalabad respectively positive for adulteration of water.

Percentage of added water in milk was calculated in all the samples which were positive for water adulteration. Out of 148 samples which were positive for water adulteration 75 (50.6%) samples were lying in low range, 66 (44.6%) in medium and 7 (4.7%) in high range. Earlier study conducted by Shaker et al. (2015) reported that 84% of milk samples collected from dairy shops had added water content of different percentages ranged between 1.1 to 56.8% whereas, 80% of street vendors milk samples had added water content ranged between 2.7 to 61.4%. In one of the recent study conducted by Amin (2016) reported that 42% raw cow's milk samples collected from dairy shops had added water content ranged between 2.5 to 21.73 % whereas, 68% of the street vendors milk samples had added water ranged between 5.96 to 23.84%.

Table 4.2.1: Percentage of added water in milk (N=148)

Range	No. of samples	Percentage
Low (5-25)	75	50.6%
Medium (25-50)	66	44.6%
High (>50)	7	4.7%

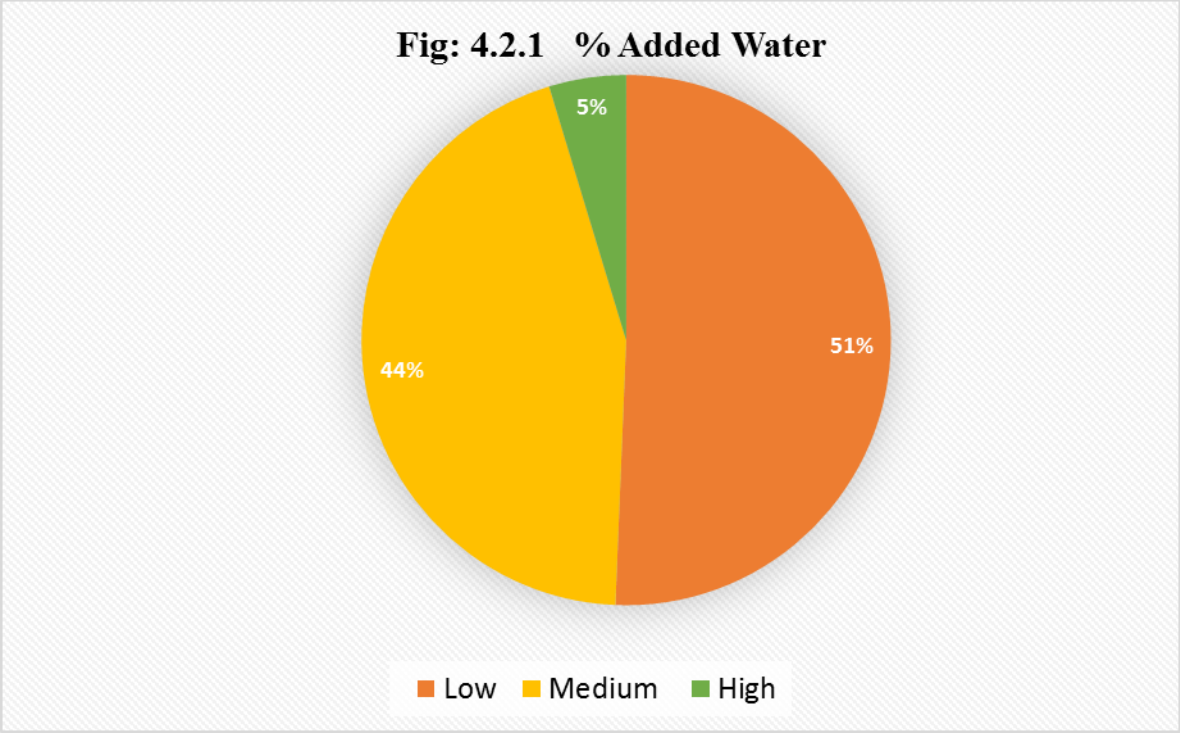


Table 4.2.2: Determination of extent of different adulterants in Market milk (n=200)

Adulterants	Total number of Positive samples	Total number of Negative samples	Overall percentage of positive samples	Overall percentage of negative samples
Water	148	52	74	26
Alizarin (Acidity/ Alkalinity)	4/23	173	2/11.5	86.50
Formalin	2	198	1	99
Neutralizers	2	198	1	99
Detergent	6	194	3	97
Sodium chloride	36	164	18	82
Skim milk powder	19	181	9.5	90.5
Sucrose	3	197	1.5	98.5
Glucose	2	198	1	99

*Other adulterants tested were urea, starch, hydrogen peroxide, maltose, cellulose, ammonium sulphate, protein, boric acid, pond water/nitrate which were not detected in any of the samples.

Fig: 4.2.2 Percentage of different adulterants present in Market milk

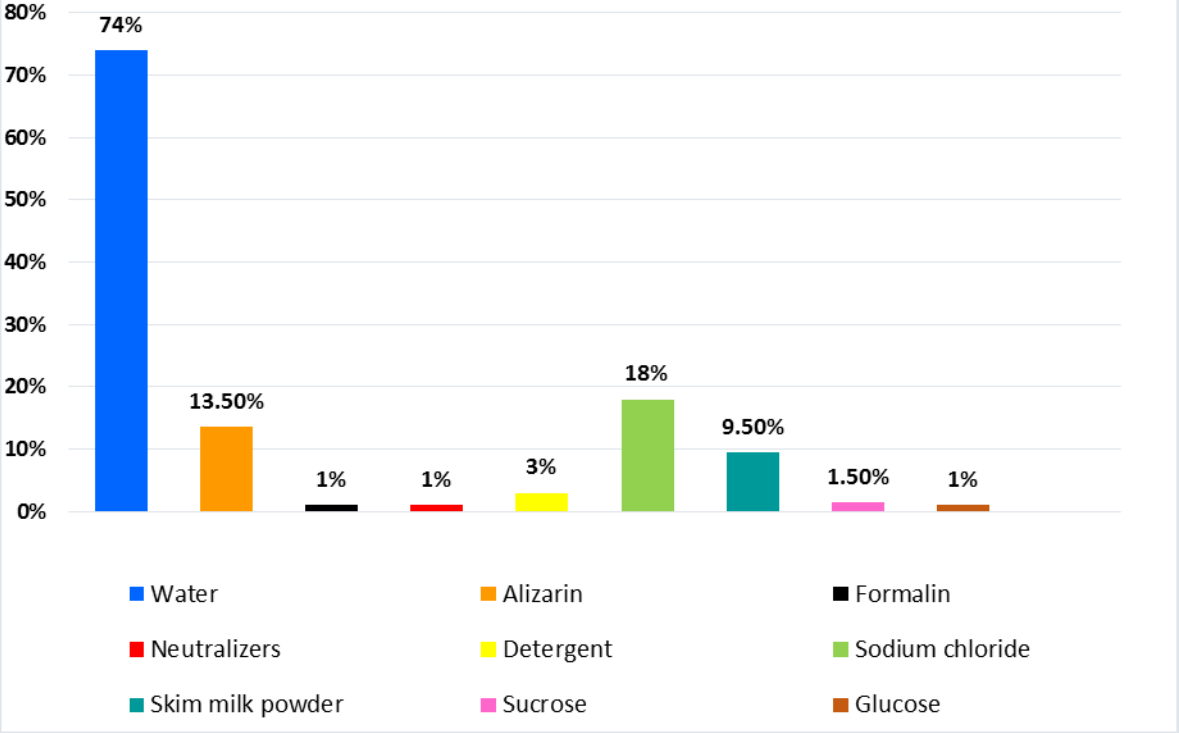
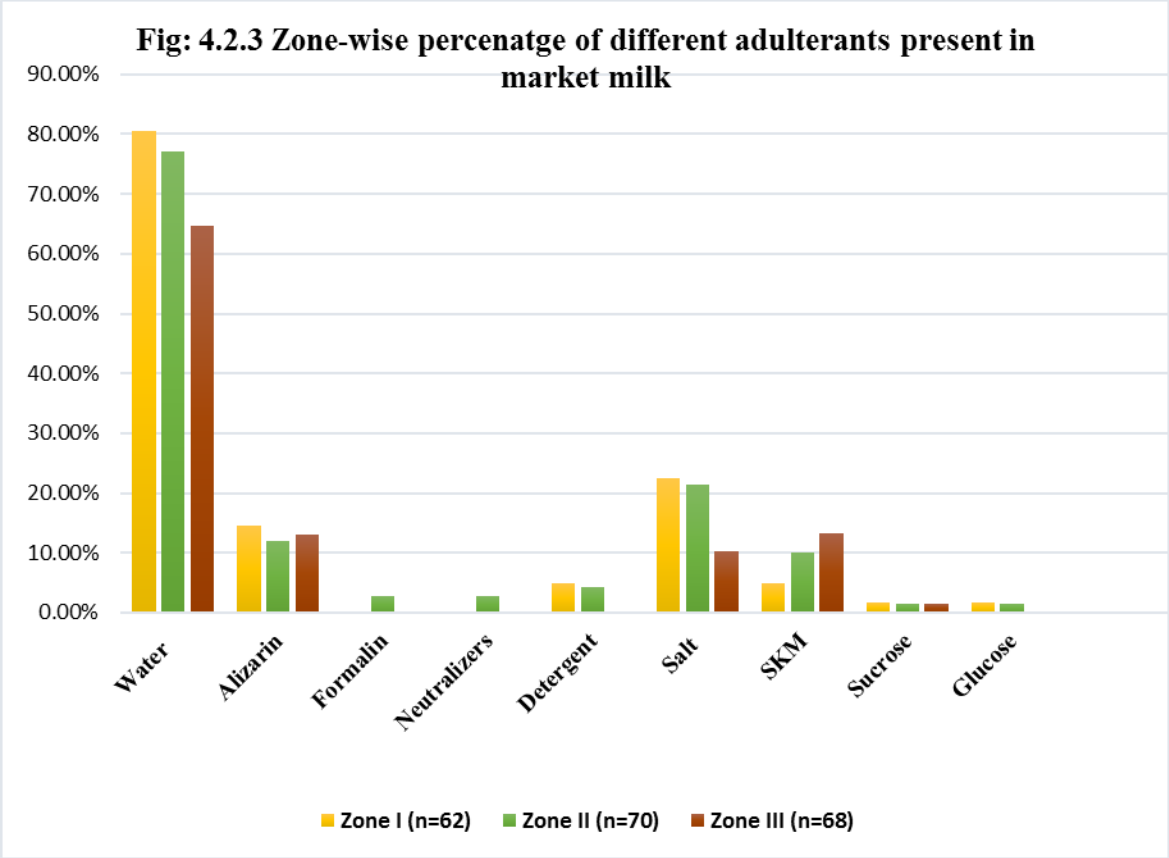


Table 4.2.3: Zone-wise determination of extent of different adulterants in Market milk

Adulterants	**Zone I (n=62)** **No of Positive samples**	**Zone II (n=70)** **No of Positive samples**	**Zone III (n=68)** **No of Positive samples**
Water	50 (80.6%)	54 (77.1%)	44(64.7%)
Alizarin (Acidity/ Alkalinity)	1/8(1.6/12.9%)	2/7(2.8/10%)	1/8(1.4/11.7%)
Formalin	-	2(2.8%)	-
Neutralizers	-	2(2.8%)	-
Detergent	3(4.8%)	3(4.2%)	-
Sodium chloride	14(22.5%)	15(21.4%)	7(10.2%)
Skim milk powder	3(4.8%)	7(10%)	9(13.2%)
Sucrose	1(1.6%)	1(1.4%)	1(1.4%)
Glucose	1(1.6%)	1(1.4%)	-



4.2.2 Alizarin

Out of 200 milk samples 27 (13.5%) samples were positive for alizarin test out of which 4 samples were acidic and 23 were alkaline in nature. Acidic nature of samples might be due to production of lactic acid due to storage of milk for long time.

Out of these 23 alkaline milk samples two samples were positive for neutralizers, 4 were positive for detergent and others were positive for salt suggested that it might be due to presence of neutralizers, detergent and salt in tested milk samples.

The alkalinity nature of milk might also be considered due to subclinical mastitis (Swetha et al. 2014). In case of Zone I number of samples 1/8(1.6/12.9%), in case of Zone II 2/7(2.8/10%), and in case of Zone III 1/8(1.4/11.7%) were positive for acidity/alkalinity respectively.

Earlier study conducted by Singuluri et al. (2014) stated that all the samples were positive for alkalinity while Swetha et al. (2014) reported that 28.26 and 9.78% of samples were alkaline and acidic in nature respectively.

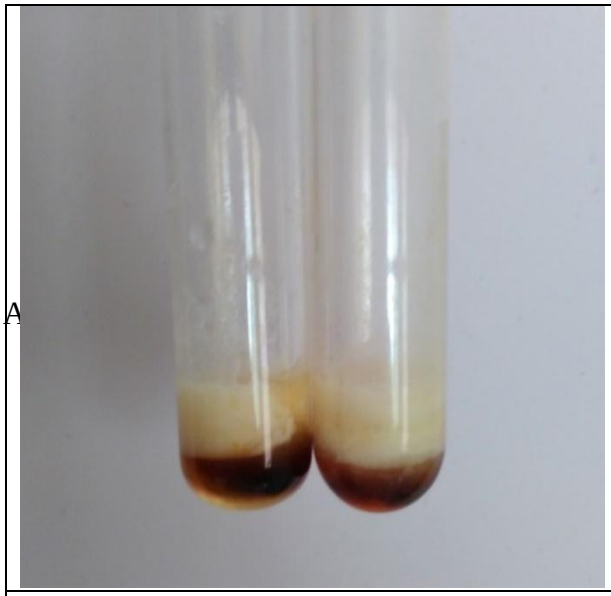
4.2.3 Formalin

The adulteration of milk samples with formalin was found to be 1% (Plate1). Formalin were generally used to enhance shelf life of milk. None of the samples were positive for formalin in Zone I and Zone II whereas in case of Zone III, 2(2.8%) were positive for formalin.

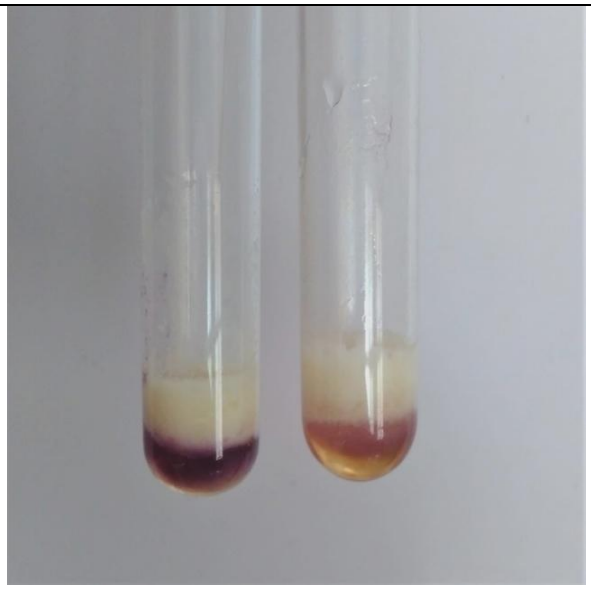
Earlier study conducted by Swetha et al. (2014) in and around Tirupati reported that 2.2% of samples were positive for formalin and Chanda et al. (2012) examined milk samples from Bangladesh and reported that 10% of samples were positive for Formalin.

Plate 1. Formalin test

4.2.4 Neutralizers



Negative



Positive

According to present study the neutralizers adulterated milk samples were 1% (Plate 2). Neutralizers were generally used to mask the effect of acidity in milk preserved for long duration so as passing it off as fresh milk (Kumar et al. 2015).

None of the samples were positive for neutralizers in Zone I and Zone II whereas in case of Zone III 2(2.8%) were positive for neutralizers.

Earlier study conducted by Swetha et al. (2014) and Ramya et al. (2015) reported that 8.7% and 6% milk samples were positive for neutralizers respectively.

Plate 2. Neutralizers test

Negative

Positive

4.2.5 Detergent

Out of 200 milk samples 6 (3%) samples were positive for detergent (Plate 3). Out of these six samples none of the samples were found positive for other ingredients except neutralizers used for synthetic milk production indicated towards absence of synthetic milk production practices in Himachal Pradesh.

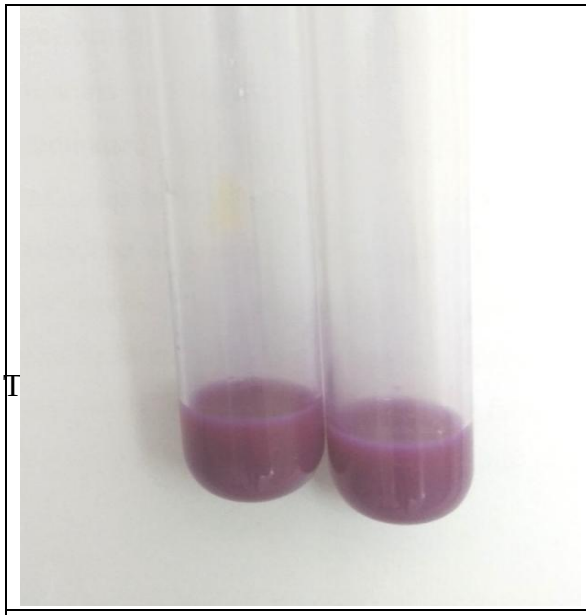
The presence of detergents in milk samples might be due to low maintenance of containers (Kumar et al. 2015). Total 3 (4.8%) samples in Zone I, 3 (4.2%) in Zone II and none in Zone III were found to be positive for detergent.

Indumathi and Obula Reddy (2015) reported that 4, 4, 8 and 24% of the samples from milk producers, milk collectors, milk vendors and retail shops were positive for detergent.

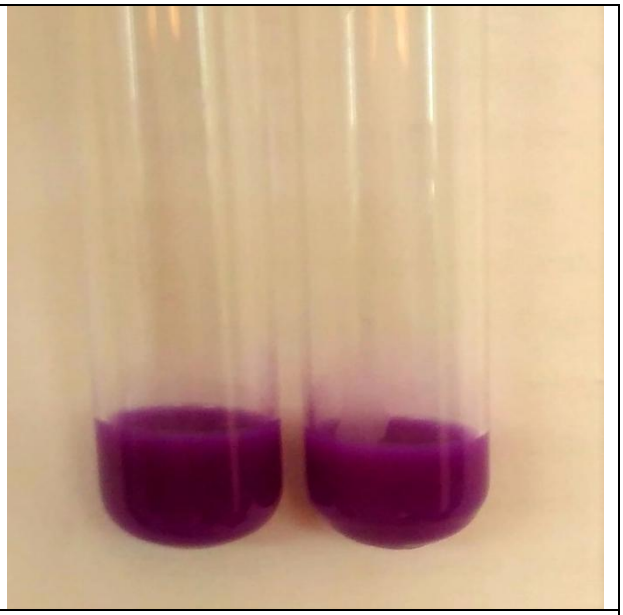
Ramya et al. (2015) and Swathi et al. (2015) reported that 10% samples were positive for detergent. Detergents like adulterants seems to be used to enhance the emulsification and dissolve the oil in water giving a frothy solution.

Plate 3. Detergent test

4.2.6 Sodium chloride



Negative



Positive

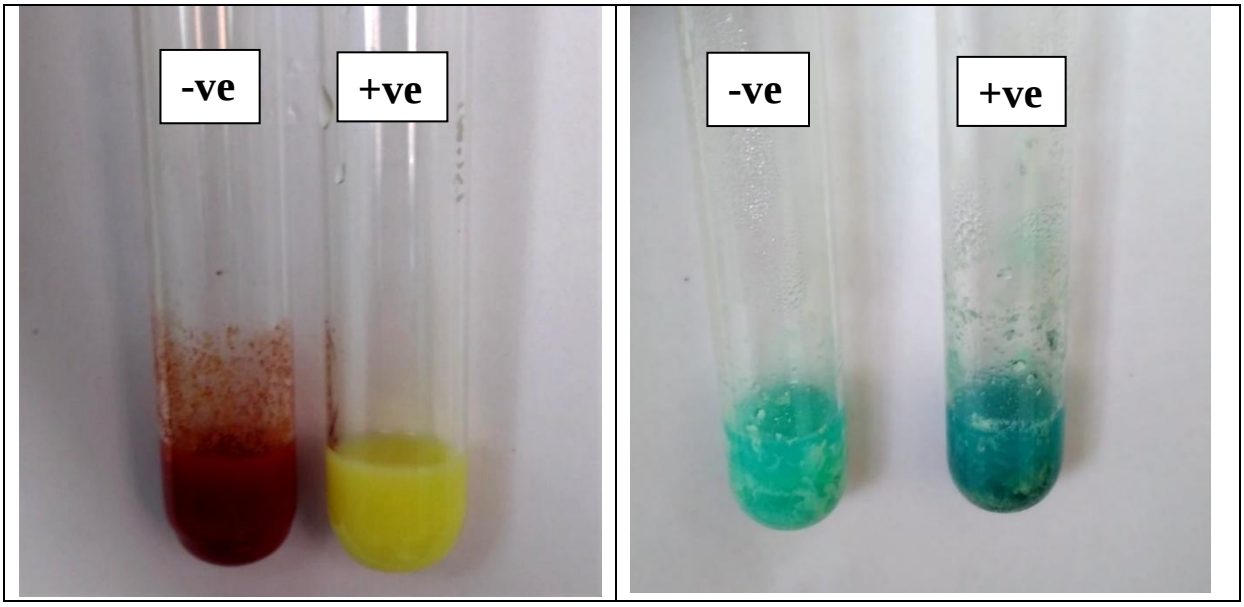
The adulteration of milk with sodium chloride was found to be 18% (Plate 4). Total 14(22.5%), 15 (21.4%%), and 7(10.2%) samples were positive for sodium chloride in Zone I, II and III respectively. Sodium chloride was added in milk to mask the effect of higher water content to increase the lactometer reading and milk solid not fat (SNF) content of the milk (FSSAI, 2014). Use of sodium chloride as a thickening agent was common.

The mineral content of milk was also affected by physiology and health condition of animal. Chloride content was found high in colostrum, lowest at peak milk yield, and then gradually increases with progress of lactation (Iyengar 1982; Jenness 1985). The increase in sodium chloride content of milk might be due to sub-clinical mastitis.

Sub-clinical mastitis increases the percentages of sodium and chloride content in milk and decreases the potassium content in milk (Kitchen 1981; Bruckmaier et al. 2004).

Indumathi and Obula Reddy (2015) reported that 28%, 16% and 12% of milk samples collected from retail shops, milk vendors, milk collectors were positive for sodium chloride. Razzagh et al. (2015) reported 10% samples were positive for salt. Brindha et al. (2017) reported that 30% samples were found to be positive for sodium chloride, similar results were observed by Swetha et al. (2014), Ramya et al. (2015), Singuluri and Sukumaran (2014).

Plate 4. Sodium chloride test	**Plate 5. Glucose test**



4.2.7 Glucose

According to present study the glucose adulterated milk samples were 1% (Plate 5). Total 1(1.6%), 1(1.4%) and none samples were positive for glucose in Zone I, II and III respectively. Glucose was added as a thickening agent to increase the viscosity of milk.

The result of present study was comparable with the findings of Swetha et al. (2015) who reported that 1.09% samples were adulterated with glucose whereas higher percentage 20%, 30%, 10% were reported by Geeta et al. (2015), Makadiya and Pandey (2015) and Ramya et al. (2015) respectively.

4.2.8 Skim Milk Powder

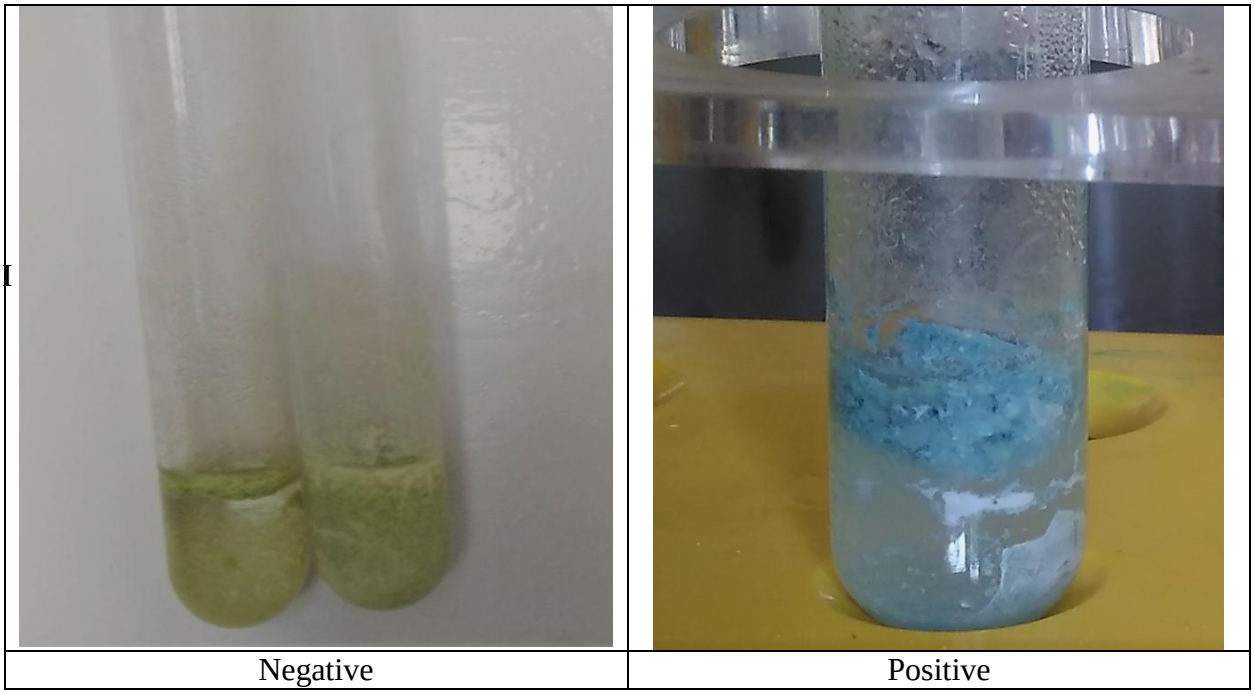
Out of 200 milk samples, 19 (9.5%) samples were positive for skim milk powder (Plate 6). Total 3(4.8%), 7(10%), and 9(13.2%) samples were positive for skim milk powder in Zone I, II and III respectively. Skim milk powder was added as a thickening agent to maintain the viscosity of milk.

The result of present study is comparable with the findings of Singh et al. (2015) who reported that 10% samples were adulterated with skim milk powder, whereas higher percentage 33.5, 45.16, 18.48 were reported by Geeta et al. (2015), Debnath et al. (2015) and Swetha et al. (2014) respectively.

Plate 6. Skim milk powder test

4.2.9 Sucrose

In current study sucrose adulterated milk samples were found to be 1.5% (Plate 7). Total 1(1.6%), 1(1.4%), and 1(1.4%) milk samples were positive for sucrose in Zone I, II and III respectively. Sucrose might be also added as thickening agent to maintain the viscosity of milk and to mask the effect of added water. Sucrose was used to restore the normal analytical values of adulterated milk in physicochemical tests (Kasemsumran et al. 2007, Santos et al. 2013b, Zhang et al. 2014). Earlier study conducted by Singuluri and Sukumaran (2014), Debnath et al. (2015), Geeta et al. (2015), Makadiya and Pandey (2015) and Ramya et al. (2015) reported a high percentage of milk adulteration with sucrose as 22%, 19.35%, 46.6%, 50% and 40% respectively.

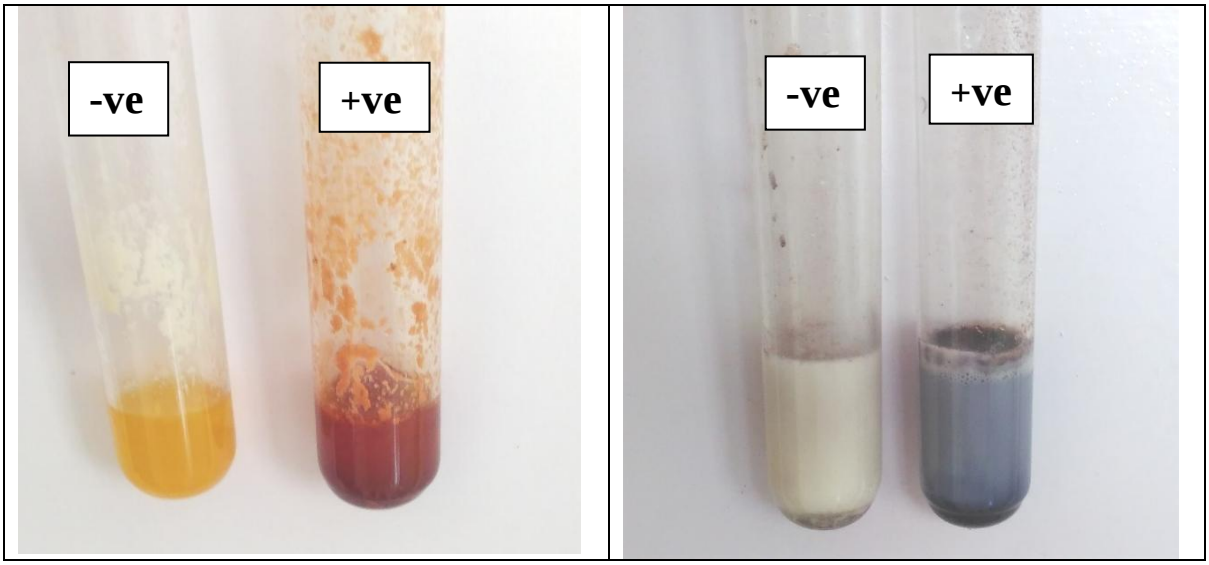


Negative	Positive

4.2.10 Hydrogen peroxide

All the milk samples tested were free from hydrogen peroxide (Plate 8). The present study was comparable with the findings of Chanda et al. (2012) from rural areas of Barisal district of Bangladesh, Kandpal et.al. (2012) from Dehradun, Indumathi and ObulaReddy (2015) from Chittoor, Andhra Pradesh, Geeta et.al. (2015) from Secunderabad, Telangana, Makadiya and Pandey (2015) Gandhinagar, Gujarat and Razaggah et.al. (2015) from Iran which found zero incidence of Hydrogen Peroxide in the milk samples. Hydrogen peroxide causes gastritis, inflammation of intestines and leads to bloody diarrhoea (Gwin et al. 2009).

Plate 7. Sucrose test	**Plate 8. Hydrogen peroxide test**



4.2.11 Urea

All the milk samples tested for urea adulteration were found negative (Plate 9). Similar results were reported by Swathi et.al. (2015) from local vendor and Indumathi and Obula Reddy (2015) from milk producers and Bendale et al. (2015).

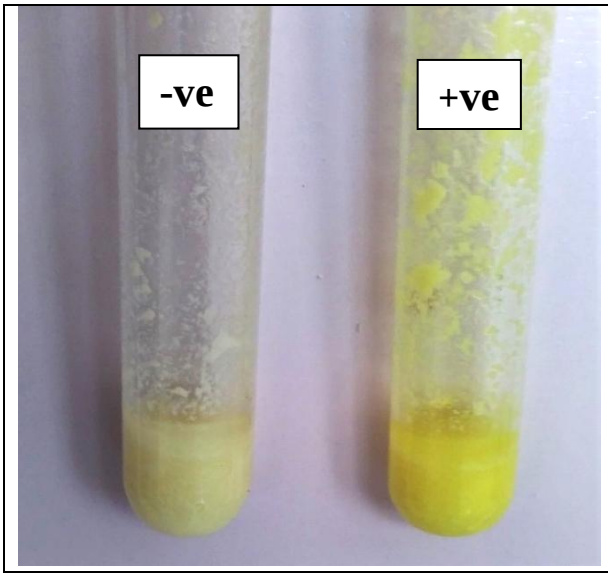
Urea might be added to milk to provide whiteness, increase the consistency of milk and for levelling the contents of Solid-Not-Fat (SNF) as are present in the natural milk. Besides, urea may affect kidney, liver and heart (Kandpal et al. 2012).

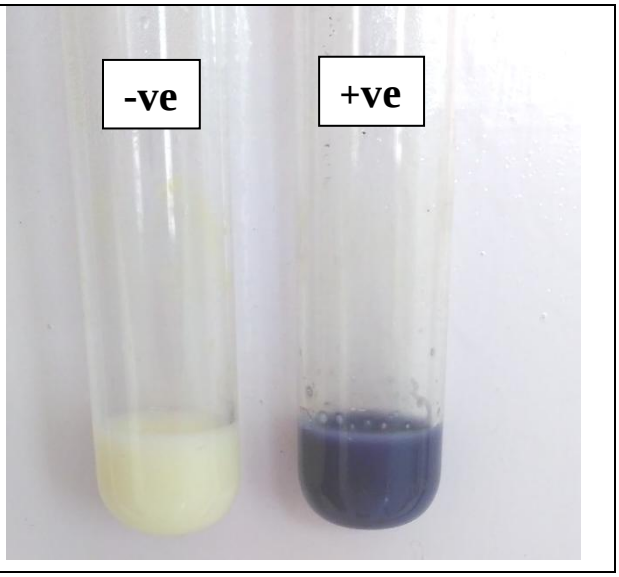
4.2.12 Starch

None of the milk samples were found positive for starch (Plate 10). Absence of starch in examined milk samples in this study had concordance with the findings of Nirwal et al. (2013) and Singuluri and Sukumaran (2014), Swetha et al. (2014), Indumathi and Obula Reddy (2015) from milk producers and milk collectors, Debnath et.al. (2015) in Branded sachets and Bendale et al. (2015).

Rideout et al. (2008) mentioned that higher amount of starch may cause diarrhoea due to the effects of undigested starch in colon. Its accumulation in the body may prove very fatal for the diabetic patients.

Plate 9. Urea test	**Plate 10. Starch test**

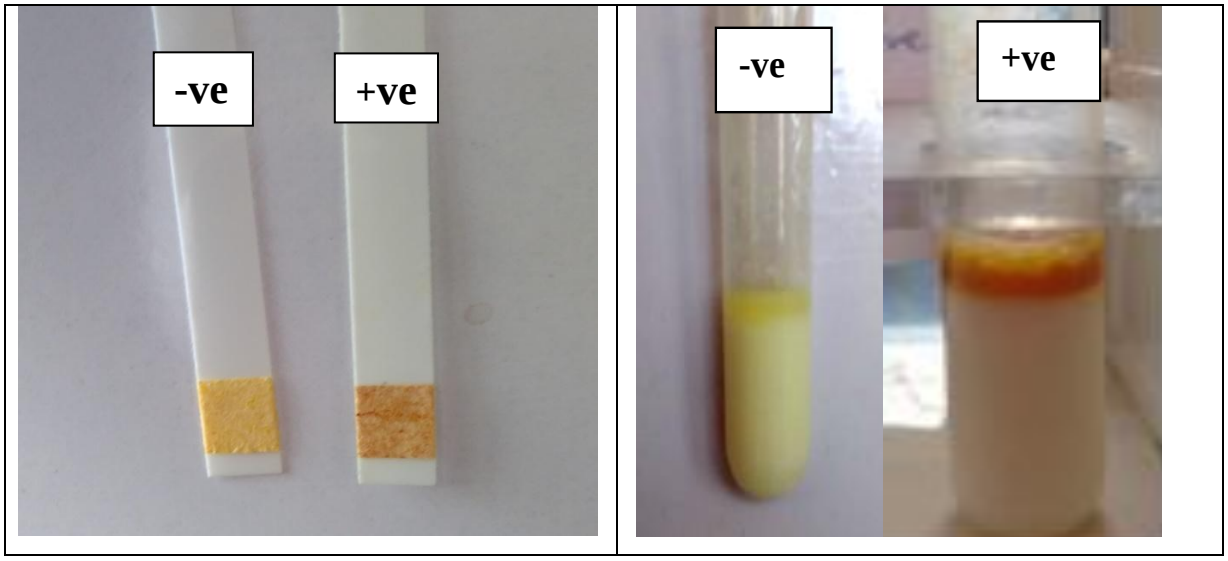




4.2.13 Boric acid

None of the samples were found positive for boric acid (Plate 11). No incidence of Boric acid in milk samples was reported by Lateef et al. (2009) from Faisalabad city, Shaikh et al. (2013a) from Pakistan, Nirwal et al. (2013) from Dehradun and Geeta et al. (2015) from Secunderabad city, Telangana. Awan et al. (2014) from Multan, Pakistan also reported no incidence of Boric acid in UHT treated milk samples. Boric Acid causes nausea, vomiting, diarrhoea, kidney damage, acute failure of circulatory system and even death (See et al. 2010; Barham et al. 2014).

Plate 11. Boric acid test	**Plate 12. Maltose test**



4.2.14 Maltose

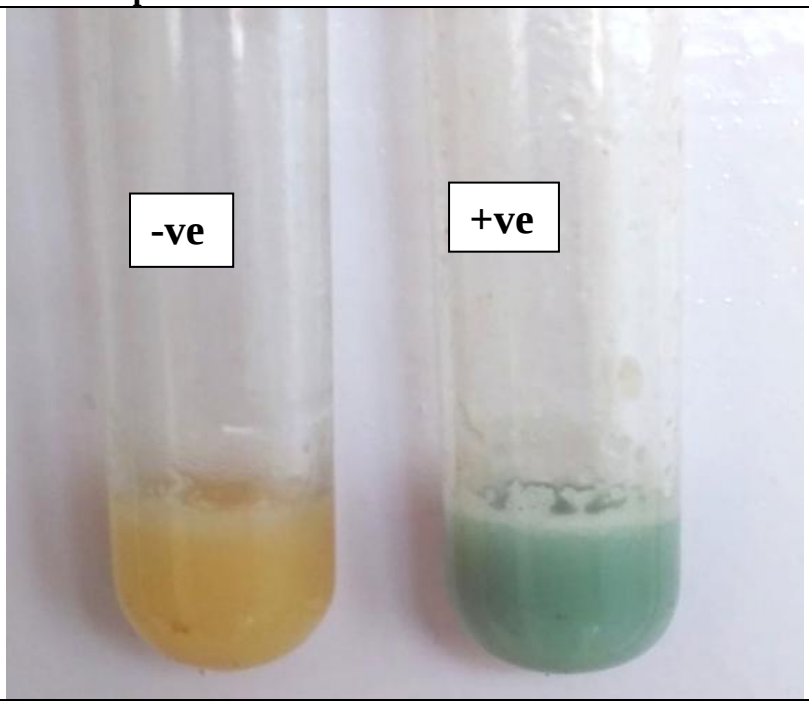
Maltose was not detected in any of the milk samples in the present study (Plate 12). Maltose might be added to give diluted milk its characteristic sweetness and also increase the thickness of milk to adjust lactometer reading (Singh et al. 2015).

4.2.15 Ammonium sulphate

Our analysis showed that the milk samples analyzed were free from ammonium sulphate (Plate 13). Similarly, no incidence was reported by Nirwal et al. (2014) from Dehradun, Lateef et al. (2009) and Awan et al. (2014) from Pakistan.

Ahirwar et al. (2015) in Mysore, Karnatka reported that milk was adulterated with 0.5, 1, 3, 5 and 7% of ammonium sulphate. Ammonium sulphate might have added to increase the lactometer reading by maintaining its density. It causes irritation in the gastrointestinal tract like nausea, vomiting and diarrhea.

Plate 13. Ammonium sulphate test



4.3 Public health importance of adulterated milk

The present survey was conducted to study the behaviour of consumers towards milk adulteration and its effect on their health. Semi-structured interview schedule/ questionnaires were prepared and administered to total 40 consumers (20 from positive and 20 negative milk samples) to collect the required information. The data was coded, edited, tabulated and statistically analysed.

Table 4.3.1 Source of milk

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Milk vendor	14	70	15	75	29	72.5
Other source (neighbour, relatives)	6	30	5	25	11	27.5

Table 4.3.1 depicts that in case of positive samples the majority of the respondents (70%) preferred milk vendor as major source of milk. Likewise, in case of negative samples majority (75%) preferred milk vendors. Thus, overall majority of the respondents (72.5%)

preferred milk vendors as source of milk. Other sources (neighbour, relatives etc.) as preferred ways of milk buying were followed by 30%, respondents in case of positive samples, 25% in case of negative samples and 27.5% in case of pooled samples. Thus, all the respondents were buying milk through unorganised milk marketing channels in the region. Unorganised milk marketing channels constitute 85% of milk marketed in India (Neeta et al. 2014). Earlier study in Kenya, Mwangi et al. 2002 reported that the various sources of milk were as follows - 20% from dairy, 28% from vendors and 12% from shops.

Table 4.3.2 Daily milk consumption

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
< 1 litres	9	45	12	60	21	52.5
2-3 litres	9	45	7	35	16	40
>3 litres	2	10	1	5	3	7.5

Table 4.3.2 revealed that in case of positive samples, 45% respondents, in case of negative samples, 60% respondents and overall, 52.5% respondents had daily consumption of milk were < 1 litres a day. Also, in case of positive samples, 45% percent of respondents, in case of negative samples, 35% respondents bought milk in the quantity of 2-3 litres per day. Overall 40% respondents bought 2-3 litres quantity of milk per day. In case of positive samples > 3 litres of milk bought by 10% of respondents, whereas in case of negative samples 5%, and overall (7.5%) respondents bought milk in quantity of >3 litres per day.

It appears that milk formed an important source of regular diet of people in the region. Javaid et al. (2009) reported that it is a necessary item of daily diet.

Table 4.3.3 Duration of consumption of milk from the same source

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
<1 year	7	35	10	50	17	42.5
1-2 year	6	30	3	15	9	22.5
2-3 year	4	20	5	25	9	22.5
>3 year	3	15	2	10	5	12.5

Table 4.3.3 revealed that in case of positive samples 35% respondents consumed milk for a period of <1 year from the same source followed by 1-2 years (30%), 2-3 years (20%), and > 3 years (15%). In case of negative samples also, majority of respondents (50%) consumed milk for <1 year from same source followed by 2-3 years (25%), 1-2 years (15%), and >3 years (10%). Overall 42.5% respondents consumed milk for a period of <1 year from the same source, whereas equal percent of (22.5%) respondents consumed milk for a period of 1-2 years, 2-3 years. This means that the consumers had reasonable choice to switch from one milk seller to another.

Table 4.3.4 Satisfaction level towards quality of milk

	Positive Samples (n=20)		**Negative Samples (n=20)**		**Pooled (n=40)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Yes	14	70	13	65	27	67.5
No	4	20	5	25	9	22.5
Don't know	2	10	2	10	4	10

Table 4.3.4 revealed that in case of positive samples majority of respondents (70%) were satisfied with the quality of milk, 20% respondents were not satisfied with quality of milk. Likewise, in case of negative samples majority of the respondents (65%) were satisfied with the quality of milk. Thus, overall majority of (67.5%) respondents were satisfied with the quality of milk.

Table 4.3.5 Assessment of adulteration

	Positive Samples (n=20)		**Negative Samples (n=20)**		**Pooled (n=40)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
No idea	3	15	1	5	4	10
Through visual appearance, taste, touch	10	50	11	55	21	52.5
Any other specific method	1	5	3	15	4	10
Trust on member of social system	6	30	5	25	11	27.5

Table 4.3.5 showed that in case of positive samples majority of the respondents (50%) preferred to check the adulteration of milk by visual appearance, taste, touch. In case of positive samples some of the respondents (30%), in case of negative samples (25%) and overall (27.5%) had trust on members of social system from where they bought milk. In case of positive samples 15% of the respondents, in case of negative (5%), and overall (10%) of respondent had no idea of assessment of adulteration. Assessment of adulteration by any other specific method was done by 5% of respondents in case of positive samples, in case of negative 15%, and overall 10% respondents.

Table 4.3.6 Experience/observation of possible harmful effect of adulterated milk on health

	Positive Samples (n=20)		**Negative Samples (n=20)**		**Pooled (n=40)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
GIT problem (nausea,vomiting, diarrhea, loss of appetite)	4	20	1	5	5	12.5
Skin problems (itching, rash, allergy etc.)	0	0	2	10	2	5
Kidney problems	0	0	0	0	0	0
BP/ Diabetes/ Arthirtis	2	10	1	5	3	7.5
No effect	14	70	16	80	30	75

Table 4.3.6 depicted that in case of positive samples the majority of the respondents (70%) had no harmful effect of adulterated milk on their health. Likewise, in case of negative samples (80%), and thus overall (75%) of the respondents had not observed any harmful effect on their health. In case of positive samples some of the respondents faced GIT problems (20%), BP/ Diabetes/ Arthirits (10%). Similarly, in case of negative samples respondents had observed GIT problems (5%), skin problems (10%), BP/ Diabetes/ Arthirits (5%). Thus, overall majority of respondents (75%) had not observed any harmful effect on their body and other health problems faced were GIT problems (12.5%), BP/ Diabetes/ Arthirits (7.5%), skin problems (5%). Regarding harmful effects of adulteration, majority of consumers were seen to be having low awareness (Gautam and Singh 2016).

Table 4.3.7 Distribution of respondents according to awareness level towards disease transmitted through milk

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Tuberculosis	6	30	5	25	11	27.5
Brucellosis	0	0	0	0	0	0
Listeriosis	0	0	0	0	0	0
Q fever	0	0	0	0	0	0
No idea	14	70	15	75	29	72.5

Table 4.3.7 depicted that majority of the respondents in case of positive samples (70%), in case of negative samples (75%), and in case of pooled samples (72.5%) had no idea of disease transmission through milk.

In case of positive samples (30%), whereas in case of negative samples (25%), and thus overall (27.5%) respondents had an idea of transmission of tuberculosis disease through milk.

Earlier studies in Pennsylvania, USA showed that 23% to 68.5% of the study participants were aware of diseases transmitted from milk (Jayarao et al. 2006).

Table 4.3.8 Distribution of respondents on the basis of adulteration ever faced

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Yes	14	70	11	55	25	62.5
No	6	30	9	45	15	37.5

Table 4.3.8 revealed that in case of positive samples majority of the respondent (70%), in case of negative samples (55%), and thus overall (62.5%) had faced the problem of milk adulteration and most of them had faced the problem of water adulteration.

In case of positive samples 30% respondents, in case of negative 9%, and overall 37.5% respondents had never faced the problem of adulteration.

Table 4.3.9. Perception of respondents over problem of milk adulteration in the region

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Very serious	2	10	1	5	3	7.5
Serious	4	20	4	20	8	20
Less Serious	10	50	10	50	20	50
No problem of adulteration	4	20	5	25	9	22.5

Majority of the respondents (50%) in all positive, negative samples and overall, had perception that there was less serious problem of milk adulteration in their region followed by no problem of adulteration in case of positive (20%), in case of negative (25%), and overall (22.5%). Likewise, 20% respondents in all cases positive samples, negative samples and thus overall, had perception that there was serious problem of milk adulteration. In case of positive samples (10%), in case of negative samples (5%), and thus overall (7.5%), had perception that there was very serious problem of milk adulteration in their region.

Table 4.3.10 Perception of respondents in terms of extent of adulteration in various types of milk

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Loose milk	13	65	15	75	28	70
Packaged milk	3	15	3	15	6	15
Do not know	4	20	2	10	6	15

Table 4.3.10 revealed that majority of the respondent in case of positive samples (65%), in case of negative samples (75%), and thus overall (70%) had perception of loose milk adulteration rather than packaged milk. In all cases positive samples, negative samples, and overall 15% of respondents had perception that packaged milk were adulterated. In case of positive samples some of the respondents (20%), in case of negative samples (10%), and 15% respondents of pooled samples had no idea about types of milk adulteration.

Table 4.3.11 Perception of respondents in terms of extent of adulteration in various types of milk products

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Milk	8	40	7	35	15	37.5
Cream	2	10	2	10	4	10
Curd	1	5	1	5	2	5
Sweets	9	45	10	50	19	47.5

Most of the respondents in case of positive samples (45%), in case of negative samples (50%), and overall (47.5%) had perception that sweets are the most adulterated milk product. In case of positive samples (40%), in case of negative samples (35%), and overall (37.5%) had perception that milk was most adulterated.

In all cases positive, negative, and overall 20% of respondents had perception that cream was most adulterated product. Similarly, in all cases some of the respondents (5%) had perception that curd was most adulterated product.

Table 4.3.12 Perception towards common adulteration ingredients used

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Water	16	80	17	85	33	82.5
Powdered milk	2	10	3	15	5	12.5
Any other	2	10	0	0	2	5

Table 4.3.12 depicted that most of the respondents in case of positive samples (80%), in case of negative samples (85%), and thus overall (82.5%) had perception that water was the most common adulterants in milk. Some of the respondents in case of positive samples (10%), in case of negative samples (15%), and thus overall (12.5%) had perception that powdered milk was the common adulterant in milk.

A study conducted by Tiwari et al. (2013) in Delhi reported that 75% of shopkeeper and vendors acknowledged water as a common form of milk adulterant.

Table 4.3.13 Perception towards water as potential health hazard adulterant

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Yes	5	25	7	35	12	30
No	14	70	9	45	23	57.5
Do not know	1	5	4	20	5	12.5

Table 4.3.13 revealed that majority of respondents in case of positive samples (70%), in case of negative samples (45%), and overall (57.5%) samples had perception that addition of water in milk is not a health hazard.

In case of positive samples (25%), in case of negative samples (35%), and overall (30%) respondents had perception that water could be a potential health hazard. Some of the respondents in case of positive samples (5%), in case of negative samples (20%), and overall (12.5%) respondents had no idea about it.

Table 4.3.14. Awareness level towards method of detecting adulteration in milk

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Yes	6	30	3	15	9	22.5
No	14	70	17	85	31	77.5

Table 4.3.14 revealed that, majority of the respondents in case of positive samples (70%), in case of negative samples (85%), overall (77.5%) respondents had no idea about simplest method of detecting adulteration in milk.

In case of positive samples (30%), in case of negative samples (15%), overall (22.5%) respondents had an idea about method of detecting adulteration in milk. The awareness about simplest method of detecting adulteration in milk was quite low (Tiwari et al. 2013).

4.3.15 Awareness about Govt laws against milk adulteration

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Yes	0	0	1	5	1	2.5
No	20	100	19	95	39	97.5

Table 4.3.15 depicted that in case of positive samples all the respondent (100%) in case of negative samples (95%), and thus overall (97.5%) respondent had no idea about government laws against milk adulteration.

Earlier study conducted by Tiwari et al. (2013) reported that there was a low awareness regarding legislation related to prevention of food adulteration.

4.3.16 Willingness of reporting of milk adulteration to authorities

	Positive Samples (n=20)		Negative Samples (n=20)		Pooled (n=40)	
	Count	**Percentage**	**Count**	**Percentage**	**Count**	**Percentage**
Yes	10	50	7	35	17	42.5
No	10	50	13	65	23	57.5

In case of positive samples (50%) respondent showed the willingness of reporting of milk adulteration to authorities whereas in case of negative samples (65%) of respondents and overall (57.5%) respondents were not willing of reporting milk adulteration to authority.

Fig: 4.3.1 Source of milk

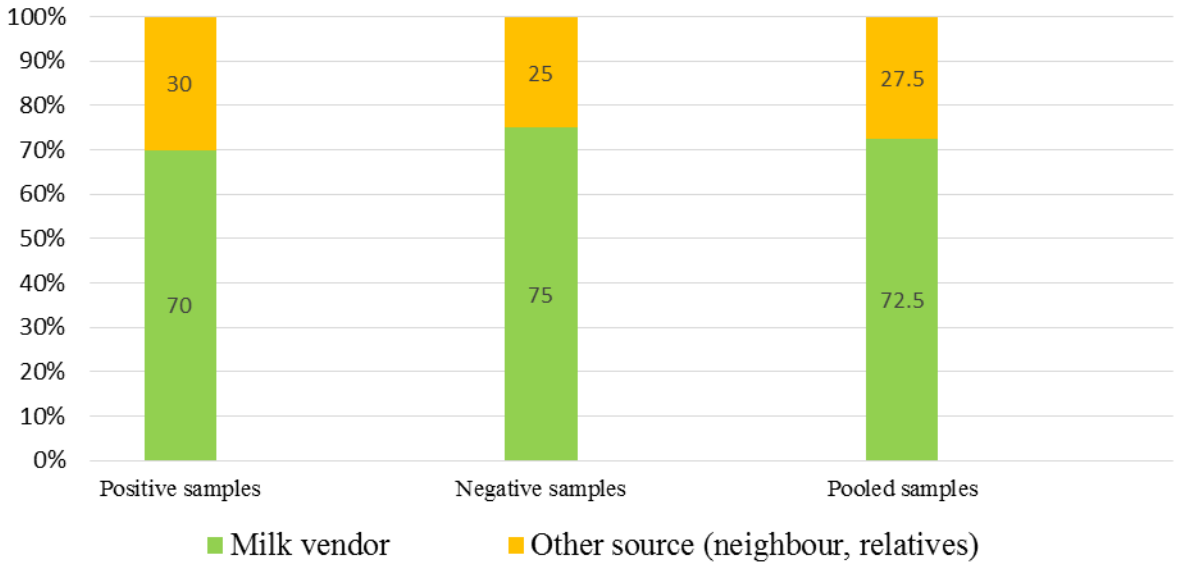


Fig: 4.3.2 Daily milk consumption

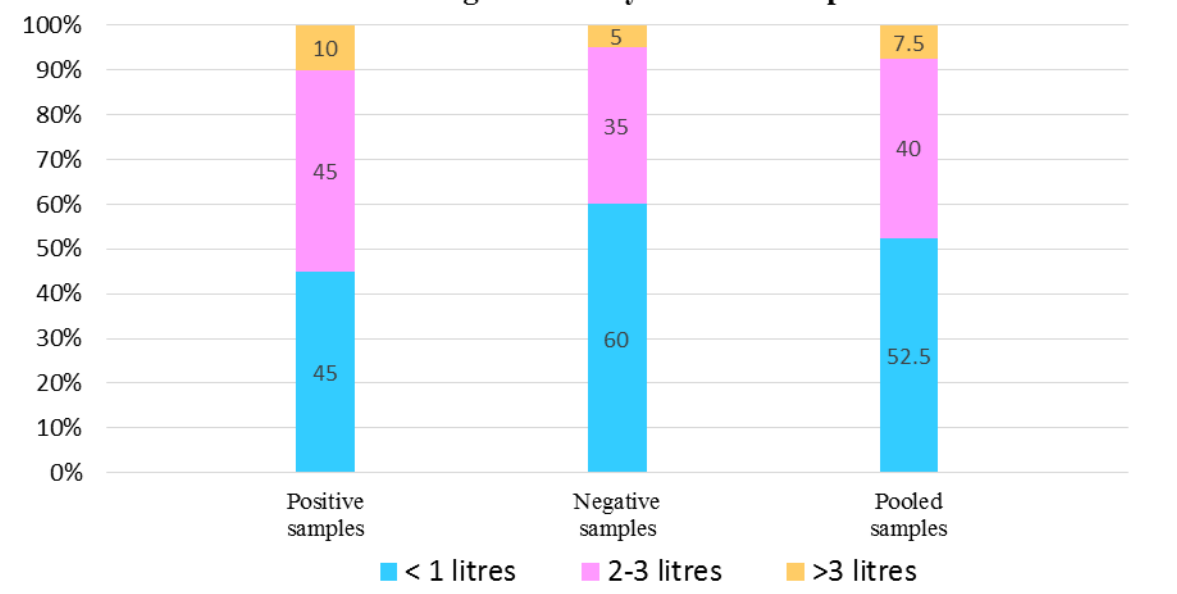


Fig: 4.3.3 Duration of consumption of milk from the same source

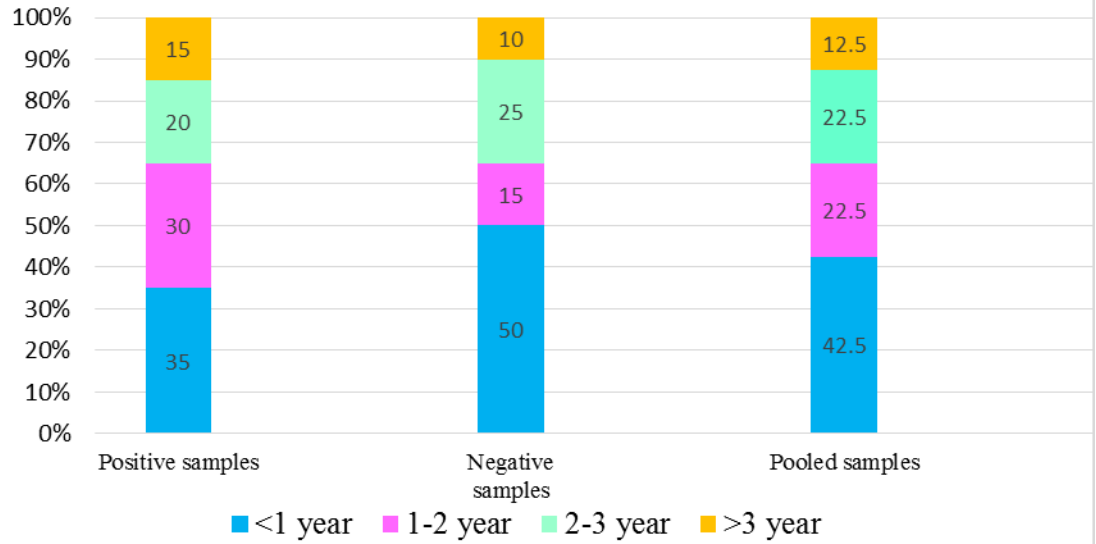


Fig: 4.3.4 Satisfaction level towards quality of milk

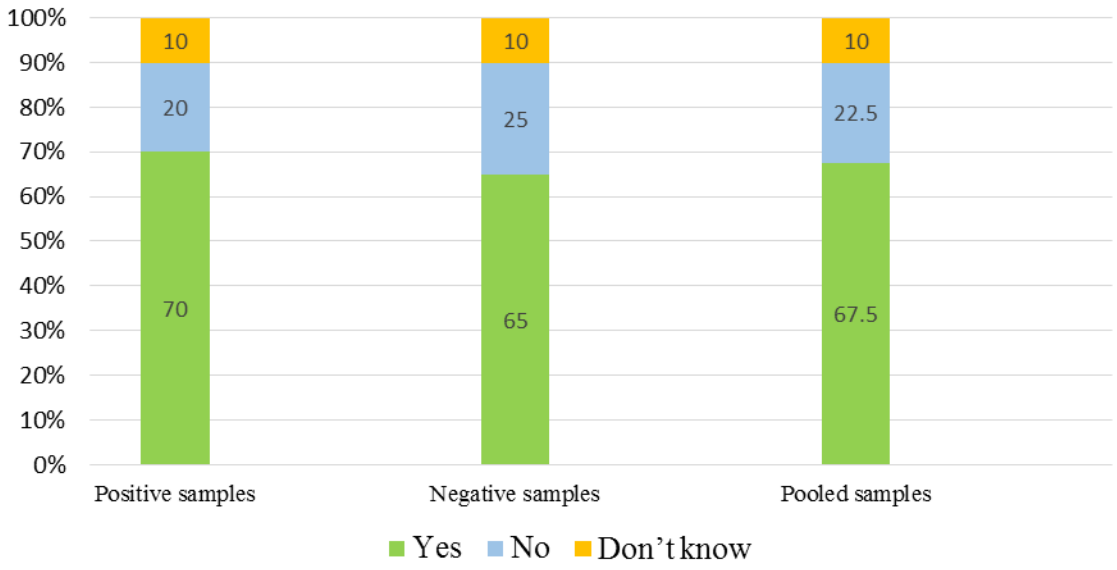


Fig: 4.3.5 Assessment of adulteration

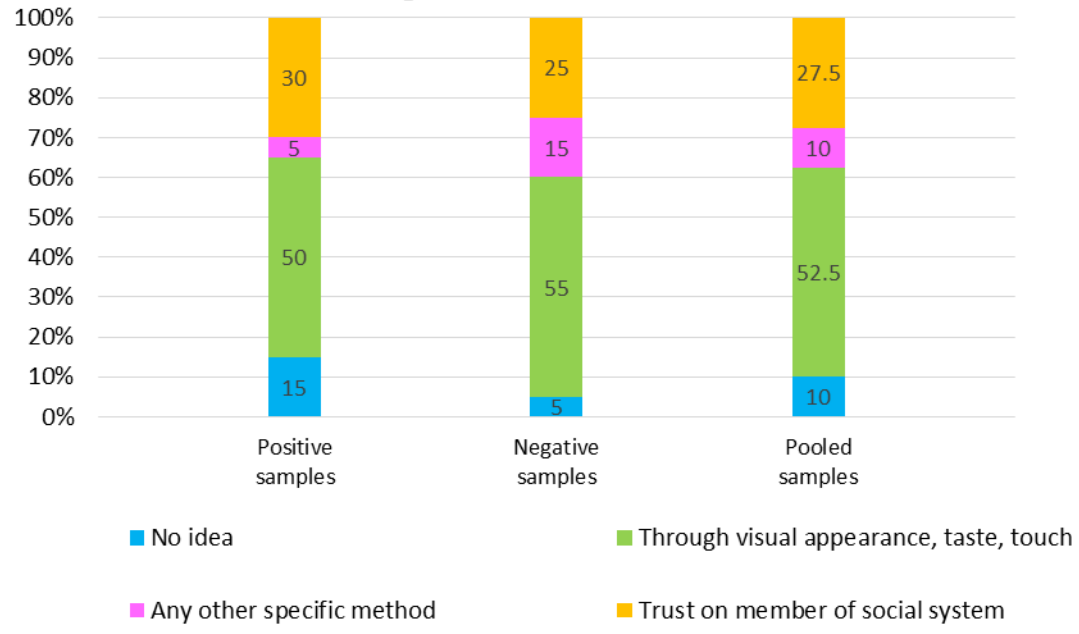


Fig: 4.3.6 Experience/observation of possible harmful effect of adulterated milk on health

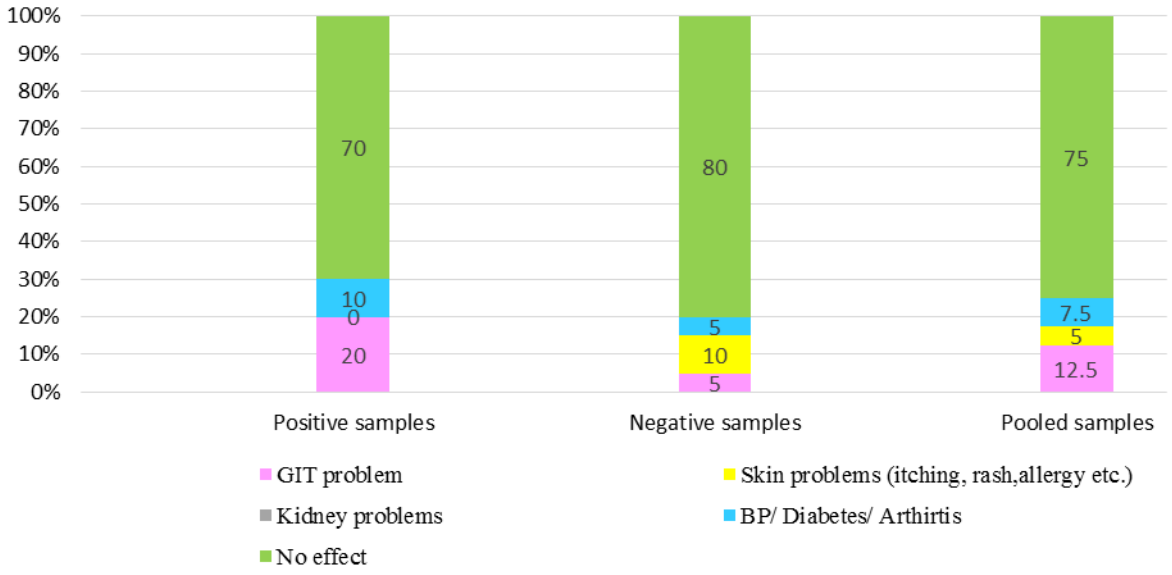


Fig: 4.3.7 Distribution of respondents according to awareness level towards disease transmitted through milk

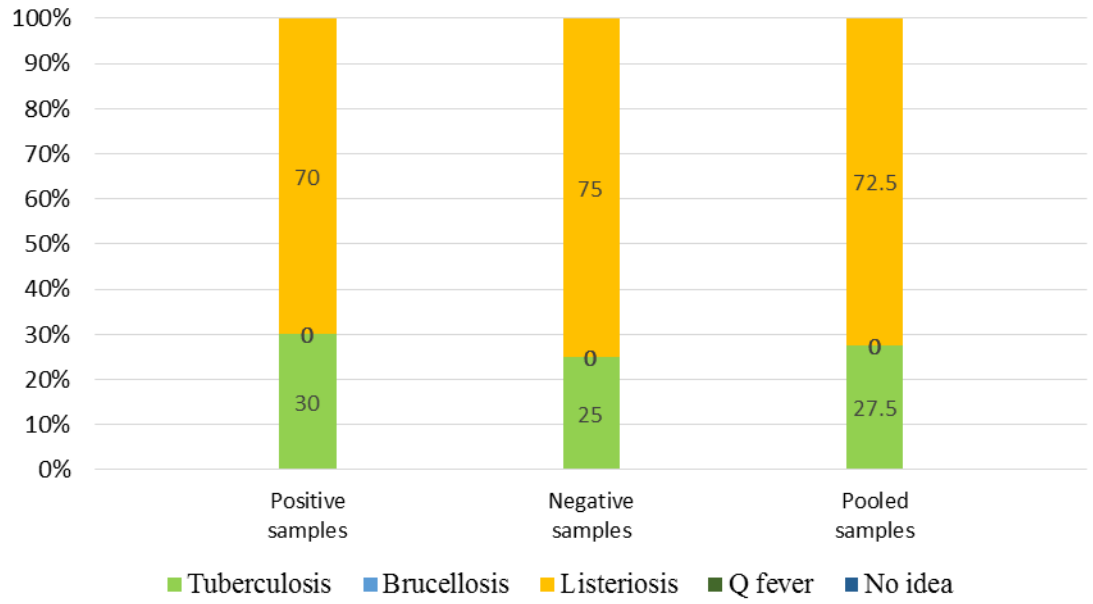


Fig: 4.3.8 Distribution of respondents on the basis of adulteration ever faced

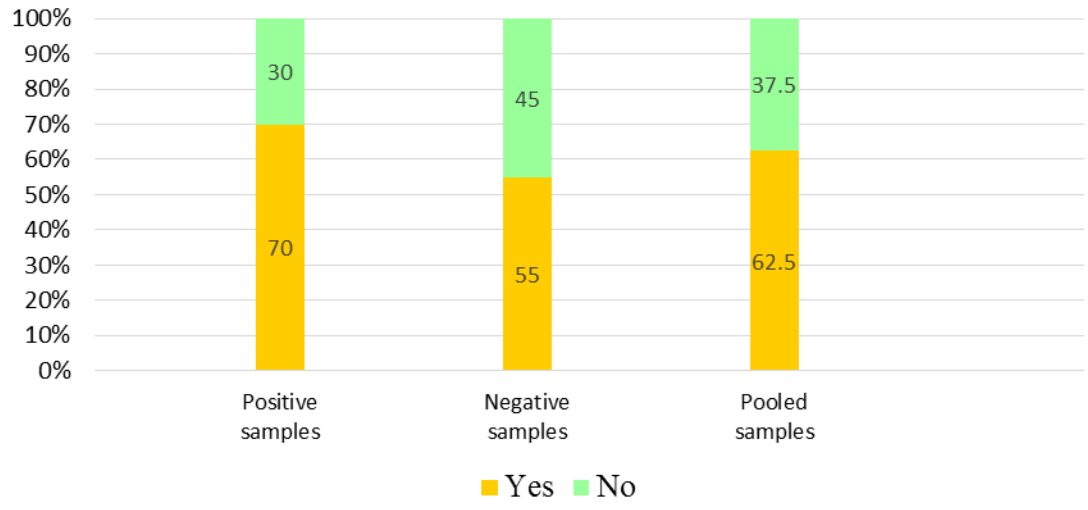


Fig: 4.3.9 Perception of respondents over problem of milk adulteration in the region

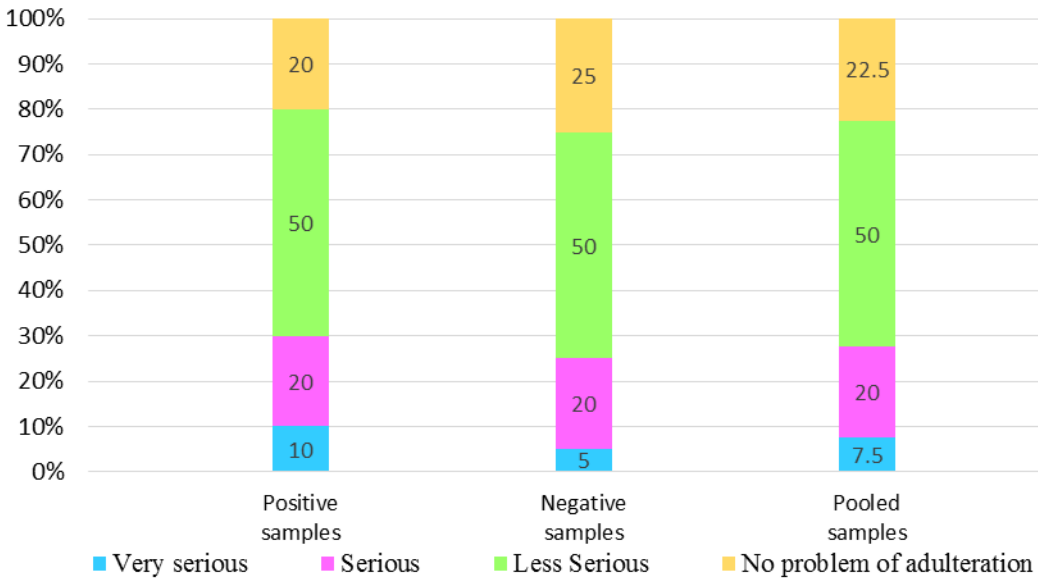


Fig: 4.3.10 Perception of respondents in terms of extent of adulteration in various types of milk

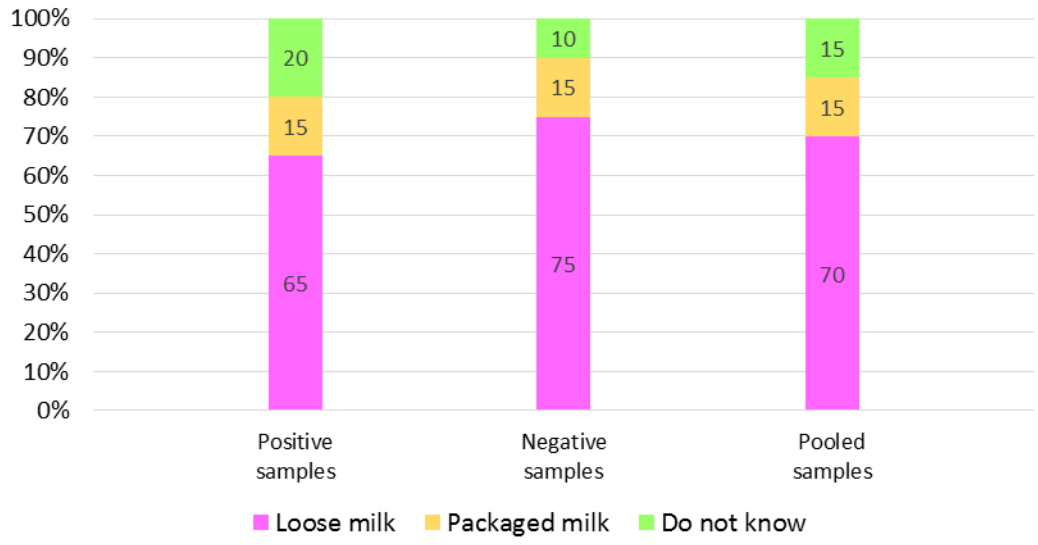


Fig: 4.3.11 Perception of respondents in terms of extent of adulteration in various types of milk products

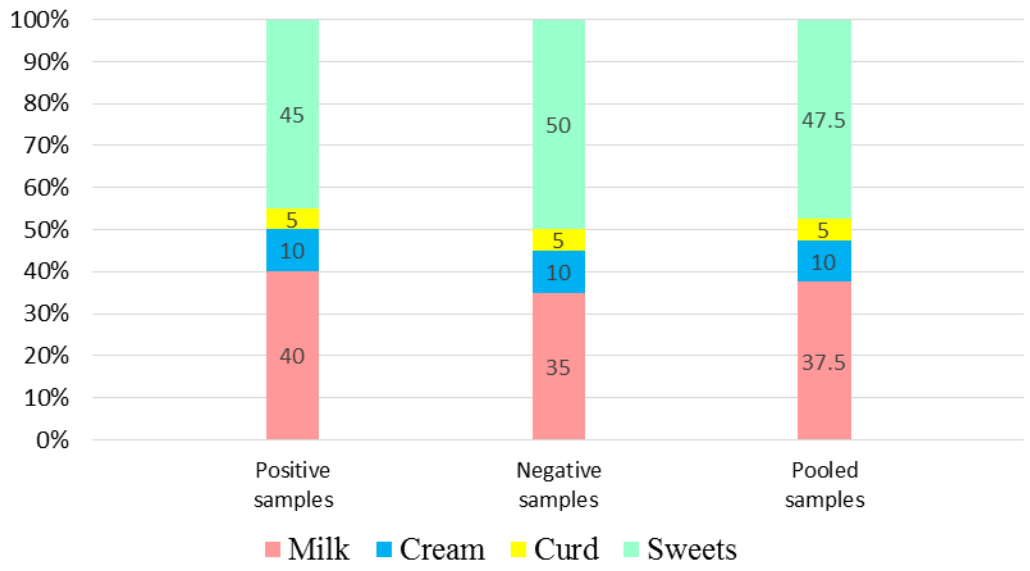


Fig: 4.3.12 Perception towards common adulteration ingredients used

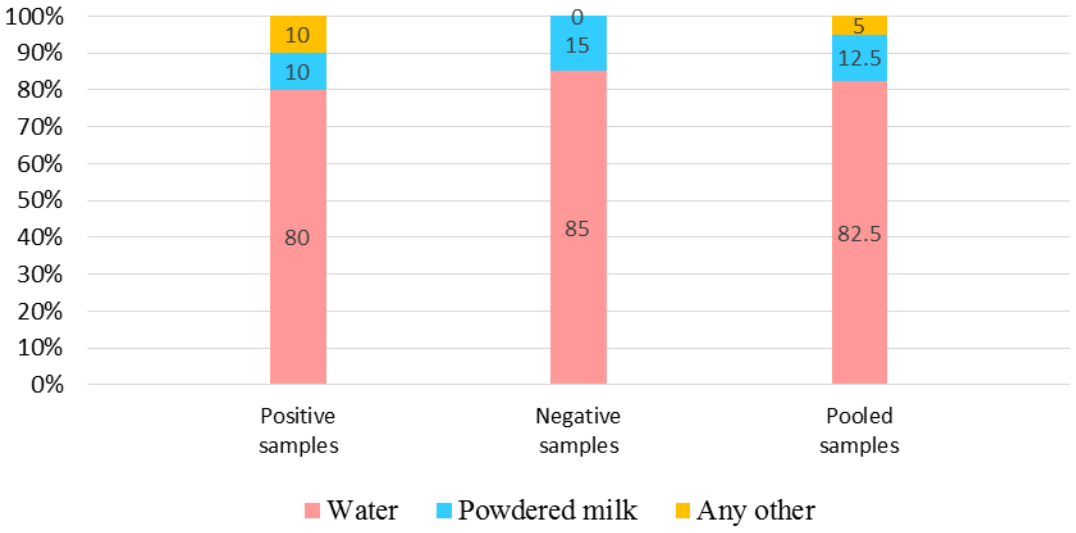


Fig: 4.3.13 Perception towards water as potential health hazard adulterant

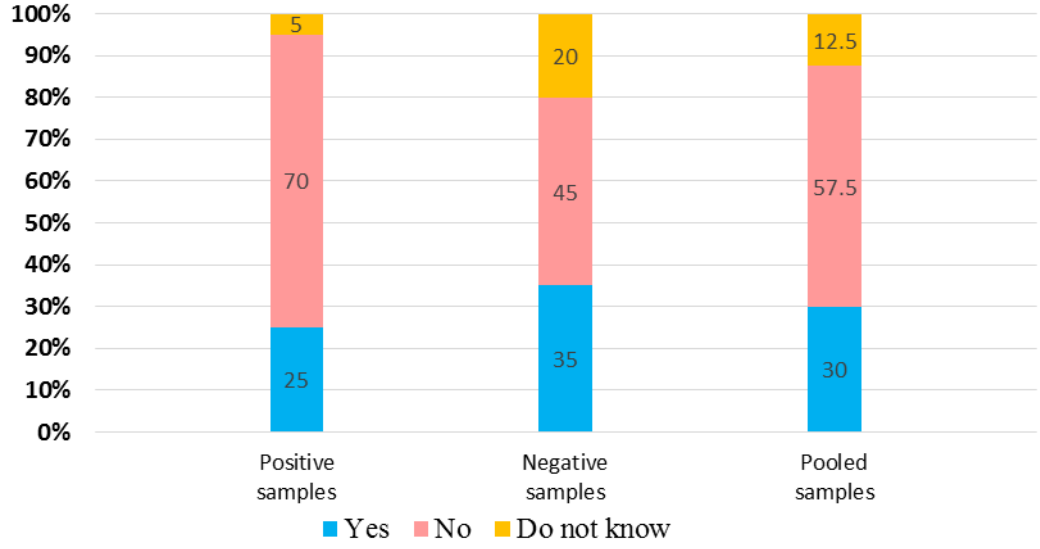


Fig: 4.3.14 Awareness level towards method of detecting adulteration in milk

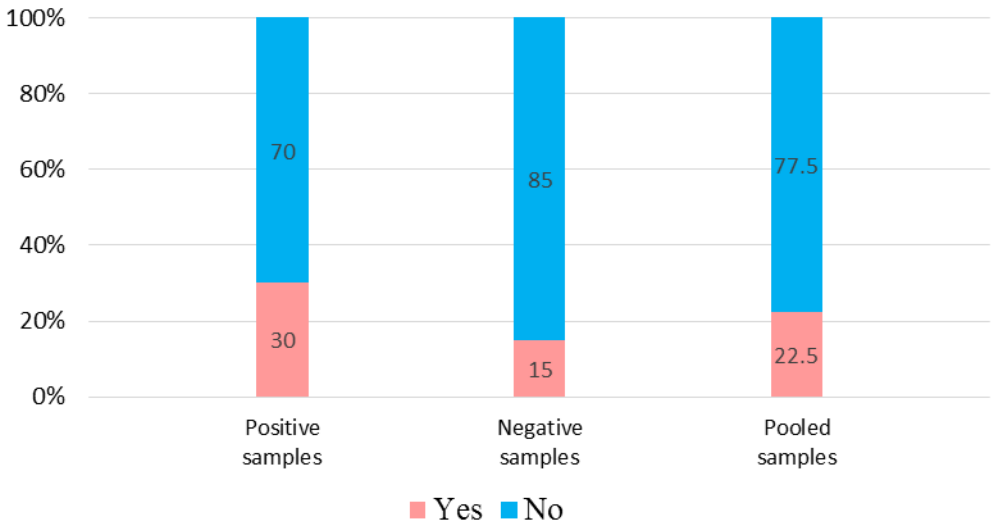


Fig: 4.3.15 Awareness about Govt laws against milk adulteration

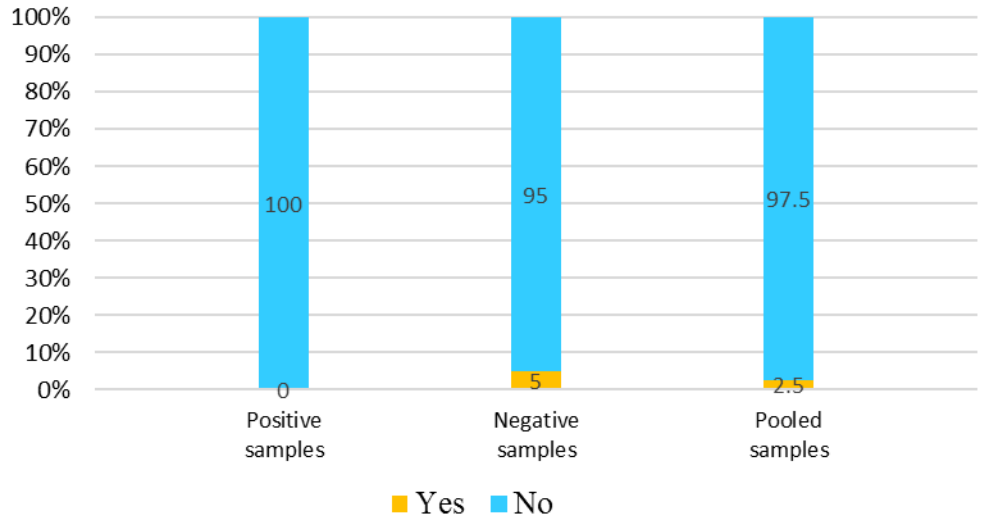
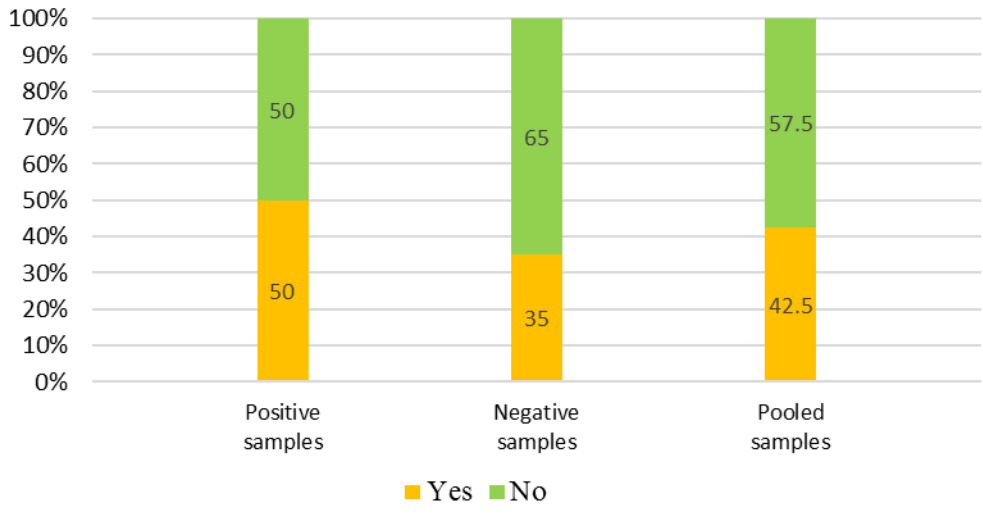


Fig: 4.3.16 Willingness of reporting of milk adulteration to authorities



CHAPTER 5

SUMMARY AND CONCLUSION

Dairy industry in India is having greater importance due to its contribution to the economy as well as to the rural poor by providing an opportunity to uplift them by generating additional income through it. Consumption of milk and milk products is deeply rooted in our tradition and it is an essential item during rituals, festivals and auspicious events. India has become the largest producer of milk in the world despite being the largest producer of milk in the world the act of intentionally debasing the quality of milk has emerged as one of the major problems to India's dairy industry. Increased demand, growth in competition in dairy industry and financial gain makes some producers to adulterate the milk. The nature of adulterants generally encountered in milk are water, removal of fat, addition of skim milk powder, reconstituted milk, thickening agents such as starch, flour, glucose, urea, salt, chlorine. Preservatives such as neutralizers which usually consists of sodium bicarbonate, sodium carbonate, sodium hydroxide and calcium hydroxide.

Adulteration of food products specially milk is a major problem and may lead to severe health problems. When consumers buy milk, they have the right to assume that it will be pure and unadulterated. Himachal Pradesh is not exceptional to this according to recent reports of government authority. Further, scanty research data about the milk quality in Himachal Pradesh leads to design the present study to assess the milk quality with reference to adulteration and its significance on consumers' health.

Total 200 raw market milk samples were collected in 100 ml screw capped clean and sterilized plastic bottles from different places of Himachal Pradesh. Each bottle was coded and subjected to laboratory techniques in an isothermal box to access the quality and adulterants present in market milk directly collected from the consumer table. The collected samples were analysed for specific gravity, fat, solid not fat and total solids by set laboratory procedure. While the adulteration tests were done by using a standard milk adulteration kit manufactured by HIMEDIA laboratories, Mumbai, India. HiMedia Adulteration Testing Kit protocol (HiMedia, Mumbai, India) as per the instructions given in the kit manual.

The results are summarized as to analyse the physico-chemical properties of market milk samples and qualitative analyses of different adulterants present in market milk. To find out the public health importance of adulterated milk a survey was conducted to study the behaviour of consumers towards milk adulteration and its effect on their health. Semi-structured interview schedule/ questionnaires were prepared and administered to total 40 consumers (20 from positive and 20 negative milk samples) to collect the required information. The data was coded, edited, tabulated and statistically analysed.

The specific gravity of milk samples ranged from 1.010-1.032 with an average value 1.022±0.005 which was less than the minimum prescribed standards of FSSAI (1.028) for cow milk in Himachal Pradesh. Out of 200 samples 148 (74%) samples were found below the standards indicating dilution with water and skimming practices. The mean specific gravity of Zone I and Zone II was 1.021±0.00, and in case of Zone III it was 1.024±0.00. The number of samples which were below milk quality standards in case of Zone I (n=62) was 50 (80.6%), in case of Zone II (n=70) was 54 (77.1%), and in case of Zone III (n=68) was 44(64.7%).

The fat percentage of milk samples ranged from 1.0-9.2 with an average value 3.5±0.10 which were just matching the minimum prescribed for market milk by FSSAI standards for cow milk in Himachal Pradesh. Out of 200 samples 139 (69.5%) samples were found below the standards. Similarly mean value of fat percentage in Zone I, II, and III were 3.30±0.19, 3.67±0.18, and 3.53±0.17 respectively. The number of samples which were below milk quality standards for fat in Zone I, 47(75.8%), in Zone II, 50(71.4%), and in Zone III, 42 (61.7%).

The solid not fat percentage of milk samples ranged from 3.6-12.8 with an average value 7.01 ±0.10 which was also less than the minimum prescribed standards of FSSAI for cow milk in Himachal Pradesh. Out of 200 samples 165 (82.5%) were found below the standards. The mean value of %SNF in case of Zone I was 6.7±0.18, in case of Zone II was 6.8±0.19, and in case of Zone III 7.52±0.16. The number of samples which were below milk quality standards for fat in case of Zone I was 56 (90.3%) in case of Zone II was 59(84.2%) and in case of Zone III was 50 (73.5%).

The total solids percentage of milk samples ranged from 4.6-19.2 with an average value 10.54±0.17 which was also less than the prescribed standards of FSSAI for cow milk in Himachal Pradesh. Total 73.5% samples were below the standards. The mean value of %TS in

case of Zone I was 10.0±0.30, in case of Zone II was 10.4±0.32, and in case of Zone III 11.06±0.27. The number of samples which were below milk quality standards for fat in case of Zone I was 51 (82.2%) in case of Zone II was 53(75.7%) and in case of Zone III was 48(70.5%).

The present study revealed the most common adulterant in milk samples was water. Out of 200 milk sample studied, 148 (74%) milk samples were adulterated with water as indicted by lowered specific gravity, fat percentage, SNF and TS content of tested milk samples. In case of Zone I (n=62) 80.6% samples, in case of Zone II (n=70) 77.1% samples, and in case of Zone III (N=68) 64.7% samples were adulterated with water. Percentage of added water in milk was calculated in all the samples which were positive for water adulteration. Out of 148 samples which were positive for water adulteration, 75(50.6%) samples were lying in low range, 66 (44.6%) in medium and 7(4.7%) in high range.

Out of 200 milk samples 27(13.5%) samples were positive for alizarin test out of which 4 samples were acidic and 23 were alkaline in nature. In case of Zone I number of samples 1/8(1.6/12.9%), in case of Zone II 2/7(2.8/10%), and in case of Zone III 1/8(1.4/11.7%) were positive for acidity/alkalinity respectively.

The adulteration of milk samples with formalin was found to be 1%. None of the samples were positive for formalin in Zone I and Zone II whereas in case of Zone III 2(2.8%) were positive for formalin.

According to present study the neutralizers adulterated milk samples were 1%. None of the samples were positive for neutralizers in Zone I and Zone II whereas in case of Zone III 2(2.8%) were positive for neutralizers.

Out of 200 milk samples 6(3%) samples were positive for detergent. Total 3(4.8%) samples in Zone I, 3(4.2%) in Zone II and none in Zone III were found to be positive for detergent.

The adulteration of milk with sodium chloride was found to be 18%. Total 14(22.5%), 15(21.4), and 7(10.2%) samples were positive for sodium chloride in Zone I, II and III respectively.

According to present study the glucose adulterated milk samples were 1%. Total 1(1.6%), 1(1.4%) and none samples were positive for glucose in Zone I, II and III respectively.

Out of 200 milk samples 19(9.5%) samples were positive for Skim milk powder. Total 3(4.8%), 7(10%), and 9(13.2%) samples were positive for skim milk powder in Zone I, II and III respectively.

In current study sucrose adulterated milk samples were found to be 1.5%. In case of Zone I number of samples 1(1.6%), in case of Zone II 1(1.4%), and Zone III 1(1.4%) were positive for sucrose.

Other adulterants tested in this study were urea, starch, hydrogen peroxide, maltose, cellulose, ammonium sulphate, protein, boric acid, pond water/nitrate and which were found to be negative in all the milk samples.

Milk vendors were the source of milk for consumers in case of majority of positive (70%) and negative (75%) samples. Neighbours and relatives provides milk to 30% respondents in case of positive samples and 25% in case of negative samples. Majority of the respondents in case of positive samples 45% respondents, in case of negative samples 60% had daily consumption of milk < 1 litres a day. High percentage (35%) of respondents in case of positive samples and even higher percentage (50%) in case of negative samples had been using milk from same source for less than one year. Majority of respondents in case of positive samples (70%) and in case of negative samples (65%) were satisfied with the quality of milk being consumed. Maximum of the respondents used visual appearance, taste, touch to assess adulteration in case of positive samples (50%) and negative (55%) samples. 30% of the respondents in case of positive samples and 25% in case of negative samples had trust on members of social system.

Majority of the respondents did not observe any harmful effect on health due to milk adulteration in case of positive (70%) and negative (80%). Majority of the respondents were not aware about disease transmission through milk in case of positive (70%) and negative (75%) samples. Majority of the respondent in case of positive samples (70%) and in case of negative samples (55%), had faced the problem of milk adulteration. Maximum of the respondents (50%) in all positive, negative samples had perception that there was less serious

problem of milk adulteration in their region. Majority of the respondent in case of positive samples (65%), and in case of negative samples (75%), had perception of loose milk adulteration rather than packaged milk.

Most of the respondents in case of positive samples (45%), and in case of negative samples (50%), had perception that sweets are the most adulterated milk product. Most of the respondents in case of positive samples (80%), and in case of negative samples (85%) had perception that water was the most common adulterants in milk. Majority of respondents in case of positive samples (70%), and in case of negative samples (45%) samples had perception that addition of water in milk is not a health hazard. Majority of the respondents in case of positive samples (70%), and in case of negative samples (85%) had no idea about simplest method of detecting adulteration in milk. All the respondent in case of positive samples (100%) and in case of negative samples (95%), had no idea about government laws against milk adulteration. In case of positive (50%) and negative samples (35%) respondent showed the willingness of reporting of milk adulteration to authorities.

CONCLUSION

None of the individual sample was found positive for all the synthetic ingredients (urea, detergent or soap, sodium hydroxide, vegetable oil, and salt) required for production of synthetic milk.

Out of 200 milk samples 74%, 69.5%, 82.5%, and 73.5% samples did not qualify the prescribed minimum standards of FSSAI for specific gravity, fat, SNF, and TS respectively in the Himachal Pradesh.

Further assessment of adulteration depicted that water was the most common adulterant (74%) found in the milk samples followed by salt (18%), alizarin (13.5%), skim milk powder (9.5%), detergent (3%), sucrose (1.5%), glucose (1%), formalin (1%), and neutralizers (1%).

Other adulterants tested were urea, starch, hydrogen peroxide, maltose, cellulose, ammonium sulphate, protein, boric acid, pond water/nitrate which were not detected in any of the samples.

Majority of respondents had perception that the problem of adulteration was less serious and water was the most commonly used milk adulterant and it would not cause any health hazard. Further, they believe on the social system for milk quality.

Majority of respondents preferred the method of assessment of adulteration was through visual appearance, taste, touch and they perceived that adulterated milk had not harmful effect on their health.

From the present survey study, it could be concluded that majority of the respondents had low awareness towards disease transmission through milk, government regulations for milk adulteration and proper reporting system.

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APPENDIX I

QUESTIONNAIRE

Questionnaire on Public Health problems with consumption of adulterated milk

a. Name

b. Address

c. Gender

d. Age

1. From where do you buy milk?

a) Packaged milk b) Milk Vendor

2. How much milk you buy on daily basis?

a) >1 litres b) 2-3 litres c) <3 litres

3. How long are you consuming the milk from the same source?

a) < 1 year b) 1-2 year c) 2-3 year d) >3 year

4. Are you satisfied with the quality of milk supplied?

a) Yes b) No c) Don't know

5. How do you assess the adulteration?

a) No idea

b) Through visual appearance, taste, touch

c) Any other specific method

d) Trust on the member of social system

6. Do you experience/observe possible harmful effect of milk adulteration in your health?

a) Gastro intestinal problems (nausea, vomition, diarrhoea, loss of appetite)

b) Skin problems (itching, rash, allergy etc.)

c) Kidney problems

d) BP/ Diabetes/ arthirits

e) No effect

7. What are the major diseases transmitted if the milk quality is poor?

a) Tuberculosis

b) Brucellosis

c) Listeriosis

d) Q fever

e) No idea

8. Have you ever come across adulteration?

a) Yes b) No **c)** If yes what was it?

9. Perception about adulteration in milk and milk product

How serious is the problem of milk adulteration in your area?

a) Very serious

b) Serious

c) Less serious

d) No problem of adulteration

10. Which among the following is more adulterated?

a) Loose milk b) Packed milk c) Do not know

11. What do you think the milk you are drinking adulterated with?

a) Water b) Powder milk c) Any other product

12. Which of the following you think is most adulterated?

a) Milk b) Cream c) Curd d) Sweet

13. Do you feel addition of water is health hazard?

a) Yes b) No c) Do not know

14. Do you have any idea about simplest method of detecting adulteration in milk?

a) Yes b) No c) yes what it is?

15. Are you aware about Government laws against milk adulteration?

a) Yes b) No

16. After getting proof for adulteration in your milk, will you complaint to any authority?

a) Yes b) No

APPENDIX II

ZONES	Altitude (m)	Areas
Zone I (Subordinate and low hills)	350-650	Una, Bilaspur, Hamirpur, and parts of Sirmaur, Kangra, Solan and Chamba district
Zone II (Mid-hills)	651-1800	Tehsils of Palmpur and Kangra , Rampur tehsil of Shimla district and parts of Mandi, Solan, Kullu, Chamba, Sirmaur and Shimla district
Zone III (High hills)	1801-2200	Shimla district (except Rampur tehsil) and parts of Kullu, Solan, Chamba,Mandi, Kngra and Sirmaur district
Zone IV (Very high hills)	>2200	Kinnaur, Lahaul and Spiti, and Pangi and Bharmaur tehsil of Chamba district

Brief Resume of the Student

Name	:	Tanu Palsra
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Mother's Name	:	Smt. Bhawna Devi
Date of Birth	:	05/03/1992
Permanent Address	:	Vill. Arnodi P.O Kotli, Teh-Kotli, Distt. Mandi H.P Pin-175003
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Academic Qualifications:

Qualification	Month/ Years	School/Board/ University	Marks (%)	Division	Major subject
10^{th}	2007	HPBOSE	73.85	I^{st}	English, Hindi, Mathematics, Science, Sanskrit, Art, Social science
10+2	2009	HPBOSE	76.2	I^{st}	Physics, Chemistry, Biology, English, Physical education
B.V. Sc. & A.H.	2016	CSKHPKV, Palampur	73.30	I^{st}	All courses covered under VCI curriculum