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A REVIEW ON ADULTERATION OF MILK

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ABSTRACT

Milk is a complex mixture and a liquid food, which can easily be adulterated. According to Prevention of Food Adulteration (PFA) definition, "Milk is the normal mammary secreation derived from complete milking of healthy milch animal without either addition there to or extraction there from. Adulteration of food cheats the consumer and can pose serious risk to health in some cases. Adulteration in milk has been a cause of concern for both the Government and the Dairy Industry. The Indian Council of Medical Research has reported that "milk adulterants have hazardous health effects. Although many known methods for detection of adulteration in milk, exists, the methods compiled below in this review are not only simple and rapid but also very sensitive to detect milk adulteration. These tests can be carried out easily by consumers for identifying the most common adulterants in milk, using simple laboratory apparatus, common chemicals and the milk adulteration test reagent kit developed.

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INTRODUCTION

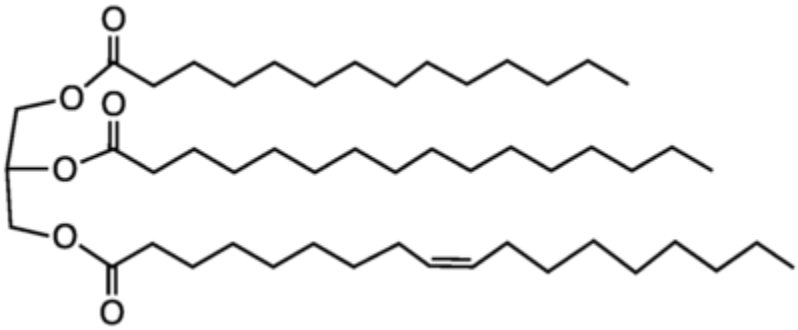
Milk is a pale liquid produced by the mammary glands of mammals. It is the primary source of nutrition for infant mammals before they are able to digest other types of food. Early-lactation milk contains colostrum, which carries the mother's antibodies to its young and can reduce the risk of many diseases. It contains many other nutrients[1] including protein and lactose.

As an agricultural product, milk is extracted from non-human mammals during or soon after pregnancy. Dairy farms produced about 730 million tonnes of milk in 2011,[2] from 260 million dairy cows.[3] India is the world's largest producer of milk, and is the leading exporter of skimmed milk powder, yet it exports very few other milk product.[4][5] The ever increasing rise in domestic demand for dairy products and a large demand-supply gap could lead to India being a net importer of dairy products in the future.[6] New Zealand, the European Union's 28 member states, Australia, and the United States are the world's largest exporters of milk and milk products. China and Russia were the world's largest importers of milk and milk products.[7][8] Both countries were self-sufficient by 2016 contributing to a worldwide glut of milk.[9]

Throughout the world, there are more than six billion consumers of milk and milk products. Over 750 million people live within dairy farming households.[10]

PHYSICAL AND CHEMICAL PROPERTIES OF MILK

Milk is an emulsion or colloid of butterfat globules within a water-based fluid that contains dissolved carbohydrates and protein aggregates with minerals.[11] Because it is produced as a food source for the young, all of its contents provide benefits for growth. The principal requirements are energy (lipids, lactose, and protein), biosynthesis of non-essential amino acids supplied by proteins (essential amino acids and amino groups), essential fatty acids, vitamins and inorganic elements, and water.[12]



Butterfat is a triglyceride (fat) formed from fatty acids such as myristic, palmitic, and oleic acids.

pH

The pH of milk ranges from 6.4 to 6.8[13] and it changes over time. Milk from other bovines and non-bovine mammals varies in composition, but has a similar pH.

EVOLUTION OF LACTATION

The mammary gland is thought to have derived from apocrine skin glands.[14] It has been suggested that the original function of lactation (milk production) was keeping eggs moist. Much of the argument is based on monotremes (egg-laying mammals).[14][15][16] The original adaptive significance of milk secretions may have been nutrition[17] or immunological protection.[18][19] This secretion gradually became more copious and accrued nutritional complexity over evolutionary time.[14] Tritylodontid cynodonts seem to have displayed lactation, based on their dental replacement patterns.[20]

PROCESSING OF MILK

Processing of milk is mainly carried out in 3 ways, namely:

Pasteurization

Pasteurization is used to kill harmful microorganisms by heating the milk for a short time and then immediately cooling it. The standard high temperature short time (HTST) process produces a 99.999% reduction in the number of bacteria in milk, rendering it safe to drink for up to three weeks if continually refrigerated. Dairies print expiration dates on each container, after which stores remove any unsold milk from their shelves. A side effect of the heating of pasteurization is that some vitamin and mineral content is lost. Soluble calcium and phosphorus decrease by 5%, thiamin and vitamin B12 by 10%, and vitamin C by 20%.[21]

Microfiltration

Microfiltration is a process that partially replaces pasteurization and produces milk with fewer microorganisms and longer shelf life without a change in the taste of the milk. In this process, cream is separated from the whey and is pasteurized in the usual way, but the whey is forced through ceramic microfilters that trap 99.9% of microorganisms in the milk (as compared to 99.999% killing of microorganisms in standard HTST pasteurization). The whey then is recombined with the pasteurized cream to reconstitute the original milk composition.

Creaming and homogenization

Figure 1: A milking machine in action.

Milk often is homogenized, a treatment that prevents a cream layer from separating out of the milk. The milk is pumped at high pressures through very narrow tubes, breaking up the fat globules through turbulence and cavitation.[22] A greater number of smaller particles possess more total surface area than a smaller number of larger ones, and the original fat globule membranes cannot completely cover them. Casein micelles are attracted to the newly exposed fat surfaces. Nearly one-third of the micelles in the milk end up participating in this new membrane structure. The casein weighs down the globules and interferes with the clustering that accelerated separation. The exposed fat globules are vulnerable to certain enzymes present in milk, which could break down the fats and produce rancid flavors. To prevent this, the enzymes are inactivated by pasteurizing the milk immediately before or during homogenization.

Homogenized milk tastes blander but feels creamier in the mouth than unhomogenized. It is whiter and more resistant to developing off flavors.[23] Creamline (or cream-top) milk is unhomogenized. It may or may not have been pasteurized. Milk that has undergone high-pressure homogenization, sometimes labeled as "ultra-homogenized," has a longer shelf life than milk that has undergone ordinary homogenization at lower pressures.[24]

ADULTERATION

Food Adulteration is an act of intentionally debasing the quality of food offered for sale either by the admixture or substitution of inferior substances or by the removal of some valuable ingredient. Food Adulteration takes into account not only the intentional addition or substitution or abstraction of substances which adversely affect nature, substances and quality of foods, but also their incidental contamination during the period of growth, harvesting storage, processing, transport and distribution.

“Adulterant” means any material which is or could be employed for making the food unsafe or sub-standard or misbranded or containing extraneous matter.

METHODS FOR DETECTION OF COMMON ADULTERANTS IN MILK

Table 1: Testing of common adulterants in milk.

S.NO.	FOOD ARTICLE	ADULTERANT	METHOD OF DETECTION
1.	MILK	Water	Place a drop of milk on a polished slanting surface: a) Pure milk flows slowly leaving a white trail behind it. b) Milk adulterated with water will flow immediately without leaving a mark.
2.		Urea	5 ml milk in a test tube + 5 ml dimethyl amino benzaldehyde solution, shaken Well. Yellow colour develops. It shows the presence of added urea.
3.		Soda	10 ml milk in a test tube + 10 ml alcohol & shaken well + few drops of Rosalic acid. Red rose colour shows in the presence of soda.
4.		Synthetic milk	Synthetic milk has a bitter after taste. Gives a soapy feeling on rubbing between the fingers. Turns yellowish on heating.
5.		Detergent	5 ml milk + few drops of bromocresol purple solution. Appearance of faint violet colour indicates the presence of detergent in milk.
6.		Starch	5 ml milk in test tube, boil than cool + 1 to 2 drops of iodine Solution. Appearance of blue colour which indicates the presence of starch.
7.		Glucose/ Invert Sugar	Take a strip of Diacetic Strip. Dip it in the milk for30 sec-1 min. Change in the colour of strip indicates the presence of glucose.

Table 2: Tests to be done in laboratory[25]

S.NO.	FOOD ARTICLE	ADULTERANT	METHOD OF DETECTION
1.	MILK	Formalin	5ml milk in a test tube + few dros of phloroglucinol solution and mix properly + few drops of sodium hydroxide solution. Flashy pink colour, shows the presence of formalin.
2.		Hydrogen peroxide	10 ml milk in a test tube + 10-20 drops vanadium pentaoxide solution. Development of pink/red colour indicates the presence of hydrogen peroxide.
3.		Vanaspati	3 ml milk in a test tube + 10 drops of HCl +Mix one teaspoonful of sugar. After 5 min examine the mixture. The red colouration indicates the presence of vanaspati in the milk.
4.		Salt	5 ml Silver Nitrate Reagent in a test tube + 2-3 drops of Potassium Dichromate Reagent + 1 ml of milk and mix thoroughly. Occurrence of yellow colour indicates the presence of salt in the milk.
5.		Sugar	3 ml of milk in a test tube + 2 ml of HCl. Heat the test tube after adding 50 mg of resorcinol. The red colouration indicates the use of sugar in the milk.
6.		Sodium bicarbonate/ Neutralizer	3 ml of milk in a test tube + 5 ml of rectified spirit + 4 drops of rosalic acid solution. Appearance of red/rosy coloration indicates the presence of sodium bicarbonate in the milk.
7.		Boric acid	3 ml of milk in a test tube + 2 drops of HCl and shake the test tube or mix up the contents thoroughly. Dip a yellow paper strip and remove it after 1 min. A change in colour from yellow to red, followed by the change from red to green, by the addition of one drop of ammonia solution takes place. It indicates the presence of boric acid in the milk.
8.		Fat	The Lactometer reading will go above 26.

SYNTHETIC MILK:

As the name suggests, *synthetic milk* is not milk but it is entirely a different component with a high degree of adulteration to increase the volume of milk and thereby the profit. Generally it is a mixture of water, pulverized detergent or soap, sodium hydroxide, vegetable oil, salt and urea.

The simplicity and rapidity with which milk can be adulterated always tempted the unscrupulous milk vendors to indulge in fraudulent practices and adulterate the milk. The ever-rising greed has given way to the development of a new type of adulterated milk known as synthetic milk.

Production of synthetic milk:

Vegetable refined oil (any brand) whose butyro refractometer reading is less than 42 is taken in a wide mouthed container along with a suitable emulsifier and thoroughly mixed so that the entire content is made into a thick white paste. After this is achieved, water is slowly added to the paste until the density of the liquid is similar to that of milk. Then it is added with urea or sodium sulphate or glucose or maltose or sometimes any one of the commonly available fertilizers is added. These substances are usually dissolved in hot water and then added to the seemingly milk like solution.

The refined oil in synthetic milk acts as a source of fat where as the hot solution of any one of the substances above mentioned acts as a source of solids not fat (SNF). The ingredients that go into the making of synthetic milk are calculated in such a way that the fat and SNF percentage is similar to mixed milk. Hence it easily passes the platform tests carried out at the village level dairy co-operative society (fat and lactometer reading etc.,) but from the health point of view of the consumers, it is highly dangerous. The taste is highly objectionable.

Table 3: Comparison between genuine and synthetic milk:[21]

Differentiating tests	Genuine Milk	Synthetic Milk
Physical tests		
Colour	White	White
Storage	On storage, it remains white	It turns pale yellow after some time
Texture	When rubbed on the palm, it doesn't form foam	When rubbed on the palm, foam formation noticed.
pH	6.6 - 6.8	10 – 11 (Highly alkaline)
Fat	4.5 – 5.0%	4.5 – 5.0%
Solids Not Fat	8 – 9%	8 – 9%
Chemical tests		
Heat	No change in colour on heating	It turns yellow on boiling
Urea test	Pale yellow colour develops	Dark yellow colour develops

Figure 2:Differentiating pure milk from synthetic milk.

Harmful Effects of Synthetic Milk:

According to physicians, use of synthetic milk inflicts very serious harms on human body causing swelling in the eyes and complications in liver and kidney. Apart from this, synthetic milk proves deadly for pregnant women and patients suffering from conditions of heart ailment and blood pressure. What is worse is that this synthetic milk is extremely poisonous for small children. Continuous use of the synthetic milk turns the human body a farm house of diseases[26].

POWDERED OR FORMULA MILK:

Essentially, powdered or formula milk is a substitute for breast milk. Not all women are able to produce breast milk enough to satiate their little ones. Some might have undergone serious breast operations and encounter certain predicaments while breast feeding whereas some are packed up in the busy world and do not have time to breast feed. Some babies, owing to certain medical conditions may also be fed with formula milk. However, we cannot ignore the fact that the breast milk is the ideal food for a baby, and powdered milk is, in the end, an artificially manufactured food that goes against nature.

Preparation of formula milk:

Powdered milk is also known as dried milk that has been made by vapourizing the liquid content, leaving behind dry powder. Commercial formula milk is a complex combination of proteins, iron, sugars, fats and vitamins and is manufactured in highly sterile conditions. Though new mothers may want to prepare their own baby formula, it is recommended to opt for commercial formulas so that the baby can get the maximum benefits.

Advantages and Disadvantages of Formula Milk:

Mothers who are not in a position to breast feed resort to feeding their babies with formula milk. Though formula milk is fortified with many minerals required by a growing baby, yet it lacks the important antibodies that breast milk provides to the baby to fight infections and grow well. Formula milk fed babies also eat less, and owing to the fact that it is easily digestible, their stomach needs to do less work as well. Feeding powdered milk also means the mother can get more rest and the other members of the family can also participate in the growing and nurturing of the baby. But powdered milk is expensive, and is not at all a replacement of mother's milk[27].

Figure 3 and 4:Pictorial representation of Powdered milk.

CONCLUSION

Milk is the nutrient rich food for not only the young one's of animals but also for human babies. It is the major food for infants/ babies upto the occurrence of milk teeth, so that they can start feeding on solid food too. But adulteration of milk and milk products now-a-days is a major issue to think on, because it effects not only the health of baby and mother but also effects the mental condition of the young one's who are responsible for making up of tomorrow's generation. Hence detection of adulterants in milk is compulsory. Though several methods are available for the detection of adulteration of milk, due to increase in adulteration by means of several external agents, because of various reasons like increase in population growth detection of milk adulterants has become complicated now-a-days. So more sophisticated methods are required for detection some of which are metioned above in this article. But, it would be better not to adulterate milk in thirst of money and try to reduce the factors that leads the traders and merchants to adulterate the milk.

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