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A Critical Review on Quality Testing of Milk and Milk Products

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A B S T R A C T

Nutritious and clean milk supply should be the main mission of every dairy producer. The quality of milk products starts at the farm and continues throughout processing. To meet increased raw milk quality standards, producers must adopt production practices that reduces bacterial contamination of milk. Use of effective management strategies to minimize contamination of raw milk will help dairy producers achieve these important goals.

Introduction

Milk is an imperative product of human diet which is essentially an emulsion of fat and protein in water, along with dissolved sugar. Raw farm milk and full fat milk have their own percentage of fat (Kala *et al.*, 2018). Poor quality affects all the segments of dairy industry, ultimately resulting in milk with decreased manufacturing properties and dairy products with reduced shelf life. Milk has to be pasteurized as a protection against pathogenic organisms.

Pasteurization is a partial sterilization accomplished by raising the milk to a temperature high enough to destroy of the causing spoilage. Several different methods are used to assess milk quality such as the Somatic cell count (SCC) and Standard plate count (SPC). The Standard plate count is an estimate of the total number of aerobic bacteria present in raw milk. The test is done in 48 hours at 90°F followed by counting bacteria that grow on plates.

The SPC is used to moniter progress since consistence application of proper milking practices, under hygiene and good mastitis prevention and contol practices should allow diary producers to produce milk with low SPC, which is less than 5000 colony forming units (cfu) of bacteria per mL. Federal regulations defined in the pasteurised milk ordinance mandate that the milk SPC should not exceed 100, 000 cfu/mL.

Contamination in Raw Milk

Mathur (1959) reported an outbreak of salmonellosis due to *Salmonella weltevredon* in a family associated with the consumption of contaminated raw milk. Murry (1966) conducted a survey to see the incidence of salmonellae in Northern Ireland milk supplies. None of the bulk collected samples contained *Salmonella*. He could isolate *S. Dublin* in the milk from two individual producers. A total of 205 pooled samples of raw buffalo milk collected at NDRI, Karnal were were analyzes for the presence of *Salmonella* by Singh and Singh (1966). They could isolate *Salmonella* from two samples. Garg *et al* (1977) isolated *Salmonella* from both, cow and buffalo milk. This organism was isolated from both samples on the same day indicating a possible common source of contamination which may either be milking utencils or the milker.

Taylor *et al* (1982) reported that an outbreak of salmonellosis occurred due to the consumption of raw milk. Galbraith et al (1982) reported that, 233 cases of outbreaks of communicable disease have occurred in England and Wales between 1951 and 1980 due to milk or dairy products that affected nearly 10 000 people, of whom four died.

Milk-borne outbreaks of salmonellosis and *campylobacter enteritis* occurred due to raw or defectively pasteurised milk. They suggested that heat treatment of milk is an effective preventive measure. MMWR in 1984 reported *Salmonella dublin* infections from 1981-1983 due to the use of certified raw milk. Wood *et al* (1984) tested the samples from 18 farms, supplying milk to cheese factory, for the presence of *Salmonella*. Milk samples from one farm were found positive. Analysis of milk samples from a herd of 35 cows revealed only one cow shedding *S.muenster* directly into the milk. Eleven out of the 181 vats of cheese were found positive for Salmonellae at curd stage and only two at finished stage. The isolation of *Salmonella* from milk filters, cream and five farm workers in England and Wales. A total of 162 raw milk samples collected from open and closed cans in Calcutta city were examined by Das and Nag (1986). Five samples were positive for *Salmonella*.

McManus and Lanier (1987) analyzed 678 samples of raw milk from bulk tank trucks of milk suppliers in Wisconsin, Michigan and Illinois. Salmonellae were isolated from 32(4.7%) samples.

Humphrey and Hart (1988) isolated Campylobacters and salmonellae from 6 and 0.2% of samples of unpasteurized cow's milk on sale to the public. They also observed that there was a significant association between the presence of *Escherichia coli* and that of *Campylobacter jejuni*. The *campylobacter*-positive samples were having higher *E.coli* count indicating faecal contamination. Vasavada (1988) reported that pathogenic bacteria are transmissible to humans through milk and milk products. Milk, cheese, and ice cream are most commonly contaminated with pathogenic bacteria, viz., *Listeria monocytogenes*, *Yersinia enterocolitica*, *Campylobacter jejuni*, and enteropathogenic *Escherichia coli*. Adesiyun (1994) evaluated the bacteriological quality of pre-processed raw milk originating from all 16 milk collection centres in Trinidad. The mean total aerobic counts for bacteria, *Staphylococcus aureus* and *E. coli* were determined. The pH and presence of somatic cells in milk were also determined. Pre-processed milk in Trinidad was found to be of poor bacteriological quality showing the high counts of *S. aureus* in milk, which is of public health significance to consumers.

Ombui *et al.*, (1994) investigated the rate of contamination with coliforms and incidence

of E. coli in raw milk supplied by farmers to dairy cooperative societies. About 42.2% percent of the milk samples from farmers cans and 10.3% of samples from cooperative cans were found to be free of coliforms, while 89.5% of the samples from farmers cans and 50% samples from cooperative cans could he considered to be of good quality with no more than 50,000 coliforms/ml of milk. Forty two E. coli strains were isolated from milk samples, five of which were found to be enteropathogenic, while none was found to be of serogroup 0157. The results indicated that a good number of farmers draw milk under satisfactory conditions. Again the study showed that raw milk can get contaminated with enteropathogenic strains of *E. coli* that can pose a potential risk to humans, thus calling for extra care when preparing milk and milk products that are to be consumed by human beings.

Desmasures *et al* (1997) collected raw milk samples from 27 farms over 6 months for *Listeria*, *Salmonella*, *Yersinia enterocolitica* and *Campylobacter*. Total bacterial counts and somatic cell counts were measured. Lactococci, Lactobacilli, dextran-producing leuconostocs, *Brevibacterium linens*, yeasts and moulds, Staphylococcus aureus and other *Micrococcaceae*, *Pseudomonas*, coliforms, *Escherichia coli*, *Enterococci*, *Clostridium perfringens* and spores of anaerobic lactate-fermenting bacteria were also counted. *Pseudomonas* (2000 cfu/ml), *lactococci* (760 cfu/ml) and *Micrococcaceae* (720 cfu/ml) were the most numerous groups. Lactic acid bacteria were detected in all samples. Coliforms were present in most samples, but 84% of samples had counts < 100 cfu/ml. *Staphylococcus aureus* was detected in 62% of milks, the average count was 410 cfu/ml. About 80% of supplies had < or = 10 *E. coli* cfu/ml and all samples had < or = 1 *Cl.perfringens* cfu/ml. Two of the tested milks were positive for *Salmonellas* (2.9%), four were positive for *Listeria monocytogenes* (5.8%), 25 for *Yersinia enterocolitica* (36%) and one for campylobacters (1.4%).

Matta and Punj (1999) examined 100 samples of raw milk, 48% were found to contain lipolytic, psychrotrophic, spore forming bacilli. On the basis of morphological and biochemical characteristics, the 59 lipolytic isolates were identified as *Bacillus cereus*, *B.polymyxa*, *B.licheniformis*, *B.circulans*, *B. subtilis*, *B.laterosporus* and *B. coagulans*. *B. cereus* (32.2%) was found to be the predominant organism.

Jayarao and Henning (1999) examined bulk tank milk from 131 dairy herds in eastern South Dakota and western Minnesota for the presence of foodborne pathogens. *Campylobacter jejuni*, shiga-toxin producing *Escherichia coli, Listeria monocytogenes, Salmonella* spp., and *Yersinia enterocolitica* were detected in 9.2, 3.8, 4.6, 6.1, and 6.1% of bulk tank milk samples, respectively. 26.7% bulk tank milk samples contained one or more species of pathogenic bacteria. It was concluded that non A-grade raw milk producers were at a higher risk of having one or more pathogens in their bulk tank milk than were Grade A producers. 26.6% dairy producers who consumed raw milk had one or more pathogenic bacteria in their bulk tank milk.

Donkar *et al* (2002) studied a total of 96 raw milk samples collected from the two sites in Ghana and identified *Yersinia* spp. (19.8%), *Klebsiella* spp (16.7%), *Proteus* spp. (7.3%), *Enterobacter* spp. (6.3%), *Escherichia coli* (2.1%), and *Staphylococcus* spp (14.6%), *Bacillus* spp. (11.5%) and *Mycobacterium* spp. (1%). Most of the organisms identified were enterobacteria and pathogenic indicating probable faecal contamination of the milk as a result of poor hygiene and though some of them occurred in few samples, the practice of

pooling milk from different sources by traders, and the absence of pasteurization generally observed among them could increase the risk posed by such organisms.

Soomro *et al.,* (2002) examined hundred raw milk samples. All the samples were inoculated on different bacteriological media and a number of biochemical tests were performed for the confirmation of the isolate. The results revealed that out of 1OO milk samples 57% showed growth of *E.coli*. The highest number of milk samples contaminated with *E. coli* was recorded in milk samples obtained from milk vending shops and houses.

Esther *et al* (2003) evaluated raw and bottled commercial pasteurised milk from two processing plants in Gaborone, Botswana for mesophilic, psychrotrophic, proteolytic and lipolytic bacteria. Proteolytic-psychrotroph counts ranged between 10^1 and 10^5 CFU/ml in both milk types. *Corynebacterium pseudodiphtheriticum* (44%) and *Bacillus brevis* (72%) predominated in raw and commercial pasteurised milk respectively. Trypsin and chymotrypsin were detected in isolates of *Bacillus circulans*, *Pseudomonas cichorii* and *Micrococcus lentus*. Esterase and esterase lipase activity were observed in *Corynebacterium nitrilophilus*, *Pseudomonas fragi*, *B. circulans*, *Bacillus coagulans*, and *M. lentus*. The study demonstrated that post-process contamination and ineffective pasteurisation compromised the quality and shelf life of pasteurised milk.

Oksuz *et al.,* (2003) examined 100 raw milk samples from different bovines for the presence of *E. coli* O157. Some physical and chemical properties were investigated. According to the analysis results, *E. coli* O157 was determined in 1% of the total raw milk samples. Shabini (2003) microbiologically analyzed 40 samples of raw milk to evaluate the degree of environment pollution and its source examining the kinds and groups of contaminants. All the samples had high total count and were positive for coliforms. It shows a high rate of microbial environment pollution and the presence of fecal contamination in the area. Kessel *et al.*, (2004) conducted a study to determine e prevalence of *Salmonella*, *Listeria monocytogenes* and fecal coliforms in bulk tank milk in the United States. 861 bulk tank milk samples were collected from farms in 21 states. 95% of the samples contained fecal coliforms. Salmonellae were isolated from 2.6% of the raw milk samples and *L. monocytogenes* was isolated from 6.5% of the samples.

Ekici *et al.,* (2004) examined 36 samples of sheep milk, 25 samples of goat milk and 4 samples of cow milk. *S. aureus* was isolated from 12 samples while *E. coli* was isolated from 6 samples. *Salmonella* spp. could not be isolated in any of the samples.

Kivaria *et al.,* (2006) examined 128 milk samples and the mean total bacterial count was 8.2 x 10^6 cfu/ml, and major bacterial isolates from the milk samples were *Escherichia coli* (6.3%), *Bacillus cereus* (6.3%), *Staphylococcus aureus* (6.3%) and *Streptococcus agalactiae* (6.3%), *Enterobacter aerogenes* (5.6%) and *Enterococcus faecalis* (4.7%).

Chatterjee *et al.,* (2006) conducted a study to assess the raw milk quality in Tarakeshwar Out of ten raw milk samples, the microbial colonies were found to be high in six samples and the colony content was low in rest four samples. The methylene blue test performed for raw milk samples showed that out of ten samples, the five samples were poor, two samples were fair, two samples were good and only one sample was found to be an excellent.

Erica *et al.*, (2007) reported that from 1988 to 2005, a total of 33 outbreaks of *Campylobacter*, *Salmonella* and *E. coli* O157:H7 infections associated with raw milk consumption had occurred. *Escherichia coli*, *Mycobacterium bovis*, *Listeria monocytogenes* and species of *Campylobacter*, *Brucella* and *Salmonella* are the most common contaminants of raw milk.

Schneider *et al.*, (2008) reported that in California in the month of September, 2006 six children were admitted to hospital due to illness caused by consumption of raw milk. The milk was found to be contaminated with *Escherichia coli* O157:H7.

Nero *et al.*, (2008) examined 210 raw milk samples collected from four important milk producing areas in Brazil for the presence of *L. monocytogenes* and *Salmonella* spp., and for enumeration of indicator microorganisms: mesophilic aerobes, total coliforms and *Escherichia coli*. The pathogens were not isolated in any raw milk sample, but poor microbiological quality was confirmed by the high levels of indicator microorganisms.

Altalhi and Hassan (2009) analyzed the bacterial quality and safety of raw milk sources in Taif region (Western Saudi Arabia) for the natural contamination of fecal coliform and *Escherichia coli* by standard most probable number method and recovered thirty-three *E. coli* strains from raw milk sample sources, which were contaminated by fecal coliform. Results suggested a possibility of potential public health threat of *E. coli* originating from raw milk sources.

Raw milk kept at refrigerator temperatures for several days invariably shows presence of several bacteria of the genera such as *Bacillus*, *Enterococcus*, *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Microbacterium*, *Micrococcus*, *Propionibacterium*, Proteus, Streptococcus, coliforms, and others (Ledenbach and Marshall, 2009)

Montel *et al.*, (2014) studied that microorganism multiply under the favourable conditions. The raw milk microbial population was numerous composed of spoilage, pathogenic micro organism with high technological significance. Similar results were observed by Perin *et al.*, (2017).

Mohamed *et al.*, (2017) analysed the microbial quality of raw milk involved count of aerobic mesophilic bacteria, total coliform, yeast and moulds, and common milk born pathogens namely Shig toxin producing *Escherichia coli* (STPC), *Salmonella* spp., *Staphylococcus aureus*, *Streptococci*, *Brucella* spp. and *Mycobacteria*.

The investigation of Owusu-Kwarteng *et al* (2018) showed that the prevalence of *Listeria monocytogenes* obtained in raw cow milk from the Northern regiont of Ghana was 8.8%, whereas no *L. monocytogenes* was detected in boiled cow milk.

Contamination in Pasteurized Milk

Felsenfeld *et al* (1950) conducted a survey on pasteurized milk and found that pasteurized milk sold in the market was free from *Salmonella*.

Varela and Olarte (1952) examined 520 samples of Mexican certified milks and isolated 25 strains of salmonellae belonging to different serotypes.

Leoford *et al.*, (1983) surveyed 80 commercially processed milk samples and found that 10% of the samples were positive for coliforms when tested within 24 hours of processing, 60% were positive after 10 days storage of samples at 6.7^{o}C indicating that during storage the number of coliforms increases.

Kapadnis and Panse (1986) examined 40 pasteurized milk and 20 raw milk samples collected from four dairies situated in Pune city. No *Salmonella* was isolated from pasteurized milk. Coliform count in raw milk ranged from 160 to 1100/100 ml indicating faecal contamination but raw milk was not examined for Salmonella.

Lin *et al.,* (1998) examined 232 milk samples and 122 environmental swabs collected from two dairy plants to determine the sources of *Bacillus cereus* in pasteurized milk and observed that incidence and average count of B. cereus spores in raw milk was very high and similar to those of *B. cereus* vegetative cells in pasteurized milk whereas in environmental swabs it was low suggesting that *B. cereus* spores in raw milk were the major source of *B. cereus* in pasteurized milk and that post-pasteurization contamination along the milk processing lines was possibly a minor source of *B. cereus* in pasteurized milk. Da Silva *et al.,* (2001) examined 90 samples of pasteurized milk of three different commercial brands in Brazil and found that bacterial counts were above the regulated values of the Brazilian government. Among 208 strains of *E. coli* isolated, 46 (22.1%) were entero pathogenic *E.coli* (EPEC). Isolation of EPEC from pasteurized milk gives an indication of the presence of other enteropathogens.

Khan and Malik (2002) examined 36 samples of raw and pasteurized milk for total viable count, staphylococcal count, total coliforms, faecal coliforms, *Salmonella* and *Shigella*. Total viable count in raw and pasteurized milk was found to be in the range of 15,900 x 10^6 to 2, 59,000 x 10^6 and 154 x 10^6 to 24000 x 10^6 cfu/100 ml, respectively. The mean staphylococcal count in raw milk was 470 x 10^6 cfu/100 ml. Total coliforms were 2.4 x 10^3 MPN/100 ml in raw milk and 2.13 x 10^3 MPN/100 ml in pasteurized. Faecal coliforms in all the samples of raw milk and pasteurized milk were found to be 1.9 x 10^3 and, 1.5 x 10^3 MPN/100 ml respectively. *Salmonella* and *Shigella* were not detected in any of the milk samples.

lgumbor and Milngo (2002) conducted a study to assess the bacteriological quality of pasteurized milk and ice cream sold in Harare, using the direct plate count method and the methylene blue dye reduction test The results from the direct plate counts revealed the presence of both pathogens and non pathogens. *Bacillus* spp., coagulase *Staphylococcus* spp., *Micrococcus* spp., *Streptococcus* spp., Diphtheroids, Fusiform bacteria, *Klebsiella* spp. and *Citrobacter* spp were isolated from both the type of samples. No significant differences were found in the plate counts of the samples obtained from the depots and the outlets for the milk and ice cream samples.

O'Ferrall-Berndt (2003) evaluated pasteurized milk available to the consumer from milk shops in a pre-defined area of Pretoria compared with a national distributor's milk. Of the 135 milk samples purchased from milk-shops, 87% were not fit for human consumption whereas the national distributor's milk did not contain any pathogens. 38.5% of samples from milk shops were alkaline phosphatase positive, indicating probable inadequate pasteurisation. Total aerobic plate and coliform counts were generally high for all milk-shop milk samples.

Escherichia coli were detected in 1 ml of 17% of milk-shop milk, 95% of which originated from milk which was alkaline phosphatase positive. *Staphylococcus aureus* was isolated from 40% of milk-shop milk samples, and *S. aureus* enterotoxins from 7.8% of 51 cultures. It was concluded that milk from milk shops was unsafe and poses a serious public health risk to consumers.

Chatterjee *et al.,* (2006) conducted a study to assess pasteurized milk samples. The colony count was low in seven samples and high in three samples. Out of ten pasteurized samples, nine samples were of good quality and one was found to be excellent. Dr Malka Halpern from the University of Haifa, Israel (2008) has identified a new bacterium *Chryseobacterium oranimense*, which can grow at cold temperatures and secretes enzymes that have the potential to spoil milk.

Ali Ahmed (2009) isolated 14 strains of Salmonella out of 169 samples of milk products e.g. cream, dahi, cheese, khoya and khoya products collected from various dealers in Bareilly city. The presence of *Salmonella* was probably due to poor hygienic practices and such contamination of milk products is of great public health significance.

Baylis (2009) studied cytotoxigenic *E.coli* sero-groups may infect humans through consumption of infected raw unpasteurized milk and milk products, which have significant contribution to the reported cases of Shiga toxin producing *E. coli* (STEC) in humans. Martin *et al* (2012) examined pasteurization of milk at lower temperature (76.1^0 C vs 79.4^0 C) induced significantly lower bacterial count (log cfu mL in pasteurized milk (1.39 vs 1.58) which remained lower (3.74 vs 4.82) even after 21 days post processing storage at 6^0C due to lactoperoxidase system.

Ivy *et al* (2012) observed that spore forming bacteria can survive pasteurization in spore form, several aerobic spore formers that can grow under refrigeration conditions have been identified in both raw milk and HTST-pasteurized fluid milk.

Harvert *et al.,* (2016) studied that non-coliform Enterobacteriaceae are an important group of bacteria including organism such as *Proteus* which are less frequent contaminants in pasteurized fluid milk.

Contamination of Milk Products

Patel *et al.,* (1962) isolated *S. enteritidis* from Basudi, a milk product like khoya following a food poisoning outbreak in Gujurat. Moutsy and Nasr (1964) examined 40 samples of Kareish cheese (An Arabian product) bacteriologically and found that the cheese contained 68 million to 6.3 billion bacteria per gram and they could isolate *S. typhimurium* only from one sample.

Garg and Mandokhot (1984) surveyed urban and rural areas to study the attitude of the makers and handlers of sweet-meat towards the hygiene sweet preparation and found that the respondents of urban areas are having more positive attitude towards hygienic sweet preparation than the respondents of rural areas. The study also revealed that *Escherichia coli*. is a potential pathogen isolated from milk products suspected to be associated with the outbreaks of gastroenteritis and food poisoning in human being.

Al-Rajab *et al.,* (1986) demonstrated *Salmonella* in 32 (8%) out of 400 samples of locally produced milk products in Iraq. Ice-cream (10.9 %), Kishfa (10 %), Gaymer (7.5%), cheese (6.6%) and Yoghurt (1.6 %) were found positive for salmonellae. The bacteriological examination of ice-cream in Netherlands. None of 36 samples of ice-cream selected out of 351 was found to contain salmonellae and the isolation of two percent of salmonellae out of 360 samples of different frozen dairy products collected from Bangalore city.

Ratnam and March (1986) reported a major outbreak of gastroenteristis in Canada due to consumption of cheddar cheese contaminated with *Salmonella*. Samples from the interior of cheese blocks yielded salmonella more

frequently as compared to the samples from exterior. The number of *Salmonella* from factory –sealed blocks of cheese and in samples obtained from homes of known cases of salmonellosis ranged from 3 to 9 per 100 g cheese.

Singh *et al.,* (1994) examined 110 samples comprising raw milk, raw cream and burfi collected from different hostels and residences of Pantnagar Campus for their sanitary quality by determining standard plate, coliform and psychrophilic counts. It was observed that 37.72 percent samples of milk and 73.33 percent of cream were of poor quality and 84.0 percent samples of burfi were unsatisfactory. The mean coliform log10 counts in raw milk and cream were recorded as 4.477/ml and 4.740/g respectively indicating the possibility of fecal contamination.

The Journal of the American Medical Association (JAMA) (1999) reported the source of a particular *Salmonella typhimurium* DT104 infection of Hispanics in the Northern California and Yakima, Washington (United States) areas was due to unpasteurized queso fresco. California allows producers to sell unpasteurized milk and milk products.

Araujo *et al.,* (2001) analyzed different types of cheese samples from Salvador City in Bahia, Brazil and found that Minas frescal cheese was of low quality due to the contamination of coliform bacteria, which included *Staphylococcus epidermidis, Proteus rettgeri, Escherichia coli, Enterobacter aerogenes, Enterobacter* and *Micrococcus* spp.

Ikram *et al.,* (2001) examined 50 samples of packed and unpacked butter for total viable count, mould and yeast count, spore formers and coliform and found that the microbial load in the unpacked sample of butter was highest i.e., 3.8 x 10^6/gm - 6.6 x 10^6/gm. The coliform count was found maximum in unpacked sample and one of the packed sample of butter (Kausar brand) i.e., 39/ml. The unpacked sample of butter contained highest number of aerobic spore formers i.e., 280/gm. The anaerobic spore-formers were found absent in 20 samples of butter and the rest contained in the range of 0-170/gm.

Soomro *et al.,* (2002) examined sixty milk product samples namely Gulabjamun, Mawa and Dahi. These samples were randomly collected from different localities/sources of Tandojam. All the samples were inoculated on different bacteriological media and a number of biochemical tests were performed for the confirmation of the isolate. Among the 60 milk product samples 31(51.66%) showed growth o*f E.coli*, the highest rate of contamination was found in Mawa/Khoa samples.

Simeao *et al.,* (2002) investigated the cause of food poisoning outbreaks In February and May of 1999, the sanitary services of the Health Board in the cities of Manhuaçu and PassaQuatro, Minas Gerais, Brazil, involving a total of 378 individuals. Samples of the cheese and raw milk were collected and analyzed. The results showed the presence of *Staphylococcus aureus* and production of enterotoxins SEC and SED.

Oksuz *et al.,* (2003) examined 50 white pickled cheeses manufactured from raw milk for the presence of *E. coli* O157 and investigated physical and chemical properties. *E. coli* O157 was determined in 4% of the cheese samples. pH values were found to be higher than 4.50 in 80% of the total cheese samples. It was due to not using lactic starters in cheese manufacturing process. Due to the low acidity of the cheese samples, *E. coli* O157 counts may increase and its survival time may be longer than in cheeses made

using starter cultures. Thus, it was concluded that white pickled cheeses manufactured from unpasteurized milk have a potential infection risk as a result of *E. coli* O157 existence.

Ojokoh A.O. (2006) carried out studies on the microbiological quality of ice cream obtained from vendors in Akure. The samples were screened for total viable counts which ranged 1.8 X 10 cfu/g – 2.0 X 10 cfu/g. Seven bacterial and three mould isolates were obtained. *Staphylococcus* species, *Klebsiella* species and *Aspergillus* species recorded maximum percentage occurrence of 100% while the least value of 10% occurrence was for *Streptococcus* species isolated from sample.

Preeti Bhatnagar *et al.,* (2007) conducted a study to determine bacterial contaminants in Khoa samples sold in Gwalior and Morena city in Madhya Pradesh. Total Fifty samples of Khoa were cultured on several media and bacterial colony counts were made. Predominant organisms isolated were *Staphylococcus* and *Streptococcus* species. It was concluded that contamination of khoa by pathogenic bacteria could be an important factor of gastrointestinal illness in the consumers.

Jayant *et al.,* (2007) examined eighteen peda samples procured from A and B grade retail shops for their overall microbiological quality and for the presence of foodborne pathogens viz. *Staphylococcus aureus*, *Salmonella* sp., Coliforms, *Listeria monocytogenes*, *Yersinia enterocolitica* and *Bacillus cereus.* The microbiological quality of peda samples from B grade shops was very poor as compared to peda from A grade shop. These showed very high total bacterial counts (6×10^7 cfu/g), high counts of *S. aureus* (as high as 7×10^6 cfu/g) and presence of coliforms and *Listeria* and *Yersinia* sp. in 33% of the samples. All the samples from a grade shops were also positive for *S. aureus* though negative for coliforms, *Yersinia, Salmonella, Listeria* and *B. cereus.* Gamma irradiation of peda reduced overall bacterial load and *S. aureus* and coliforms could be totally eliminated.

Contamination from Handlers

Garg and Mittal (1991) reported that Enterococci are widely distributed in nature and gain entry into milk and milk products through the water supply, equipment, and insanitary and unhygienic conditions of production and handling. The prolific growth of enterococci in foods may lead to formation of clinically significant levels of pressor amines that are very thermostable and therefore remain active even after heat processing. These pressor amines may be involved in the onset of migraine attacks and produce hypersensitive crises in psychiatric patients who are being treated with monoamine oxidase inhibitors for depression. Saran (1995) reported that raw milk quality can be directly related to bacterial content of the milk. Milk with low bacterial and somatic cell counts cannot be produced unless milking equipment is effectively cleaned and disinfected between milking and the cows are kept healthy. Giffel and Beumer (1998) conducted a research on dairy farms, at two dairy processing plants and pasteurized milk to determine the major contamination sources of milk with *Bacillus cereus*. On dairy farms it was found that udders get contaminated from soil and feces, finally resulting in the presence of *B. cereus* in raw milk. The organism could be detected in 35% of the raw milk samples analyzed. During processing, an increase in the percentage of positive samples was observed suggesting equipment may also play an important role in contamination.

Birgitta *et al.,* (2000) studied the involvement of a pasteurizer in the contamination of milk by *Bacillus cereus* in a commercial dairy

plant. Dogan and Boor (2004) studied that high total bacterial number in bulk tank milk may be due to an environmental pathogen *Streptococcus uberis* which may be added to the milk due to bovine mastitis. It does not grow during storage of raw milk at < 10°C temperature (storage temperature of raw milk according to PMO standards FDA 2001).

Jayarao *et al.,* (2004) studied the relationship between different bacterial groups that occur in bulk tank milk by collecting samples from one hundred twenty six dairy farms of Pennsylvania. The samples were examined for somatic cell count(SCC), preliminary incubation count, laboratory pasteurization count, coagulase-negative staphylococcal count, environmental streptococcal count, coliform count, and gram-negative non-coliform count. The milk samples were also examined for presence of *Staphylococcus aureus*, *Streptococcus agalactiae*, and *Mycoplasma*. It was observed that there is a positive relationship between SCC and other parameters but coliform count was less related to somatic cell or other bacterial count.

Oliver *et al.,* (2005) studied the presence of food borne pathogens in milk and the dairy farm environment. They studied how the presence of pathogens depends on ingestion of contaminated feed followed by amplification in bovine hosts and fecal dissemination in the farm environment. The final outcome of this cycle is a constantly maintained reservoir of food borne pathogens that can reach humans by direct contact, ingestion of raw contaminated milk or cheese, or contamination during the processing of milk products**.** Srairi *et al.,* (2006) carried out a research to evaluate the hygienic quality of raw milk and its relationship to milking conditions in Morocco. They examined 109 bulk milk samples obtained directly after milking from 109 different farms for their hygienic quality. The raw milk tested was found to be of poor hygienic quality. three types of milking profile were studied.

Profile 1: one milking per day, calf suckling and irregular cleaning of hands and udder;

Profile 2: one to two milking per day, calf suckling and regular hands and udder cleaning.

Profile 3: two milking per day, no calf suckling and regular cleaning of hands and udder. It was concluded that calf suckling practice may play a role in reducing the fæcal coliforms and staphylococci counts in milk by the elimination of the foremilk, which is known to be the most contaminated by bacteria, whereas cleaning practices, under the current hygienic conditions in the farms, seem to be ineffective to generate good hygienic environment. Ali Ahmed Hassabo (2009) investigated the adulteration of marketable fresh milk adulterated with water and starch at Khartoum state. Three hundred samples from Khartoum, Omdurman and Bahri were collected. All samples were chemically examined and analyzed to observe their quality. The research concluded that the adulteration at Khartoum state is due to addition of water (35.3%) rather than Starch.

Olaimat *et al.,* (2018) reviewed on the emergence of antibiotic resistance among *L.monocytogenes* strains isolated from food products and possible ways the resistance has developed. Due to this emergence of antibiotic resistance of the pathogen, future outbreaks and spread of the diseases may be hard to manage.

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