

Mini Review

A Mini Review on Dairy Sector and Production in Pakistan

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Abstract. Raw milk is recognized as a complete diet and have high food values and supplies nutrients like water, proteins, lactose, fat, carbohydrates, vitamins etc. Animal-source food plays a very impressive part in poverty reduction, nutritional improvement, food security and health in developing countries. Pakistan is rated as one of the leading milk producer country in the world. Over 8 million rural families are directly engaged in livestock production and secure above 30-40% of their annual earnings. Over the year livestock has emerged as the biggest sub-sector in agriculture as it contribute 60.1% to the agriculture value addition and 11.5% to the GDP during FY2021, while milk producing animals are underfed situation. In Pakistan, 80% milk is produced at the small scale in rural area, 15% in peri-urban and only 5% in the urban areas. It is estimated that 97% milk is marketed in raw form and rest is processed. The milk production and distribution systems are outdated and un-organized, the whole setup is controlled by the informal private sectors. Different hazardous contamination incorporate into the dairy chain during milk production, processing, transportation, storage and serving that may affect milk quality profile. Milk contamination occurs by endogenous and exogenous contamination sources. Unhygienic practices of milk handling from farms to table promotes the chance of pathogenic microbial contamination which terribly affect its composition, quality and shelf life. Adulteration in the raw milk is the main problem in Pakistan. Food related diseases are quite common in Pakistan and different approaches like unhealthy conditions and absence of food standards, unhygienic and inadequate sanitation, poverty and illiteracy are the certain root causes in spreading of these diseases. During the milk supply chain different hurdles like, lack of chilling system, inadequate transportation infrastructure and untrained staff are the core issues related to Pakistan dairy sector. Dairy staff are usually uneducated and resistant to anti-traditional practices. Quality has become the most important feature in almost all stages from farm to table. Therefore, trainings and skill development programs for dairy staff can ensure the quality milk production by utilizing the latest technology.

Keywords: challenges, dairy, Pakistan, quality, status

Introduction

Milk in Pakistan. If consumed in its natural state, raw milk is regarded as a full diet since it contains nutrients such as water (85.5-89.5%), proteins (2.9-5%), lactose (3-5.0%) and energy containing fat (3-4%). Solids in total are made up of fat and solids-not-fat (SNF), carbohydrates, 0.1% vitamins (fat-soluble vitamins A, D, E, K and B1, B3, B6, B12), organic acids and enzymes. As seen in Table 1, there is a substantial amount of minerals (0.6-0.9%) such as, calcium, potassium, magnesium, phosphorus, sodium and iodine (Ayub *et al.*, 2020; Owusu-Kwarteng *et al.*, 2020; Farooq, 2017; Barham *et al.*, 2014; Imran *et al.*, 2008). Raw milk can be defined as “milk not receiving thermal

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treatment above 40 °C or any equivalent process” (Marri *et al.*, 2020).

Milk occupies a prominent position in the food chain since it is a very nutritious and rich diet for humans. In addition to its primary components (fat, protein and carbs), milk contains 150 additional essential

Table 1. Milk composition

Main constituent	Range (%)	Mean (%)
Water	85.5-89.5	87
Proteins	2.9-5.0	3.9
Lactose	3-5.5	4.3
Fat	3-4.0	3.5
Vitamins	0.9-1.1	0.1
Minerals	0.6-0.9	0.8

nutrients (vitamins, micro and micro-elements etc.) that are essential to human health (Marri *et al.*, 2020; Shkromada *et al.*, 2019). Due to milk's nutritive qualities, more than 6 million individuals throughout the world consume it and 150 million families engaged in production (Quintana *et al.*, 2020). The demand for milk was higher in wealthy countries than in developing ones but the difference has closed as a result of population growth and urbanization (Bhatt, 2016). Dairy industry is one of the leading worldwide agri-food sector for its size and economic importance (Marri *et al.*, 2020).

All lactating animals have nearly identical chemical compositions but their concentrations vary due to a variety of factors, including animal species, breed distinctiveness, lactational stage, frequency of milking, age, seasonal variations, feed, milking interval, diseases, stress, abnormal conditions drug and hormone injection (Muhammad *et al.*, 2009). The desire for products that are fresh, natural and full of nutrients which have a long shelf life and are free of chemical preservatives has increased significantly in the modern era. According to this viewpoint, raw milk consumption has expanded due to the firm conviction that it contains incredibly healthful elements, especially when ingested by people who may have lowered immunity, such as those who are very young, very old or immune-compromised individuals (Melini *et al.*, 2017). Milk is an absolute rich source of nutrients, contains more than 20 different trace elements and many of them are essential for biological systems of/in human body (Huque *et al.*, 2018).

Animal-source food pays a very impressive part in poverty reduction, gender equality, livelihood sustainability, nutritional improvement, food security and health in developing countries (Vries *et al.*, 2020). Additionally, the 17 worldwide sustainable development goals (SDG) established by the UN, including SDG1: Zero Hunger, SDG3: Good Health and Well-Being and SDG8: Decent Work and Economic Growth which are favourably influenced by dairy production (Wanjala *et al.*, 2018). The purpose of the study was to visualize the entire picture of Pakistan's present dairy sector, included livestock farming, challenges and drawbacks, milk distribution practices from farm to table for its safety and future demands.

Livestock farming in Pakistan. Livestock farming is the important component of the Pakistan rural economy

as it regularly financing the farming families (Farooq, 2017). Different animals such as buffalo, cattle, sheep, goat and camel produce milk but the buffalo and cattle are the cheap milk producer. Pakistan is ranked among the largest milk producer country in the world. The last 25 years milk production increased at the rate of 4.8%, which is quite low as compared to other developing countries because the milk producing animals are usually underfed and lack of feeds (Farooq, 2017; Iqbal *et al.*, 2015). A small proportion of the total milk is sold out as in raw form at the farm gate and through a large chain of intermediaries, retailer, sweet shops (halwais) or to the consumers at their doorstep mainly on foot or on bicycles or supplied to different dairy companies (Iqbal *et al.*, 2015; Iqbal and Ahmad, 2005).

The practices of milk production system in Pakistan are similar to the rest of the developing countries. Typically, there are five main dairy production systems in Pakistan based on location, herd size and level of management. These five systems are smallholder subsistence, smallholder market oriented, rural commercial, peri-urban and large peri-urban (Sattar, 2020). Approximately 80% milk is produced at small scale in rural areas, 15% peri-urban and 5% in the urban areas (Sattar, 2020; Pakistan Economic Survey, 2019-20). In Pakistan, livestock has emerged as the largest subsector in agriculture since last few decades. It is considered as one of the more secure source of income for small scale farmer and poor families (Khan *et al.*, 2013). More than 8 million rural families are involved in livestock production, and they earn more than 30-40% of their income through this sector. After the COVID-19 pandemic restriction Pakistan's agriculture sector showed strong (2.67%) growth and 2.58% growth rate was recorded in agriculture sub-sector, livestock (Pakistan Economic Survey, 2019-20). It is estimated that 97% milk is sold in raw form and rest is processed (UHT). About 20% milk for human consumption wastages (15% faulty transportation and lack of chilling facilities and 5% in calf feeding). In this scenario about Rs.20 billion worth of milk and its products were imported by Pakistan in 2017-18 (Sattar, 2020).

Average annual milk production during 1960s and 1970s was 6.6 million tonnes and 8.1 million tonnes respectively which increased to 61 million tonnes in 2019-2020 and 63 million tonnes 2020-21, with 3.21% annual average increase. Annual human consumption also increased at the same rate to that of milk production as in 2017-18 and it was 46682 thousand tones, 48185

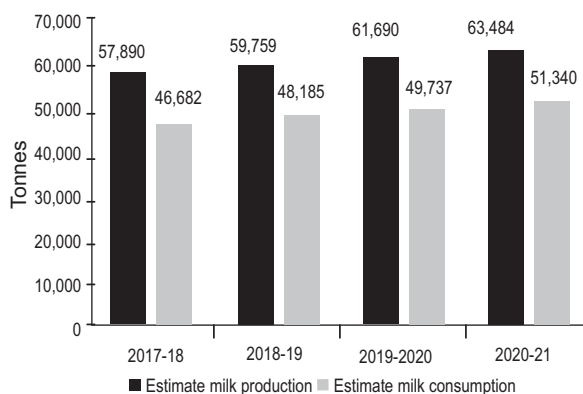
Table 2. Estimate milk production/consumption (tonnes)

Species	2017-2018	2018-2019	2019-2020	2020-2021
Estimate milk production	57,890	59,759	61,690	63,484
Cow	20,903	21,691	22,508	23,357
Buffalo	35,136	36,180	37,256	38,363
Sheep	40	40	41	41
Goat	915	940	965	991
Camel	896	908	920	932
Estimate milk (human consumption)	46,682	48,185	49,737	51,340
Cow	15,722	17,353	18,007	18,686
Buffalo	28,109	28,944	29,805	30,691
Sheep	40	40	41	41
Goat	915	940	965	991
Camel	896	908	920	932

thousand tonnes in 2018-19, 49737 thousand tonnes in 2019-20 and in 2020-21 was 51350 thousand tonnes as shown in Table 2 and Fig. 1 (Sattar, 2020; Pakistan Economic Survey, 2019-20).

On consumption side, 26% of food budget in Pakistan is spent on milk and its products. But, as the population and urbanization increase, the demand of livestock products also increased, therefore, it will be challenging to meet this demand over the next few years. Current livestock- population of the country includes 42.4 million buffaloes, 51.5 million cattle, 31.6 million sheep, 80.3 million goats and 1.1 million camels, as shown in Table 3 (Pakistan Economic Survey, 2020-21).

The province Punjab has the largest buffalo population, with 64% of the total, followed by Sindh with 26%, Khyber Pakhtunkhwa (KPK) with 7% and Baluchistan

**Fig. 1.** Estimate milk production/consumption (tonnes).

with only 1.2%. Punjab also has the largest cattle population, with 48% of the total, followed by Sindh with 23%, KPK with 20% and Baluchistan with 7%. The Punjab and Sindh are the major milk producing provinces, with annual production of 25.62 million and 9.35 million liters respectively. KPK produces an estimated 4.88 million liters/year and Baluchistan 0.81 million liters (Sattar, 2020). Provincially, annual per capita consumption is highest in Sindh, at 246 Kg. In Punjab it is about 132 Kg, in KPK about 86 Kg and in Baluchistan about 108 Kg. The average milk yield of the cow and buffalo is 14 and 10 L/day respectively. It is still 5-6 times less than the developed world. It is deemed that agriculture must maintain a growth rate of more than 5% in order to ensure a rapid growth of national income, attaining macroeconomic stability, effective employment of growing labour force and a reduction in rural poverty in Pakistan (Iqbal and Ahmad, 2005). For these and other social and economic reasons, as well as the fact that dairy animals are a reliable source of regular cash income, economically utilize the labour of the family, create social security and supply expanding markets, the dairy industry must be developed (Khan *et al.*, 2013).

Table 3. Estimated livestock population (million nos.)

Species	2018-2019	2019-2020	2020-2021
Cattle	47.8	49.6	51.5
Buffalo	40	41.2	42.4
Sheep	30.9	31.2	31.6
Goat	76.1	78.2	80.3
Camel	1.1	1.1	1.1

Milk contamination factors. Milk productions under unhealthy conditions and its marketing through informal channels especially in the developing countries in problematic to protect the milk from contamination (Aamir *et al.*, 2018). Raw milk is a good medium for colonizing and multiplying of many pathogenic micro-organisms (Verraes *et al.*, 2015). Normally, milk microbial contamination happens in two ways. The first is endogenous contamination in which the milk is contaminated by direct transfer of pathogenic microbes from the blood to the milk through an udder infection called mastitis. The second way is exogenous contamination where milk contamination occurs during milking process or post milking through poor sanitary conditions, unhygienic practices, low or inappropriate milk storage, mishandling and poor transportations (Aamir *et al.*, 2018; Verraes *et al.*, 2015). Food safety hazards are commonly defined as any biological, chemical or physical agents in a food or a food condition that create serious health consequences. Such risks may enter the dairy supply chain during milk production, processing, transportation, storage and serving, which may have an impact on the safety and quality of the milk (Shiferaw *et al.*, 2000). Traditionally, raw milk has been valued for its high nutritional content. However, due to unsanitary conditions and poor hygiene, raw milk is now considered one of the ideal conditions for the growth of pathogenic micro-organisms. As a result of its direct interaction with several contaminated sources such air, dirt, worker hygiene, excretion from infected udders and utensils used in production and processing areas, the safety of raw milk becomes a challenge (Qamar *et al.*, 2020). Bacterial contaminated milk can easily be spoils in a very short time and could be a possible cause of many milk-borne diseases in humans. According to the literature > 90% of all dairy related diseases are caused by several pathogenic bacteria like *Staphylococcus aureus*, *Salmonella* spp. and *Escherichia coli* (Gwandu *et al.*, 2018). Traditionally, the milk quality was judged on its composition at the end of the last century, now the health and hygienic parameters are also equally considered (Quintana *et al.*, 2020). Among the microbial populations, about 90% gram-negative bacteria and lesser presence of indicator and some other bacteria are account for safety and quality of milk/milk products (Banik *et al.*, 2014).

Based on previously reviewed literature, the main microbiological hazards related to consuming raw milk are considered to be caused by pathogenic bacterial

species, specifically enterotoxin-producing *Staphylococcus aureus* and human pathogenic verocytotoxin producing *Escherichia coli* (VTEC), human pathogenic *Listeria monocytogenes* and *Salmonella* spp. (Verraes *et al.*, 2015).

Adulteration. Food adulteration is a serious issue worldwide. Deliberate fraud by mixing low cost and poor quality ingredients, to earn more benefit at the cost of the quality of food intended for sale is very common in the developing world (Akhtar, 2015). Adulteration in the raw milk is the main problem in Pakistan. Milk dealers maximize their surplus in three ways by selling adulterated milk, addition of water, removal of valuable components and along with addition of additives. Mostly the intermediates add the locally available unauthorized constituents like starch, flour, caustic soda, urea, vegetable oil, antibiotics further they also add chemical preservatives to extend shelf life (Tanveer, 2015). Because of this, the milk sold in local markets for consumption by the general population contains relatively little nutritional value. However, the adulteration not only degrades the quality of the milk but also may seriously threaten public health. For example, carbonate (HCO^{-3}) in milk may cause gastrointestinal problems (gastric ulcer, diarrhea, colon ulcer and electrolytes disturbance), hydrogen peroxide (H_2O_2) disturbs the antioxidants, natural immunity acid base balance and blood pH in the body, while ammonia in the milk may causes the loss of immunity, kidney problems and sensory disturbances. Formalin (CH_2O) is a strong carcinogen it causes vomiting, diarrhea and abdominal pain. Boric acid (H_3BO_3) causes nausea, vomiting, diarrhea, kidney damage, acute failure of circulatory system and even death. Benzoic acid ($\text{C}_7\text{H}_6\text{O}_2$) produces adverse effects such as asthma, urticarial and metabolic acidosis (Barham *et al.*, 2014). Further, melamine ($\text{C}_3\text{H}_6\text{N}_6$) causes the urinary tract problems in infants and children (Khan *et al.*, 2017; Barham *et al.*, 2014). In Pakistan, a middleman (Gawalas) adds poor quality ice blocks to the milk during its storage and transportation to avoid milk spoilage further decline the milk quality (Ullah *et al.*, 2016).

Food borne bacteria. Milk from the healthy animals is often nitrous and contains few bacteria. The chances of microbial contamination increase upto 100 fold if it is produced under un-hygienic conditions (Shah *et al.*, 2016). Raw milk may be contaminated by numerous pathogenic bacteria such as *Escherichia coli*, *Salmonella*

spp., *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Listeria monocytogens* and *Leptospira* spp. and cause milk spoilage due to proteins, fat and carbohydrate degradation and thus the milk's other properties like colour, texture, taste and smell also deteriorated (Ayub *et al.*, 2020; Aamir *et al.*, 2018). Contaminated foods not only damage the human health but also have drastic impacts on the economy too (Khaton *et al.*, 2014). Most of the foodborne pathogens live in the ruminant intestinal tract that is why dairy herds are considered a major reservoir of *Salmonella* and *E. coli*. Likewise, *Listeria* spp. naturally inhabit in plants and soil environment (Oliver *et al.*, 2005). Pathogens such as *E. coli*, *Salmonella* or *Listeria* cause diarrhea and associated complications like kidney failure (Akhtar, 2015).

Food related diseases like, (hepatitis, typhoid, diarrhea etc.) are quite common in Pakistan. The root causes in spreading of food borne diseases are unhygienic conditions, absence of food standards, poor sanitation, poverty and illiteracy in addition to lack of awareness (Javed, 2016). Food-borne diseases are the utmost prevalent public health problems worldwide. Food normally contaminates during production, collection, transportation, preparation or during processing and becomes a source of human infection. Globally, food-borne illnesses are responsible for an estimated 600 million cases and 420,000 deaths. Among, bacteria are mainly convicted as causes of foodborne illnesses (Ayele *et al.*, 2017).

Challenges. The demands for dairy products rapidly increased due to faster population growth rate, increased urbanization, rate of rise in income and consumer's preferences for natural animal's base products to fulfill their protein and calcium requirements (Farooq, 2017). Dairy staff are usually uneducated and resistant to anti-traditional practices that may be risky for both animals and for the end milk consumers (Tanveer, 2015). The fast growing world population and global war trade situation have posed extraordinary challenges to food safety and security especially in developing countries to maintain and improve their economic status. According to World Health Organization (WHO), different food-borne diseases mostly affect the economy of poor nations. Therefore, WHO has enlisted food safety and security among its top 11 priorities and deeply participated to address the related issues in developing countries (Akhtar, 2015). In present technology revolution era, every country trying its best to minimize the food related health hazards in different ways like

by advancing the hygienic conditions, food storage temperature, un-hygienic processing etc. to present contaminated free food to the consumers. Mishandling and un-awareness of hygienic measures by the food handlers may invite pathogens to spoil the foodstuff and thus get chance to spread disease among consumers. Moreover, when infected food handler blow air into the polythene bags to open them actually they transfer disease causing agents to the purchaser (Javed, 2016). Dairy products are biochemically unstable and can easily accept external order and contaminants therefore, it is a great challenge to maintain its quality from farm to table (Tahir *et al.*, 2019). Upto 20% milk is being wasted due to non-availability of proper cooling and storage mechanism or lack of cold chain and chillers. It is reported that only 3-5% of total milk production of the country is marketed through proper channels and remaining is marketed in raw form by informal agents (doodhi) (Khan *et al.*, 2013).

Food safety practices. The basis of a food safety system consists of a combination of good manufacturing practices (GMPs), sanitation standard operating procedures (SSOPs) and the hazard analysis and critical control point (HACCP) system. Whereas GMP comprises a series of basic procedures and conditions to guarantee food safety according to specific legislation, the HACCP is a preventive approach that identifies the critical control points (CCPs) of a production process in order to control product safety. Implementation of the GMPs and SSOPs is a fundamental pre-requisite to make implementation of the HACCP system feasible (Cusato *et al.*, 2013).

If HACCP is applied to milk marketing it should consider the advancement to milk safety at all phases of the chain. Hazard analysis and critical control point system (HACCP) has been internationally acknowledged and accepted as the system for the effective food safety management. It is important to develop a food safety policy and plan for the implementation of HACCP because most of dairy foods are sensitive have less shelf life and are prone to foods borne diseases due to poor handling and manufacturing practices (Shiferaw *et al.*, 2000). Basically the safety and production are linked in the dairy food chain; from production through handling and processing to consumption. Therefore, in order to minimize the food safety risks associated with milk and dairy products, there is the need for a continuous system of preventive measures beginning with safety of animal feed, through good farming practices and

on-farm controls, to good manufacturing and hygiene practices, consumer's safety awareness and proper application of food safety management systems throughout the dairy chain (Owusu-Kwarteng *et al.*, 2020).

Future demand. Quality has become the most important feature in almost all stages such as food production, processing, distribution and consumption (Pakistan Economic Survey, 2020-21). Nutritionally enriched milk with enhanced biological potential and without health risks are generally demanded (Imran *et al.*, 2008). To provide safe and quality food to consumers is the basic responsibility of the concern authorities. Therefore, microbiological assessments should play an important part in the dairy sector to protect the public health and minimize the economic losses by initial revealing of poor sanitizing and unhygienic milk handling practices (Angulo *et al.*, 2009). Trainings and skill development programs for dairy staff should be carried out regularly to improve livestock production, feeding management, basic sanitation and disease prevention measures. Most importantly there is dire need to develop milk collection system by utilizing the latest technology to minimize the middle man (doodhi) role, to modernize the milk transportation facilities from rural areas to urban areas and to increase the post-harvest shelf life of milk (Khan *et al.*, 2013).

Conclusion

The outdated and disorganized milk production and distribution systems in Pakistan are under control of the haphazard private sectors. Pakistan's existing economic and environmental policies make it difficult to maintain sustainable growth, as mass production is put off by high transportation costs, inadequate infrastructure and expensive feed costs. Due to limited development spending, the government's attempts for development in all of these areas are insufficient. The main problems with Pakistan's dairy industry relate to several obstacles that arise within the milk supply chain, such as a lack of a chilling system, long distances, poor road infrastructure, insufficient transport facilities, excessive transportation costs and unskilled workers.

Conflict of Interest. The authors declare that they have no conflict of interest.

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