

## A THOROUGH REVIEW ON MILK ADULTERATION, ITS EFFECT ON HEALTH AND DETECTION TESTS

Dr. S. M. Lahankar<sup>1</sup>, Dr. Ujwala Chavan\*<sup>2</sup> and Dr. Nilesh Gore<sup>2</sup>

<sup>1</sup>Asso. Professor, Department of Agadtantra, Govt. Ayurvedic College, Osmanabad.

<sup>2</sup>PG Scholar, Department of Agadtantra, Govt. Ayurvedic College, Osmanabad.

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**\*Corresponding Author**

**Dr. Ujwala Chavan**

PG Scholar, Department of  
Agadtantra, Govt. Ayurvedic  
College, Osmanabad.

### ABSTRACT

Milk is considered as complete food as it contains abundant of nutrients which required for growth and development in infants, adults and elder ones. It is a good source of proteins, fats, sugars, vitamins and minerals. Unfortunately, milk and milk products are easily adulterated throughout developing as well as developed countries due to lack of monitoring and proper law enforcement. Nearly 68.7% of milk and milk products sold in India as not per standards laid down by the Food Safety and Standard Authority of India (FSSAI). Due to high proportion rate of global population increased demands of milk than its production. Normally adulteration of milk is done for either financial

gain or due lack of hygiene during processing, storage, transportation and marketing. Common adulterants found in milk are water, starch, urea, skim milk powder, cane sugar, formalin, detergents and so on. Milk adulteration not only decreases its nutritive value but also leads to several health issues. It is an efficient vehicle for various diseases from unhygienic dairy animal, human handlers, adulterants and some environmental factors like polluted water, flies, dust, etc. Presenting study conducted for thorough review on milk adulteration, its effect on human health and its detection methods or tests.

**KEYWORDS:** Milk, Adulteration, Unhygienic, Water, Financial Gain, Urea.

### INTRODUCTION

Milk is an ideal food for infants, adults as well as elder persons due its large quantity of nutrients.<sup>[1]</sup> It is one of the valuable sources of protein, fats, vitamins, various types of minerals as well as carbohydrates for growth and development of body.<sup>[2]</sup> the contents of milk are different with breed, feed, stage of lactation, season of year and many other factors.<sup>[3]</sup> it is

easily digested and absorbed in the body tissues. It contains 87% water, 3.9% fat, 3.3% protein, 5% lactose, and 0.7% ash. It provides bone forming calcium and minerals, energy supplying lactose and milk fat, body building protein, health giving vitamins, along with it provides certain essential fatty acids with all essential amino acids.<sup>[4]</sup> In ancient science, Acharya *Sushruta* explained properties of milk such as milk is *Madhura rasatmaka*, *Sheeta viryatmaka*, it gives strength to body, increase life span also rejuvenating property.<sup>[5]</sup> Due to these properties of milk make it an ideal and important food in the routine diet.

Unfortunately, milk is simply adulterated throughout developing and underdeveloped countries due to increased demand of nutritious food and low socioeconomic customers. It is adulterated either for financial gain or lack of hygiene during processing, storing, transportation, marketing and unorganised and non-regulated marketing system and poor law enforcement. Food adulteration rates are increasing day by day and if we talk about milk, the adulteration rates are higher in India followed USA and Russia. It is very common that Indian milkmen mixing water in milk before delivering it to the customers for financial profit. But, nowadays, vendors are not only mixing water but also hazardous substances like urea, hydrogen peroxide, detergents, formalin etc. which are not only decreases the quality of milk but also harmful to the consumers. Nearly 68.7% of milk and milk products sold in India as not per standards laid down by the Food Safety and Standard Authority of India (FSSAI). It is more prevalent in northern state as compared to southern state.<sup>[6]</sup> National survey on milk adulteration 2011 found that due to lack of hygiene and sanitation in handling and packaging, detergents used in washing containers and other surfaces find their way into milk and its products.<sup>[7]</sup>

Milk powder is the second most food which is easily adulterated after olive oil.<sup>[8]</sup> For increasing shelf life of milk some adulterants are added into milk to prevent financial loss from spoilage of milk during its storage, transportation and marketing. Water is the most common and oldest form of adulterant in milk for increasing the quantity of milk. It decreases the quality as well as nutritional value of milk. Due to this, thickening agents are used like starch, flour, skimmed milk powder, whey powder to counter the dilution of milk. Vegetable oil, cane sugar or urea to compensate the fat, carbohydrates or protein content of milk. Some chemicals such as hydrogen peroxide, carbonates, bicarbonates, antibiotics, caustic soda, melamine, formalin, chlorides, ammonia are used to increase shelf life of milk.<sup>[9]</sup>

Adulteration of milk is burning and global problem of both government as well as dairy industry. Milk is an efficient vehicle for a great variety of diseases. The source of contamination of milk may be dairy animal, human handler, adulterants, environmental conditions like contaminated vessels, pond water, flies or other micro-organisms. Adulterated milk gives harmful effect on health and vital organs like heart, liver, kidney. So, presenting thorough review of milk adulteration has been conducted from various research articles and news papers for brief knowledge related to milk adulteration, its effect on health and commonly performed detection tests.

### **Methodology**

This study is conducted by following manner for fulfilment of its aim and objectives.

1. Conceptual study
2. Comparative study
3. Result and discussion
4. Conclusion

**Adulteration:** Food adulteration is a growing problem which has needed to elaborate and investigate as a potential food safety and public health concern in recent era.<sup>[10]</sup> This situation is remarkably worse in developing and under developed countries due to lack of management and proper law enforcement. Food and Drug Administration (FDA) was defined adulteration in 2009 as “the fraudulent, intentional substitution or addition of a substance in a product for the purpose of increasing the apparent value of the products or reducing the cost of its production” and can often encompass effects public safety through the unknown addition of allergens, toxins and hygienic risk.<sup>[11]</sup> Generally, adulteration is for two reasons, first is financial gain and second is improper hygienic condition during processing, storing, transportation and marketing. Unfortunately, it leads to stage where consumer is either cheated or often affected by diseases. It is very common in developing countries like India, China. So, it is most important for consumer to acquire knowledge related to common adulterants and their effect.

### **Common adulterants in milk**

Various types of adulterants are used in milk. Among them some kinds of adulterant and their impact on health of human body are discussed below.

**Water**

Food Safety Standards Authority of India (FSSAI) was conducted a survey in 2011 on milk adulteration and concluded that most common adulterant found in milk to be the addition of water.<sup>[12]</sup> It is added for increasing quantity of milk which decreases its nutritive values. Lactometer is used to detect water quantity in milk. If water is contaminated there is risk of water borne diseases to human such as diarrhoea, amoebiasis, shigellosis, cholera, giardia, etc, So, from ancient years water is the cheapest and easiest way for adulteration of milk.

**Urea:** It is the natural constituent of raw milk and its maximum value declared by Food Safety Standards Authority of India (FSSAI), Act 2006 and Prevention of Food Adulteration (PFA) rules 1955 is 70mg/100ml.<sup>[13]</sup> It is added in milk for increment of protein in milk. It can also be increased due to unbalanced feeding of cows.<sup>[14]</sup> It also used for heat stability, to provide whiteness, for levelling the content of solid not fat (SNF) and increase the consistency of milk. Increased content of urea in milk may produce harmful effects on heart, liver and kidneys. It produces symptoms like acidity, indigestion, ulcers and cancers. It especially effects on kidneys as they do more work to excrete urea from urine.<sup>[15]</sup>

**Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>):** To increase shelf lifespan of milk various chemical preservatives are added in raw milk which is very common practice in worldwide. It is used as a preservative for increasing shelf life as development of micro-organisms spoil the milk. It can cause gastrointestinal complications which can further leads to gastritis and inflammation of intestine. Also, it disturbs the antioxidants in the body interrupting natural immunity and hence increasing aging.<sup>[3]</sup>

**Detergents:** It is added in milk to alter and dissolve the oil in water and giving a frothy solution which gives specific white colour of milk. It can cause gastrointestinal complications.

**Starch:** Starch is added in milk frequently to counter the value of vitamins and for energy. But, if large quantity of starch added in milk may leads to diarrhoea due to its effect of undigested starch in colon. It proves fatal in diabetic patient due to it accumulates in body.<sup>[16]</sup>

**Carbonates and bicarbonates:** These products are added as an adulterant in milk which may leads to disruption of hormone which can helps us to regulate and development of reproduction.<sup>[17]</sup>

**Chlorine:** After addition of water, for compensation of density of the diluted milk chlorine is added. Mastitis in cows also raises chlorine level in milk.<sup>[18]</sup> It can have affected on heart by clogging in arteries, so, heart related problems are developed. It can be detected in milk by performing titration with potentiometric detection and conductometric sequential injection analysis because of its simplicity and convenient method.<sup>[19]</sup>

**Antibiotics:** Antimicrobial agents in milk may cause certain effects on health of consumer such as allergic reactions, increase in the number of antibiotic resistant, interference in intestinal flora and some of antibiotics like sulfamethazine residues may leads carcinogenic properties, also causes tissue damage.<sup>[20]</sup> It interferes in the bacterial fermentation process which produces important losses in fermented products.<sup>[21]</sup> Minimal amount of penicillin residue can cause urticaria.

**Whey / liquid whey:** It can be used for increases volume of milk where huge amount of cottage cheese is prepared. It is safe when minimal quantity is used. High doses can cause some side effects such as increased bowel movements, nausea, thirst, bloating, cramps, anorexia, fatigue and headache.

**Chloride and Ammonia:** Chlorides in milk disturbs acid base balance in the human body also alters blood pH. Ammonia in milk can leads to regression, loss of acquired speech, kidney problem and sensory disturbances.

**Formalin:** It is found that milk was contaminated with formalin or formaldehyde. It is used as preservative of milk for increasing shelf life of milk. It not only decreases the nutritive value but also is carcinogenic. It does not show any significant influence on specific gravity and freezing point of milk. But, it decreases pH of milk.

**Melamine:** Melamine is added in milk for rise in protein content falsely. It is not only added in milk but also various foods like wheat gluten, chicken feed and processed food. Though it is not carcinogenic, but in extreme cases, may leads to renal failure and infant death.

Further, milk can be adulterated by rice flour, skim milk powder, chemical preservatives, reconstituted milk, milk of other animal, salt, vegetable oils, animal fat, etc. Adulterants are used to rise in volume, thickness, viscosity of milk and to maintain the composition of nutrition.

**Adulteration detection tests:** Qualitative and quantitative measurements of milk is important for food safety in the production process. There are several analytical methods have been proposed for rapid conclusion of quality and authenticity of milk such as liquid chromatography, gas chromatography, mass spectrometry, etc. Other analytical techniques like freezing point, osmometry, solid not fat percentage, fat %, electrophoresis, etc.<sup>[22]</sup> Also, different electrical methods are available to detect milk adulteration are potentiometric sensors, conductance measurement, conductivity ultrasonic detectors, E nose, E tongue, capacitance growth curve, impedance probe and so on.

#### **Following are the test for commonly used adulterants**

**Test for water:** Lactometer is used for detection of water in milk. The presence of water can be detected by putting a drop of milk on a polished slanting surface. Then, the drop of pure milk flows slowly leaving a white trail behind it, whereas milk adulterated with water will flow immediately without leaving a mark.

**Test for detergent:** Shake 5-10ml of milk sample with an equal quantity of water. Dense lather indicates presence of detergents.

#### **Test for urea**

1. Take a teaspoon of milk in a test tube. Add half teaspoon of soyabean or arhar powder. Mix up the contents thoroughly by shaking the test tube up to 5 minutes. Dip a red litmus paper after half a minute. A change in colour from red to blue indicates the presence of urea in milk.

2. Take a 5 ml of milk sample in test tube, add 20mg soyabean powder with 3 drops of 0.5% bromothymol blue. Observe for 10 minutes, blue or green colour of sample indicates the presence of urea.

#### **Test for synthetic milk**

Synthetic milk has a bitter taste, gives a soapy feeling on rubbing between the fingers and turns yellowish on heating.

#### **Test for synthetic milk protein**

Milk can easily be tested by urease stripes. The colour chart of the urease strip test given below will show quantity of urea present in milk.<sup>[23]</sup>

Table No. 1.

Sr. No.	Urea in milk	Colour of strip
1.	0 -- 0.2mg	Yellow
2.	0.2— 0.7mg	Peach
3.	0.7—1.2mg	Reddish brown
4.	1.2—1.7mg	Pink
5.	1.7—14.0mg	Magenta

**Test for starch:** Take 3 ml of milk sample in test tube, boil it for 2 minutes and allow to cool. Then add 2- 3 drops of 1% iodine tincture. The dark blue colour of mixture indicates presence of starch in milk.

**Test for sugar:** Take 15 ml of milk sample in test tube, then add 0.1 gm resorcinol powder and 2ml concentrated HCl. Then boil it on boiling water for 5 minutes. Observe for colour, red or pink colour indicates the presence of sugar.

**Test for salt:** Take 5ml of 0.134% silver nitrate ( $\text{AgNO}_3$ ) in test tube and then add 2 – 3 drops of 10% potassium chromate mixture, after appearance of red colour add 1ml of milk sample. Yellow colour of mixture indicates presence of salt.

#### Test for glucose

1. Take 5ml of milk sample in test tube, add 5ml Borfoeid liquid and kept it in water bath for 3 – 5 minutes. Blue colour of mixture indicates presence of glucose.
2. Take a strip of a Diacetic strip and dip it in the milk for 30 seconds to 1 minute. If strip changes colour, then it shows that the sample of milk contains glucose.

**Test for maltose:** Take 25 ml milk and boil, then add 5% lactic acid and allow it for cooling and filter. Take 5ml filtered liquid in test tube, add 1% iodine solution. Brown colour of mixture indicates presence of maltose.<sup>[24]</sup>

#### Diseases by contamination of milk

##### 1. Infections of animals that can be transmitted to human.

Table No. 2.

Sr. No.	Primary importance	Lesser importance
1.	Tuberculosis	Cowpox
2.	Brucellosis	Foot and mouth diseases
3.	Streptococcal infections	Anthrax
4.	Staphylococcal enterotoxin poisoning	Leptospirosis
5.	Salmonellosis	Tick bone encephalitis
6.	Q fever	

2. Infections primary to human that can be transmitted through milk: typhoid and paratyphoid fevers, shigellosis, cholera, enteropathogenic *Escherichia coli* (EEC) and non – diarrhoeal diseases like diphtheria, viral hepatitis, etc.

**Prevention of Adulteration:** The adulteration of milk is banned due to hazardous effect on health especially on infants. Due to milk adulteration above diseases are caused hence prevention and awareness in public is very essential. It can be prevented by providing strict law enforcement, proper maintaining hygiene during processing, storing, transportation and marketing. It can be prevented by routine check up of animals and vaccination, before drawing milk maintain external hygiene of animals or surroundings. Keep utensils clean, sterile and covered. Major precaution for adulteration of milk, before consuming boil it for at least 15 minutes, due to this large number of micro-organisms are destroyed. Also, conduction of various programmes related to awareness of milk adulteration in school, society or other public places. It can be prevented by commonly used adulteration detection tests or methods. Legal authorities should frequently investigate or observation of milk industry for attaining minimal legal standards.

## DISCUSSION

Milk and milk products adulteration has existed since historical times. Due to this it was essential to specify regulatory standards to counter alteration in food, evolve methods for detection of adulteration particularly milk with easiest way, sometimes toxic chemicals are added which gives harmful effects on human health. Due to increase the demand of milk in markets and lesser production of milk are the main cause of adulteration of milk i.e. either for financial gain or due to lack of hygiene maintain during process, storage, transportation and marketing. It is more common in developing and under developed countries which direct impact on physicochemical properties of milk. Due to expanding of small holding farmers and poor milk handling processes and lack of proper law enforcement, milk adulteration increases day by day. To keep milk temporarily fresh, some chemicals or preservatives are added to compensate financial loss due to spoilage of milk, during its transportation and marketing. Among them water is the most common adulterant used worldwide, if it is contaminated may leads to several health issues. Other common adulterants like melamine, starch, detergents, urea, carbonates, cane sugar, etc. are used to increase shelf life and nutritive compositions of milk. But some chemicals are toxic to human body like chloride alters acid base balance, ammonia in milk can develops regression, loss of speech, sensory

disturbances or renal diseases. So, milk adulteration, poor hygiene, malpractice, lack of preservation technology, cooling facilities and sanitation conditions are the main causes of loss in quality of milk.

## CONCLUSION

Due to high nutritional value of milk, it is an important constituent in routine diet and considered as an ideal or complete food. Unfortunately, milk is easily adulterated due to its global increased demands. Adulteration of milk is not only altering the quality of milk but due to some toxic chemicals it gives adverse effect on health. Milk adulteration is the growing problem of both government and dairy industry in recent era. It can be adulterated by intentionally or accidentally. Milk used for human consumption can be adulterated by water, urea, starch, detergents, etc. and may cause diseases related to heart, liver, kidneys or some are carcinogenic. So, for milk adulteration various analytical or qualitative detection methods are available. Thus, more analysis is necessary to bring awareness in public about fraudulent or negligence in milk production and marketing. Also, peoples must be aware about what kind of mil they consume, and legal authorities should frequently observations and investigations of milk marketing for attaining minimal legal standards. So, it is expected that this paper gives overall review related milk adulteration, common adulterants, its effect on human health, adulteration detection tests and preventing majors.

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