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BACTERIOLOGICAL SOURCES, PATHOLOGICAL RISKS AND SPOILAGE CONTROL OF RAW MILK

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Abstract

Milk is a vital part of human diet worldwide for many centuries. People are consuming it for centuries in form of raw or boiled milk and in the form of traditional milk products. Thus, its importance in our daily life could not be denied. Milk is considered as a complete diet due to its superior nutritional properties. When handled improperly it serve as one of the most favorable habitat for microbial growth to both spoilage and pathogenic agents. Here common microbiology of raw milk is discussed, it includes a brief overview to most common micro-organisms present in raw milk e.g. Pseudomonas, E. coli, Listeria, Brucella, Bacillus, Campylobacter, Mycobacterium, Staphyloand Streptococci and Lactobacillus group their sources, diseases, spoilage and control.

Keywords: Raw milk, Micro-organisms, Diseases, Spoilage

For thousands of years milk is being consumed by people of all communities. Milk can be obtained from cows, buffaloes, water buffaloes, goats, sheep, horses, camels, yak, donkeys or even reindeer. Unheated or unprocessed milk was being used for quite a long time and was considered safe and reliable. It was very important for different cultures in tropics even centuries before the invention of refrigeration. Primitive people use fermentation to preserve and take benefit from it that made it even better food for them.

Milk is fresh, clean, secretion of lacteal glands of healthy milking animals (one or more) excluding milk obtained 15 days before and 5 days after calving and which should contain the prescribed standards of Fat and SNF.

Components	% age
Water	87-88%
Fat	4-6%
SNF	8-8.2%

Though the milk obtained from milk animals is processed later but we cannot call it fabricated or engineered food. It has about 87% water and remaining 13% are solids. Solids include fat, proteins, carbohydrates, vitamins and minerals. Fat has fat soluble while water has water soluble vitamins in it. Presence of all these nutrients in milk make it nearly perfect natural food.

Milk production in Pakistan is mostly done in villages by farmers with small land holdings or by agricultural laborers that are landless. A large amount of milk being produced is collected by suppliers and dairies but still people convert it into traditional dairy products due to lack of facilities like storage, refrigeration and transportation. Due to economic and educational backwardness of producer, milk is produced under most unsatisfactory conditions.

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Milk animals are usually kept in a part of living space, small closed or open yards near to house with flooring of mud. In summer buffaloes wallow in ponds making themselves full of dirt and rarely washed before milking.

Hand milking is adopted after suckling by calf is being done. Only few large modern farms use milking machines for this purpose. Due to unavailability of refrigeration and long distance between producer and consumer milk is held at ambient temperatures for long time that leads to high microbial growth. Exposure to high ambient temperature for long time in this region is the main cause of rapid microbial growth in milk. [3]

Milk has 87-88% water which is freely available for microbes and other chemical reactions. Also, milk has fat, carbohydrates, protein and favorable pH that fulfill all the requirements of microbes. So, it is very favorable food for microorganisms. Microbes will spoil it in 6-8 hours if not handled properly after milking. Most commonly bacteria are present in milk, while some species of yeast and mold are also present in it. Most commonly present microbes in raw milk are as under:

Pseudomonas genera finds its way to milk through soil and water. This genus is responsible for spoilage in milk e.g. blue color is produced by *Pseudomonas synciani*, yellow color is produced by *Pseudomonas synxantha*, brown color is produced by *Pseudomonas putrificians*, green color is produced by *Pseudomonas aurogenosa*. They also induce flavor to milk e.g. *Pseudomonas mucidolense* produces potato like flavor in the milk. *Pseudomonas fluorescens* can cause lipolysis and proteolysis in milk. *Pseudomonas fragi* can produce extracellular enzymes (proteolytic and lipolytic) that are heat stable and cause spoilage. This causes bitty (broken) cream & milk due to formation of flakes or small clots in milk & cream due to lecithinase and phospholipases activity. Major cause of this spoilage is phospholipases. Adapting common GMP's can reduce their incidence and can easily be killed by pasteurization. [1], [5]

Brucella spp is found in many animals including cattle, sheep, and goats. Fever, headaches, backpain, sweats and physical weakness are symptoms of its illness. Sometimes fever, fatigue and joint pain may occur. *Only way to control is through pasteurization.*

Campylobacter jejuni is found in contaminated water sources and in the intestinal tract excreting in feces of cattle and on udder due to unhygienic conditions. *Disease like fever, abdominal pain, cramping, diarrhea, bloody diarrhea, nausea and vomiting* are caused due to its presence. It can be reduced by following GMP's and by pasteurization.

Coxiellaburnetii is found in many animals and shed in milk, urine and feces of animals. It causes Q fever whose symptoms include sudden onset of high fever, chills, severe headache, sweats, chest pain, abdominal pain, nausea, vomiting, diarrhea, sore throat and cough that may lead to death if not treated. *Conditions for milk pasteurization are specifically established to destroy it due its heat resistant non-spore forming nature.* Apart from pasteurization it can be reduced by maintaining hygienic conditions.

Escherichia coli O157:H7 is one strain from a large bacterial family. *E. coli strains* are considered fecal coliforms. Its toxins can cause illness in humans e.g. bloody diarrhea and abdominal cramps. In some cases, i.e. in young children it causes hemolytic uremic syndrome that destroys red blood cells and cause kidney damage or failure and in some cases death. It is also involved in spoilage

of milk. It causes gas production in milk due to acidic fermentation of lactose also called as “Stormy Fermentation” because of foam formation on surface. Such milk is not fit for human consumption. It also causes sweet curdling of milk due to enzyme “proteases” which targets casein bacteria use lactose and convert into acid and aldehyde components that causes sweetness. Following hygienic conditions can greatly decrease it and is destroyed by pasteurization. [1],[2],[8]

Staphylococcus aureus is present due to mastitis in milking animals. This bacterium causes skin infections, respiratory disease and food poisoning. It can be controlled by improving animal health, good quality feed and pasteurization that readily kills it.

Streptococcus agalactiae is present in feces, contaminated water and present in milking animals suffering from mastitis. It causes infections in new born that starts from fever, vomiting and irritability, and can consequently lead to hearing loss. It can be controlled by improving animal health, good quality feed and by pasteurization.

Streptococcus thermophiles is also present in animals suffering from mastitis. This microbe causes spoilage in milk and is not involved in any diseases and acts as probiotic. It can be controlled by improving animal health, good quality feed and by pasteurization.

Streptococcus lactis is also present in milk of animals suffering from mastitis. This microbe causes acid fermentation resulting in sour acidic flavor and it act as probiotic in human body. It is easily killed during pasteurization.

Milking animals suffering from mastitis also contain *Streptococcus cremoris* in their milk. It causes Streptococcal infections e.g. fever, sour throat, tonsillitis and some pneumonias. It can be reduced by improving animal health, good quality feed and by pasteurization.

Leuconostoc lactis generally comes from environment as it is present in air and often grows on feed and dung of animals. This microbe causes spoilage of milk i.e. doing heterofermentation by converting sugars present in milk into different products thus it causes a wide range of spoilage activity. It is also responsible in acid and slime production in milk. It can be controlled by maintaining hygiene and can easily be destroyed by pasteurization.

Bacillus cereus is naturally found in cattle gut. Feed act as major source. It can enter the milk due to unhygienic environment. It causes a minority of illnesses (2–5%) e.g. severe [nausea](#), [vomiting](#), and [diarrhea](#). It causes sweet curdling of milk due to enzyme “proteases” which targets casein, use lactose and convert into acids and aldehyde components that causes sweetness. It is involved in gas production by converting lactose into acids and CO₂ on fermentation which is also called “Stormy Fermentation” due to foam on surface. Such milk is not fit for human consumption. It is also involved in proteolysis which causes butyric smell. It causes bitter (broken) cream & milk due to formation of flakes or small clots in milk & cream due to lecithinase and phospholipases activity. It can be controlled by maintaining hygienic environment and by pasteurization. It is spore forming so proper pasteurization is needed to destroy its spores. [1],[5], [8]

Lactobacillus lactis is present in animals suffering from mastitis. This microbe causes spoilage in milk doesn't cause any disease and act as probiotic. It is easily killed by pasteurization.

Lactobacillus bulgaricus is naturally present in intestine of animals and humans so major source is through animal contact, dirty udders and utensils. It is not responsible for any type of disease but it is involved in acid fermentation which causes milk spoilage. It is easily killed during pasteurization.

Lactobacillus acidophilus is naturally present in human and animal gastrointestinal tract and mouth. This specie ferments sugars into lactic acid. It doesn't cause any disease and some strains act as probiotic. It can easily be killed by pasteurization or any other such heat treatment.

Propionibacterium genera is primarily facultative parasite and commensal of humans and other animals by living in and around their sweat glands, sebaceous glands and other areas of their skin thus finds its way in milk due to unhygienic conditions. It causes some skin diseases in humans when infected milk gets contact with skin and causes skin problems that resembles acne. [6]

Listeria monocytogenes is found in water and soil so enters milk from many environmental sources. It causes listeriosis i.e. headache, fever, muscle aches, stiff neck, septicemia, meningitis and in worse cases cause miscarriage, stillbirth, premature delivery, abortion, or death. Maintaining hygienic environment can reduce their presence and can be destroyed by pasteurization. [2]

Mycobacterium bovis and *Mycobacterium tuberculosis* are present in infected cattle worldwide. They cause lung disease tuberculosis. They can only be controlled through pasteurization.

Salmonella spp. is present in the intestinal tracts of almost all warm-blooded animals thus unhygienic conditions during milking are major cause of this. It causes illness whose symptoms include diarrhea, abdominal cramps, and fever. It is responsible for gas production due to fermentation of lactose into acids and CO₂ also termed as "Stormy Fermentation". Such milk is not fit for human consumption. Its number can be reduced by maintaining hygienic environment and by pasteurization. [2], [8]

Yersinia enterocolitica is found in farm animal's intestinal tract and in the environment. It causes illness i.e. fever, abdominal pain and diarrhea. It can be controlled by hygienic environment and by pasteurization. [2]

Clostridium butyricum is present in soil so flooring or bedding is a major source of it. It doesn't cause any disease but cause spoilage in milk due to production of butyric acid by fermentation. It also causes gas production in milk by acidic fermentation of lactose which causes foaming and termed as "Stormy Fermentation". Such milk is not fit for human consumption. They are also responsible for proteolysis mostly alkaline proteolysis in milk which results in butyrine smell and produces sharp sour flavor in milk. It causes bitty (broken) cream & milk due to formation of flakes or small clots in milk & cream due to lecithinase and phospholipases activity. It is comparatively tough to kill on pasteurization temperature and mostly survives pasteurization so good hygiene and good bedding can reduce this microbe. [1], [5], [8]

Enterobacter aerogenes is mostly found in gastrointestinal tract of animal where it does not cause any disease. It is also found on various feed materials, soil and wastes. So, find its way in milk due to unhygienic environment. It causes bacteremia, ophthalmic infections, intra-abdominal infections, skin and soft-tissue infections, lower respiratory tract infections, CNS infections, urinary tract infections (UTIs), endocarditis, septic arthritis and osteomyelitis. It also causes gas production due to acidic fermentation of lactose which causes foaming and termed as "Stormy Fermentation". Such milk is not fit for human consumption. It causes bitty (broken) cream & milk due to formation of flakes or small clots in milk & cream due to activity of lecithinase and phospholipases. Ropy

fermentation is also caused by this i.e. abnormal ropiness and viscous-slimy textured milk. [1],[5],[7],[8]

Kluyveromyces is a yeast. It grows on feed, bedding material and on cow dung. Its spores are also present in air thus unhygienic environment is responsible for their transfer to milk. They are lactose positive hence cause lactose fermentation leading to gas production causing foaming on surface and termed as "Stormy Fermentation". Such milk is not fit for human consumption. It also results in changed milk flavor shifting it towards slightly sour taste. [1], [8]

Aspergillus is a mold. It grows on feed especially bread that is given to animals in villages, bedding material and on cow dung. Its spores are present in air and unhygienic environment leads it to milk. They cause acidic fermentation of lactose in milk that leads to gas production this causes foaming on surface and called as "Stormy Fermentation". It causes proteolysis in milk, proteases target casein and convert it into acids and aldehyde components resulting in sweet taste. They produce Aflatoxins that can cause serious health hazards e.g. renal failure, liver damage, nervous breakdown, and problems related to digestion. In rare cases can cause death of individual. [1], [8]

Rhizopus is also a mold. It grows on feed especially bread that is given to animals in villages, bedding material and on cow dung. Its spores are present in air that lead them to milk. They cause gas production by acidic fermentation of lactose which results in foaming on surface and hence called as "Stormy Fermentation". [1], [8]

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