Review Article

COMPREHENSIVE SCREENING OF COMPONENTS IN MILK AND ASSESSMENT OF ITS HYGIENE

Koppula Jyothi[1]*, Shaik Ayesha Ameen[1] and Babitha Angaluri[2]

[1]Department of Pharmaceutical Analysis,
K.C Reddy Institute of Pharmaceutical sciences, Guntur,
Andhra Pradesh, India.

[2]Department of Pharmaceutical Analysis, Hindu college of pharmacy,
Guntur, Andhra Pradesh, India.

ABSTRACT

Food adulteration is a universal concern and emerging countries are at greater risk accompanying with it due to lack of monitoring and policies. However, this is one of the most communal phenomena that have been overlooked in several countries. Since three decades, world milk production has amplified by more than 59 percent, from 530 million tonnes in 1988 to 843 million tonnes in 2018. India is the world's largest milk producer, with 22 per cent of world-wide production, followed by the United States of America, China, Pakistan and Brazil. Since the 1970s, most of the growth in milk production has been in South Asia, which is the foremost driver of milk production growth in the developing world. Unfortunately, in contrast to public belief, milk adulterants can pose serious health hazards leading to fatal diseases. This paper presents a thorough review of common milk adulterants. Nowadays milk is being adulterated in more sophisticated ways that demands for cutting edge research for the detection of the adulterants. This review intends to contribute towards the common information base regarding possible milk adulterants and techniques to maintain hygiene while processing.

Keywords: Adulteration, Kjeldhal Method, IDF Procedure, AOAC method, globular proteins, diluents, melamine.

INTRODUCTION

Due to the nutritional value of milk, it's testing and quality control is a small, medium or large scale requirement in any dairy processing industry. Milk is made up of 87% of water, so it can be contaminated by exploitative middlemen and unfaithful farmworkers. The basic factor that determines the quality of dairy products is the quality of raw milk. Raw milk of good-quality can only yield good-quality milk products, for any processor to make good dairy products, good quality raw materials are essential. Moreover, high nutritive value of milk makes it an ideal medium for the rapid multiplication of bacteria, particularly under unhygienic production and storage at ambient temperatures. The hygienic properties of milk are of vital importance in the production of milk and milk products that are safe and suitable for their intended uses. To achieve this quality, good hygiene practices must be implemented. Lack of financial incentives for quality improvement; and insufficient knowledge and skills in hygienic practices are found to be the prime difficulties tackled by small-scale dairy producers. Quality assurance of raw milk can only be achieved when some basic quality tests are carried out at various stages of milk transport from the manufacturer to processor and finally to consumer. Milk can be tested for:

- Organoleptic evaluation is checking the physical appearance, taste and smell in order to determine the overall quality.
- Compositional features especially fat, solid and protein contents are tested usually to ensure the levels of key components in milk.
- Physical and chemical characteristics are important criteria in studying the nutritional aspects of milk.
- Adulteration of milk with water, preservatives, added solids. Manufacturers in order to gain profits, perform adulteration in two ways by substituting with inert substances or by adding spurious substances that may be hazardous to health.

- Testing of hygiene involves analysis of conditions of processing, cleanliness. Poor hygiene introduces additional bacteria into the milk thereby making it susceptible to spoilage. To ensure the high preserving capacity of milk it is necessary to practice good hygiene.

COMPOSITION AND NUTRITIONAL VALUE OF RAW MILK: Milk is a considerable resource of products that have a different composition. Four components are dominant in quantitative terms: water, fat, protein and lactose; whereas the minor components are minerals, enzymes, vitamins, and dissolved gases. The fig: 1(flow chart) provided below shows the percentage of components present in milk.
It fulfils the demand of the consumer who seeks more and more inventive products with consistent quality. The dairy industry needs to make use of all the riches of this raw material, which is both simple in appearance and complex in composition. In common, cow milk is less rich in lactose, fat content and protein. On the other hand, the mineral content is alike. Milk contains numerous groups of nutrients; organic substances present in about equal quantity and are divided into elements builders, proteins, and energy components, carbohydrates and lipids. It also includes functional elements, such as traces of vitamins, enzymes and dissolved gases (5% by volume), mainly carbon dioxide (CO2), nitrogen (N) and oxygen (O2), and dissolved salts, particularly in the form of phosphates, nitrates and chlorides of calcium, magnesium, potassium and sodium.

Water: Milk comprises 88.6% of water, amount of water is depends upon the amount of lactose synthesized by the secretory cells of the mammary gland. Hydrometers are calibrated for different uses, such as a lactometer for measuring the density (creaminess) of milk.

Carbohydrate: Lactose is the chief carbohydrate of milk formed by the blending of one molecule of D-galactose and one molecule of D-glucose. Though lactose is a sugar, it has no sweet flavour. During the fermentation of milk by lactic acid bacteria lactose is used as substrate, differing in the fermented products such as yoghurt and cheese.

Proteins: Milk proteins have approximately the same composition as the egg protein, except for the amounts of methionine and cysteine, knowingly lower. Indeed, the sulfur amino acids are the limiting factors in milk. Casein and the complex milk protein contain good proportion of all amino acids essential for growth and maintenance. Total nitrogen and non-protein nitrogen content of milk can be estimated by Kjeldhal Method, IDF Procedure, and AOAC method.

Fat: In milk, fat is the key source of energy, present in the form of an emulsion of fat cells; fat content can be found in small cells suspended in water which varies substantially by race and composition of feed. Estimation of fat in milk can be estimated by Rose Gottlieb, Werner Schmidt and Gerber Method.

Minerals: The major salt elements, potassium, sodium, calcium, magnesium etc., are differentiated if the content is more than 0.1 g per litre of those containing trace amounts.

Vitamins: Levels of A, D and E are variable; depending on the season as there is an insignificant increase throughout the pasture season (spring-summer). They are fat-soluble, so it is found in fat and lost during skimming. Other vitamins are water soluble and are found in the serum. In the case of ascorbic acid (C), it is present in small quantities in fresh milk and is destroyed by contact with air and also during pasteurization. For cow milk, the milk processing techniques can significantly change the amount of vitamin C.

Enzymes: Enzymes are exact globular proteins produced by living cells. Each enzyme has its isoelectric point and is vulnerable to various denaturing agents such as pH change, temperature, ionic strength, organic solvent.

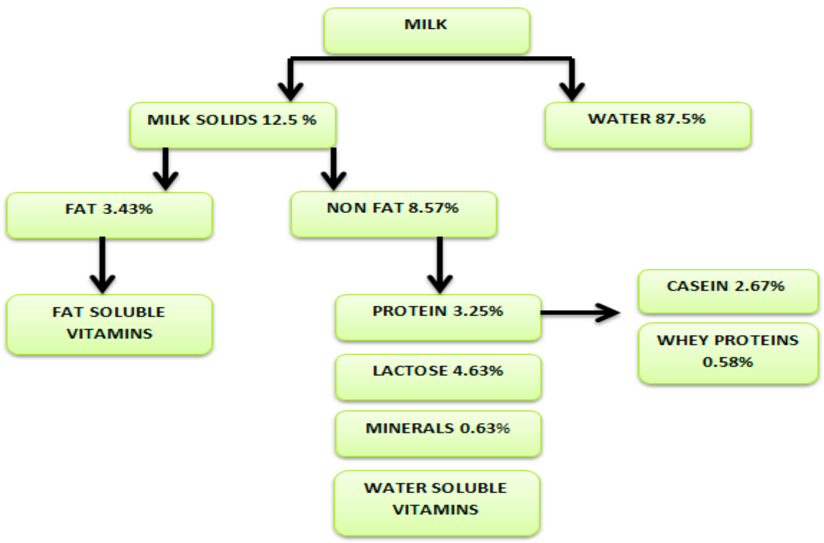

Fig. 1: Flow chart representing the components of milk

Adulteration of milk

It largely involve addition of vegetable protein, milk from different species, addition of whey and watering which are known as economically prompt adulteration. These do not cause any severe health risk. Still, some adulterants are too harmful to be ignored. Some of the utmost adulterants in milk having inauspicious health effect are urea, formalin, detergents, ammonium sulphate, boric acid, caustic soda, benzoic acid, salicylic acid, hydrogen peroxide, sugars and melamine. Adulterants are added in milk to raise these parameters, thereby enhancing the milk quality in dishonest way. For example, cane sugar, starch, sulphate salts, urea and common salts are added to increase solid-not-fat (SNF). Adulterants most likely found to be present in milk are shown in fig: 2. Urea, being a natural constituent of raw milk, has a maximum limit imposed by FSSAI (Food Safety and Standards Authority of India) which is to be 70 mg/100 ml. Marketable urea is added to milk to increase non-protein nitrogen content. Likewise, melamine to increase protein content falsely. Ammonium sulphate is to increase the lactometer reading by upholding the density of diluted milk. Formalin, Salicylic acid, Benzoic acid and Hydrogen peroxide act as preservatives and prolong the shelf life of the milk. As milk fat is very expensive, some processors of milk and dairy products separate milk fat for gaining profits and compensate it by adding non-milk fat such as vegetable oil. Detergents emulsify and dissolve the oil in water giving a frothy solution, which are the preferred properties of milk.

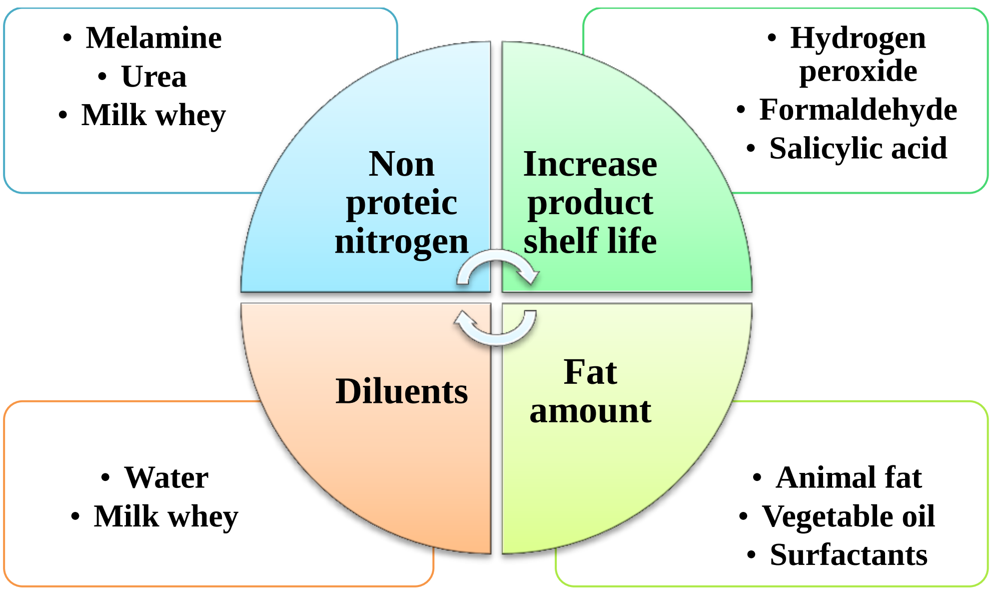

Fig. 2: various types of adulterants found to be present in milk

Unfortunately, some of the adulterants have severe health effect, occasionally in the long run. The assimilation of melamine at levels beyond the safety limit can bring renal failure and death in infants. Peroxides and detergents together in milk can cause gastro-intestinal problems, which can lead to gastritis and inflammation of the intestine. Extreme starch in the milk can cause diarrhoea due to the effects of undigested starch in colon, although, amassed starch in the body may be very fatal for diabetic patients. Urea in milk overloads the kidneys as they have to filter out more urea content from the body. Moreover, carbonate and bicarbonates might cause disturbance in hormone signalling that synchronize progress and reproduction.

VIGILANCE OF HYGIENIC STATUS OF MARKET MILK

Milk an aseptic lacteal secretion of healthy dairy animals may get contaminated from contaminated environment, containers, water, etc. Conversely, some time the lactating animals may be suffering from sub-clinical mastitis and other diseases and milk from such cases may decompose the bulk of milk. Some infectious bacteria such as tubercle bacilli, brucella spp, streptococcus spp, etc., are implicated to be cause of mastitis in dairy animals. These pathogens will pass on to raw milk. Such pathogens can be abolished by pasteurization of the milk, but as spore forming and thermoduric bacteria can sustain in the pasteurized milk and alleviate the shelf life of milk and destroy the milk. Upholding a high standard of hygiene is one of today's most important milk production goals. The hygiene level in a straight line influences the production's financial result and dairies are imposing this by progressively raising their quality specifications for raw milk. More prominently though, customers are considerate about the care of dairy products and the situations under which these are produced. It is therefore necessary to safeguard high quality raw milk can be produced from healthy animals under good hygienic conditions and that regulate measures are applied to look after human health.

MEASURES FOR MAINTAINING HYGIENE DURING PROCESSING OF MILK

The final quality of dairy products offered to the consumer, is determined by characteristics of the whole process - from the animal's feed production to the consumer's table.

From Feed to Bulk Milk Tank

Barn locations

The hygienic and compositional quality of the feed plus drinking water can effortlessly affect the raw milk's quality. Animals consuming feed of inferior hygienic quality, may show digestive disorders - resulting in an unhygienic animal environment, with probably poor hygiene while milking and negative animal health. Poor quality may contain certain microorganisms or spores that spread in the barn while feeding and then transfer to the milk during milking. The quality of cheese originating from raw milk produced under such conditions may be seriously affected. Moreover, barn environmental issues may further negatively influence health and can embrace the animal's udder health. Important udder health risk factors include barn type and design, along with stalls, manger height, floor type, bedding material, frequency of manure exclusion, cleanliness of stalls, hoof care, clipping of cow's hair, barn humidity and the ventilation system. Hoof health is of certain importance herein. Cows should be kept clean and dry, under convenient conditions. When handling raw milk without making an allowance for the above factors, the milk producer risks obtaining it from unhealthy animals and may find antibiotic or veterinary drug residues present. The anticipatory measure is to govern animal health by pro-actively considering the above and other factors.

Pre-milking preparation

Pre-milking udder preparation includes fore milking and teat cleaning, has a direct mastitis-controlling effect since it reduces the number of pathogens. It also has an indirect mastitis-avoiding effect because it diminishes the risk of teat congestion and oedema to an active teat-cup position, at the start of milking. The latter effect consequences in a summarized milking duration and improves the degree of udder evacuation. Numerous investigations demonstrate the importance of practising good pre-milking teat or udder preparation processes. Recent research authorises teats should be dry before milking. Wetting of the teats before milking followed by drying - did provide low bacterial counts in the milk. Washing of the whole udder should be evaded. If this is required, then it is critical teats are wiped before attaching the milking machine. Cotton towels were found to be larger to paper towels for reducing bacterial and spore counts in milk. Cleaning for 20 seconds was shown to be 50 per cent more effectual than cleaning for six seconds.

Milk inspection

The 89/362/ECC (EU) directive states: "Before milking of the individual cow, the milker must inspect the appearance of the milk. If any physical deformity is detected, milk from the cow must be withheld from delivery". This demand can easily be fulfilled in conservative milking and appropriately implemented by using a foremilk cup. However with Automatic Milking Systems (AMS) it cannot be fulfilled if there is no human attendance during milking. Suggestions have been subjected to change this directive but consultations are still in progress both by and between, legislators and scientists. The definition of abnormal milk is a highly important issue in this context. It is up to individual national authorities to decide how to apply the directives to AMS and to ensure safe and high quality in their countries until such new or adapted directives are available.

Milk extraction

Mechanical milk extraction should be performed using machines that are designed, tested and serviced as per prevailing standards. These machines must also be used within accepted milking routines. Machine settings like milking vacuum and pulsation features should be applied in accordance with the producer's directions. In overall if this is followed, good udder health can be maintained. However if over-milking and inappropriate pre-milking planning are practised, or high frequencies of liner slip are not prohibited - udder health can be negatively affected. The latter can occur directly through raising the number of new infections, or indirectly by influencing teat condition.

Post milking teat disinfecting

Investigation work carried out since the mid-seventies shows the viability of applying post milking teat sterilizing. Post milking teat dipping or spraying is extensively used today. It is predominantly effective in preventing environmental mastitis kinds. Frequency of mastitis formed during the dry period is an increasing problem. Such infections may carry on into lactation and cause clinical mastitis or elevated milk somatic cell counts. Dipping dry cow's teats consuming a special teat seal with a long lasting effect is an important tool for helping control such mastitis.

Cleaning of milking equipment

The milking equipment must be cleaned as soon as possible after milking. A rinse cycle should initially be employed, using tepid water. The purpose of this is to eliminate residuals from the milk and soil in advance of the cleaning cycle. Cleaning using detergents must be performed within sufficient time and with the cleaning solution at the uppermost possible temperature. It is significant to have as much turbulence as possible for the cleaning solution during cleaning. Cleaning should be done completed by flushing the milking system with clean water then draining it, or by flushing it with clean air. Regular and efficient cleaning of the milking system is particularly important when using AMS. Washing with acid detergent may be required at frequent intervals, based on the hardness of the water.

Cooling of milk

It is generally recommended that milk be cooled to a refrigerated temperature within a small number of hours after milking and stored at 4 °C or below. Primary cooling might be essential to avoid the blend temperature of the milk in the bulk tank, surpassing a certain level. Cooling of milk shortly after extraction is also important for minimising lipolytic activity. The latter process becomes more important the higher the milking frequency and also in AMS, where intervals in the middle of milking occasions vary for individual cows.

CONCLUSION

Though financial gain is considered to be the major reason for milk adulteration, scarce supply for the growing population all over the world has paved the ground for this as well. This problem is more critical in the developing and under developed countries due to lack of adequate monitoring and law enforcement. In addition, awareness and access to information can play vital role in these regions to overcome this issue.

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