

Microbiological Quality of Milk and Milk Products in Jabalpur City

Pooja Singh¹, Ranvijay Singh^{2*}, Bhavana Gupta³, Sabya Sanchi Tripathi¹, Shakuntala Birla¹, Sujata Meravi¹ and Bhanu Pratap Singh⁴

¹MVSc, Department of Veterinary Public Health & Epidemiology, College of Veterinary Science & Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, INDIA

²Associate Professor, Department of Veterinary Public Health & Epidemiology, College of Veterinary Science & Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, INDIA

³Assistant Professor, Department of Veterinary Public Health & Epidemiology, College of Veterinary Science & Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, INDIA

⁴Teaching Associate, Department of Livestock Product Technology, College of Veterinary Science & Animal Husbandry, NDVSU, Jabalpur, Madhya Pradesh, INDIA

*Corresponding Author: rsvet24oct@gmail.com

How to cite this paper: Singh, P., Singh, R., Gupta, B., Tripathi, S. S., Birla, S., Meravi, S., & Singh, B. (2020). Microbiological Quality of Milk and Milk Products in Jabalpur City. *International Journal of Livestock Research*, 10(12), 194-200. doi: <http://dx.doi.org/10.5455/ijlr.20200718.055005>

Received : Jun 22, 2020
Accepted : Nov 24, 2020
Published : Dec 31, 2020

Copyright © Singh *et al.*, 2020

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Abstract

The present study was done to assess the sanitary / hygienic quality of milk through standard plate count and coliform count in milk and milk products. A total of 210 milk and milk products (42 each of raw milk, khoa, ice-creams, flavored milk and dahi) were collected from different sources in Jabalpur city in sterile bottles and poly bags. The bacteriological quality of milk and milk products were examined by standard plate count (SPC) and coliform count. The present study of milk and milk products showed that 30.9% and 64.2 % of raw milk samples had high standard plate counts (SPC) and coliform count, respectively. In investigation of khoa samples, higher SPC (83.34%) and coliform count (35.66%) were observed, with significant difference among the groups of products. Among ice-cream samples, 11.9% displayed higher SPC while, 40.47% showed high coliform counts. The SPC and coliform count of flavored milk viz. 76.1% and 78.5% samples were under acceptable limit respectively, while, 23.8% and 21.4% had SPC and coliform count above prescribed limit, respectively. The examination in dahi samples showed 42.85% and 28.57 % had higher SPC and coliform counts, respectively. The presence of bacterial count and coliform count in milk and milk products revealed poor sanitary conditions prevailing in the environment and thus, consumption of same may pose public health hazard.

Keywords: Assessment, Microbiological Quality, Milk and Milk Products

Introduction

Foodborne diseases are a growing public health problem worldwide, which occur as a result of ingestion of foodstuffs contaminated with microorganisms or chemicals. The contamination of food may occur at any step between food production to consumption. It may occur due to unhygienic practices and contamination by polluted water, soil or air. Food borne illness besides commonly causing gastrointestinal symptoms, are also associated with neurological, gynaecological, immunological, multiorgan failure and cancer problems and thus precipitate mortality. WHO reported that the burden of food borne diseases by bacteria, viruses, parasites, toxins and chemicals is around 600 million, or 1 in 10 people around globe, falls ill each year after consuming contaminated food. Out of that, 420 000 people die, including 125 000 (30%) children below 5 years of age (WHO, 2015). In a report from USA, around 48 million people get sick from a foodborne illness with 128,000 hospitalizations and 3,000 deaths (CDC, 2015).

In food, milk have high nutritive value and moisture content, therefore these products serve as an excellent culture medium for the growth and multiplication of microorganisms. The pathogen gain entry into milk directly from dairy animals, milkers, farm environment particularly from water, utensils, dust etc besides udder infection. Milk products are generally contaminated with equipments, unpasteurized milk, inadequate or faulty methods of pasteurization /sterilization, packaging or storage and contaminated hands of occupational workers (Burton, 1986; Tassew and Seifu, 2011). The persistence of the pathogens in the milk and milk products lead to formation of biofilms and thus, exposure to consumers to zoonotic bacteria (Tassew and Seifu, 2011; Bashir *et al.*, 2014; Aboubaker *et al.*, 2016; Nema *et al.*, 2018). The common diseases transmitted by the milk and its products are brucellosis, tuberculosis, salmonellosis, *E. coli* infections, campylobacteriosis, listeriosis etc. (Dhanashekar *et al.*, 2012; Harve *et al.*, 2016; CDC, 2017; Singh *et al.*, 2018; Thakur *et al.*, 2019). Thus, to observe the quality of milk and milk products, the present study included standard plate count and coliform count of the products. The study would give better idea about the food conditions viz. sanitary quality, protection of food from spoilage and protection of health from microbial hazard.

Materials and Methods

A total of 42 raw milk (14 each of home, dairy and vendor samples) and 168 milk products (42 each of khoa i.e., 14 each of sweet shop, khoa market and home, ice-creams, flavored milk and dahi (14 each of brand I, brand II and local), was procured from different sources like vendors, homes, dairy and retail shops in Jabalpur city in sterile bottles and poly bags and examined for the quality. Standard plate count (SPC) and coliform count of milk and milk products was done as per the method described by Salfinger and Tortorello (2015).

Standard Plate Count (SPC)

Standard plate count was used to determine the number of microbes / ml or gm in a milk and milk products sample. In brief, 10 ml or gm of milk and its product was diluted in 90ml of normal saline solution (1:10 dilution) and further serial dilution were made by taking 1ml of diluted sample in 9 ml of normal saline. One ml of diluted sample was taken on plate count agar in duplicate plates and incubated at 37°C for 24 - 48 h and was counted as "colony forming unit" (cfu / ml or gm). For accurate counts, the optimum count should be within the range of 30 to 300 colonies / plate.

Coliform Count

The coliform count was used to determine the number of coliforms / ml or gm in milk and milk products samples. For this, 1 ml of serially diluted sample as mentioned above was taken and was uniformly mixed with 10 ml of violet red bile agar (VRBA) in petriplates. After solidification of media, 5-8 ml VRB agar was overlaid in each plate and then plate was incubated at 37°C for 18-24 h. The purple red colonies were counted from the plates showing 15-150 colonies. The cfu / ml or gm was determined using the formula $\text{cfu per ml of sample} = \frac{\text{number of colonies}}{\text{(amount plated X dilution)}}$.

Statistical Analysis

The microbial counts were converted to logarithm of the number of colony forming units per ml of milk and its

products samples (log CFU/ml). The data were subjected to analysis of variance, least significant difference for comparing the means to find the difference between groups. The smallest difference (D5%) for two means to be significantly different ($P < 0.05$) was reported (Snedecor and Cochran, 1995).

Results and Discussion

The SPC and coliform count of milk and its products is an index of the sanitary quality and handling of milk and hygiene at farm. It also indicates storage condition, temperature maintenance and herd health. The microbial counts above 10^5 - 10^6 cfu /ml indicate contamination of milk and aren't fit for processing. The raw milk obtained from the udder of healthy animals is clean, safe, sound and wholesome (O'Brien *et al.*, 2008; Sarkar, 2016). In India, most of the foodborne diseases are sporadic and often not reported. In nationwide study, 13.2% prevalence at the household level was reported (Kohli and Garg, 2015).

Table1: Bacteriological quality of raw milk

Standard plate count/ml	Number of samples	Coliform count/ml	Number of samples
< 10 lakhs	29 (69.04%)	0- 10/ ml	15 (35.7%)
>10 lakhs	13 (30.9%)	> 10/ ml	27 (64.2%)

Table 2: Bacteriological analysis of raw milk from different source (mean±SE)

Bacteriological quality		Mean ± S.E.
SPC (log cfu/ml)	Home	5.61±0.02
	Dairy	5.48±0.03
	Vendor	5.92±0.22
Coliform count (log cfu/ml)	Home	1.69±0.03 ^b
	Dairy	1.53±0.04 ^a
	Vendor	1.60±0.02 ^{ab}

$n=14$, means with different superscripts in the same row indicate significant difference ($P < 0.05$)

The present study revealed that 30.9% samples had high count viz. between 10-50 lakh, while, 64.2% samples had coliform count viz. > 10 / ml. Similar findings had also been reported by various workers viz. Chatterjee *et al.* (2006) reported 60% samples of raw milk had high count ($>10^6$). Another study on raw milk obtained from vendors in Bhopal showed SPC 6.13 ± 0.083 cfu /ml and coliform count 4.01 ± 0.1413 cfu / ml (Jain and Srivastava, 2014). Likewise, an investigation from different corners in Madurai revealed higher mean SPC and coliform viz. 12.5×10^6 cfu/ml and 10^3 - 10^4 cfu / ml, respectively. Further, they reported coliform bacteria to be approximately 90% with 70% presence of *E. coli* from 60 milk samples tested (Lingathurai and Vellathurai, 2010). In a comparative examination of the bacterial load in the rural and urban milk samples in Sambalpur (Odissa), the average count was 8.257 ± 0.937 log cfu / ml and 8.756 ± 0.803 log cfu / ml, respectively (Minj and Behera, 2012).

Observation in developing countries also displayed poor hygienic condition of milk viz. evaluation of microbial quality of raw milk from farmers and milk cooperatives in Ethiopia revealed the mean bacterial and coliform count was 7.58 ± 0.09 log₁₀ cfu / ml and 4.49 ± 0.11 log₁₀ cfu / ml, respectively (Dey *et al.*, 2011), while another report from Azad Kashmir (Pakistan) revealed 4.5×10^5 , 58.3×10^7 and 1.7×10^9 counts in household milk, milk man and restaurant milk, respectively (Bashir *et al.*, 2014). Similarly, investigation on microbial contamination of raw and boiled milk sold in Kenya, revealed that all the raw milk samples contained ≥ 100000 cfu / ml of SPC while 60% samples had >50000 cfu / ml coliform bacteria (Ogot *et al.*, 2015). Besides this, different workers also found presence of coliform especially *E. coli* in milk samples (Ekici *et al.*, 2004; Mubarack *et al.*, 2010; Salman and Hamad, 2011). The presence of higher SPC and coliform is an indicator of insanitary conditions in farm environment like unhygienic milk handling, contamination from animal bedding, feces, unhygienic water, milking machine and equipment's and filthy udder condition etc. Inadequate cooling of milk and udder infections or poor practices during production, processing, distribution were also responsible (Oliver, 2005; O'Brien *et al.*, 2008; Agarwal *et al.*, 2012; Minj and Behera, 2012). A study had shown that variation in counts may occur due to seasonal variations viz. higher in summer than in winter due to higher temperature which enhances the growth of bacteria (Dahiya and Srivastava,

2012).

Samples drawn from different milk products showed higher SPC and coliform counts than the permissible level of FSSAI (2015), although these products were pasteurized or prepared at higher temperature. The permissible level of SPC for pasteurized/flavored milk, ice-cream, paneer and khoa is 3×10^4 - 5×10^4 , 1×10^5 , 1.5 - 3.5×10^5 and 2.5 - 7.5×10^4 /g respectively, while for coliform count the permissible limit is absent/0.1ml, 10^1 - 10^2 , 10^1 - 10^2 and 10^1 - 10^2 /g for pasteurized/flavored milk, ice-cream, paneer and khoa respectively (FSSAI, 2015). In the present study, 83.34% and 35.66% of khoa samples had higher SPC and coliform, respectively. An observation on 50 samples of khoa in Chambal region (Madhya Pradesh) showed the viable counts between 1.3×10^4 to 2.1×10^6 cfu /g with the presence of pathogenic organisms (Bhatnagar *et al.*, 2007). The higher count in current study on ice-cream was supported by an observation in Punjab, wherein samples of ice-cream showed average viable count to be 8.3×10^4 cfu / g. The same study revealed higher counts in other products like rasgulla, paneer etc. (Chatli *et al.*, 2014). Another investigation in Bhopal (Madhya Pradesh) on Indian cheese showed higher SPC with a mean of 5.53 ± 0.1510 log 10 cfu / gm and coliform counts with a mean of 4.51 ± 0.0872 log10 cfu / g along with a wide variety of pathogens and spoilage type bacteria in the samples of Indian cheese (Jain and Srivastava, 2012). Examination of dahi in Bangladesh showed higher counts viz. 5.92 ± 0.09 and 5.84 ± 0.06 (Dey *et al.*, 2011). The difference in counts could be ascribed to variation in regional condition i.e., temperature, hygienic practices etc.

Table 3: Bacteriological quality of khoa

Standard plate count/gm	Number of samples	Coliform count/gm	Number of samples
< 25,000	7 (16.66%)	0- 50	27 (64.34%)
>25,000	35 (83.33%)	>50	15 (35.66%)

Table 4: Bacteriological analysis of khoa from different sources (mean±SE)

Bacteriological quality		Mean±S.E.
SPC (log cfu/g)	Sweet shop	4.46±0.04 ^a
	Khoa market	4.84±0.10 ^b
	Home	4.31±0.03 ^a
Coliform count (log cfu/g)	Sweet shop	1.35±0.01 ^b
	Khoa market	1.82±0.01 ^c
	Home	1.15±0.02 ^a

n=14, means with different superscripts in the same row indicate significant difference ($P < 0.05$).

Table 5: Bacteriological quality of ice-cream

Standard plate count/gm	Number of samples	Coliform count/gm	Number of samples
< 2,50,000	37 (88.0%)	0- 10	25 (59.53%)
> 2,50,000	5 (11.9%)	>10	17 (40.47%)

Table 6: Bacteriological analysis of ice-cream from different sources (mean±SE)

Bacteriological quality		Mean±S.E.
SPC (log cfu/g)	Brand I	4.46±.10 ^a
	Brand II	4.44±.10 ^a
	Local	4.78±.07 ^b
Coliform count (log cfu/g)	Brand I	1.67±.05
	Brand II	1.68±.05
	Local	1.81±.04

n=14, means with different superscripts in the same row indicate significant difference ($P < 0.05$).

Table 7: Bacteriological quality of flavored milk

Standard plate count/ml	Number of samples	Coliform count/ml	Number of samples
0- 30,000	32 (76.1%)	0- 10	33 (78.6%)
30,000- 50,000	10 (23.9%)	> 10	9 (21.4%)

Table 8: Bacteriological analysis of flavored milk from different sources (mean±SE)

Bacteriological quality		Mean±S.E.
SPC (log cfu/g)	Brand I	Absent
	Brand II	Absent
	Local	4.58±0.03
Coliform count	Brand I	Absent
	Brand II	Absent
	Local	1.89±0.04

n=14, means with different superscripts in the same row indicate significant difference (P<0.05)

Table 9: Bacteriological quality of dahi

Standard plate count/gm	Number of samples	Coliform count/gm	Number of Samples
< 30,000	24 (57.14%)	0- 10/ gm	30 (71.4%)
30,000- 50,000	18 (42.85%)	10-100/ gm	12 (28.57%)

Table 10: Bacteriological analysis of dahi from different sources (mean±SE)

Bacteriological quality		Mean±S.E.
SPC (log cfu/g)	Brand I	5.44±0.03 ^a
	Brand II	5.41±0.03 ^a
	Local	6.38±0.10 ^b
Coliform count (log cfu/g)	Brand I	1.33±0.03 ^a
	Brand II	1.39±0.03 ^a
	Local	1.66±0.04 ^b

n=14, means with different superscripts in the same row indicate significant difference (P<0.05)

The presence of microorganisms in products like dahi, ice-cream, flavoured milk or khoa is of considerable importance as these products are either fermented or pasteurized or sterilized, which do not support the growth of bacteria. Therefore, the presence may be attributed to faulty process of pasteurization / sterilization of milk or due to traditional method of preparation which made thermophilic organisms to escape during the process of heat treatment. Post pasteurization processing or preparation, unhygienic handling and contaminated raw material are also important factors for the high count and presence of coliform as these are environmental organisms (Chye *et al.*, 2004; Bhatnagar *et al.*, 2007; Ogot *et al.*, 2015). High water activity of the various milk products (>0.95) and higher temperature during storage increases the counts at fast pace. Presence of higher counts and coliform in milk and its products is an indication of gross level environmental contamination that may lead to the presence of *E. coli*, *Enterobacter sp.*, *Klebsiella sp.* and *Shigella*, *Salmonella*, *Streptococci sp.*, and *Pseudomonas sp.* These pathogens may cause disease outbreaks ranging from diarrhea to potentially fatal infections like typhoid, hemolytic uremic syndrome (HUS) and hemorrhagic enteritis (Agarwal *et al.*, 2012; Aboubaker *et al.*, 2016).

The present study reflects that to know the sanitary quality of milk and its products, both SPC and coliform study should be included because SPC gives the total viable count and coliform reflects insanitary practices in the environment. The results of the study showed that the milk and milk products were contaminated with microbes which may be pathogenic and thus, constitute a serious public health hazard. Therefore, the milk and its products should be handled during procurement, production, processing and transportation in clean and sanitary environment viz. clean utensils, milking machine, milk parlour and apparently healthy hands. Besides, ingredients added should

be pasteurized / sterilized and there should be maintenance of cold chain. Sanitation and hygiene should be maintained at urban farms as well as in the rural farms. Most of the milk procurement and distribution should be brought under organized sector.

Conclusion

The milk and its products had shown the presence of high bacterial and coliform count in many samples of milk and milk products than recommended level (FSSAI, 2015), which indicated widespread occurrence of poor hygienic and sanitary quality during collection, processing and distribution in the food chain. This may pose high risk to the consumer and enhances the chances of public health hazard due to consumption of products. Therefore, there is need for implementation of hygienic / sanitary practices viz. HACCP in the environment of milk and milk products to provide clean, wholesome milk as well as milk products to the consumers.

Acknowledgments

The authors are grateful to the Dean, College of Veterinary Science & Animal Husbandry, NDVSU, Jabalpur and Madhya Pradesh Council of Science and Technology, Bhopal for providing financial assistance and necessary facilities to conduct the MVSc research work of the first author.

Conflict of Interests

There is no conflict of interest.

Publisher Disclaimer

IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

References

1. Aboubaker, M. G., Enas, M. A., Salah, M. A., Said, K. A., Hesham, T. N., Ashraf, A. M., Fatim, T. G., Ilaria, B. and Ibrahim, M. E. (2016). Enterohemorrhagic *E. coli* O157 in milk and dairy products from Libya: Isolation and molecular identification by partial sequencing of 16S rDNA. *Veterinary World*, 9: 1184-89.
2. Agarwal, A., Awasthi, V., Dua, A., Ganguly, S., Garg, V. and Marwaha, S.S. (2012). Microbiological profile of milk: Impact of household practices. *Indian Journal of Public Health*, 56 (1): 88-94.
3. Bashir, S., Awan, M. S., Khan, S. A., Suthar, V., Khan, M. M. and Tehseen, M. K. (2014). Microbiological quality evaluation of raw milk consumed in and around Rawalakot, Azad Jammu and Kashmir. *International Journal Microbiological Research*, 5 (2): 112-116.
4. Bhatnagar, P., Khan, A. A., Jain, M., Kaushik, S. and Jain, S. K. (2007). Microbiological study of khoa sold in Chambal region (Madhya Pradesh): A case study. *Indian Journal of Microbiology*, 47: 263-266
5. Burton, H. (1986). Microbiological aspects of pasteurized milk. *Bulletin of International Dairy Federation*, 200: 9-14.
6. CDC. (2015): CDC and Food Safety. <http://www.cdc.gov/foodsafety/foodborne-germs.html>
7. CDC. (2017). Raw (unpasteurized) milk. Updated 02/22/17. <http://www.cdc.gov/foodsafety/foodborne-germs.html>
8. Chatli, A.S., Tangri, R., Chawla, H. and Komal, R. (2014). Microbial quality evaluation of milk products. *International Journal Development Research*, 4: 623-628.
9. Chatterjee, S. N., Bhattacharjee, I., Chatterjee, S.K. and Chandra, G. (2006). Microbiological examination of milk in Tarakeswar, India with special reference to coliforms. *African Journal of Biotechnology*, 5(15): 1383-85.
10. Chye, F.Y., Abdullah, A. and Ayob, M. K. (2004). Bacteriological quality and safety of raw milk in Malaysia. *Food Microbiology*, 21: 535-41.
11. Dahiya, R. and Srivastava D. N. (2012). Milk quality at various stages of sampling of Haryana dairy development co-operative federation Ltd. *Asian Journal of Dairy Food Research*, 31(4):252-255.
12. Dey, S., Iqbal, A., Ara, A. and Rashid, M.H. (2011). Dahi available at Sylhet Metropolitan City. *Journal of Bangladesh Agricultural University*, 9(1):79-83.

13. Dhanashekar, R., Akkinapalli, S. and Nellutla, A. (2012). Milk-borne infections. An analysis of their potential effect on the milk industry. *Germs*, 2(3): 101–109.
14. Ekici, K., Bozkur, H. and Isleyici, O. (2004). Isolation of some pathogens from raw milk of different milch animals. *Pakistan Journal of Nutrition*, 3(3):161-62.
15. FSSAI. (2015). Milk and milk products- Food Safety and Standard Authority of India. fssai.gov.in/Portals/0/Pdf/Draft_Regulation_on_Microbiological_standards_milk_and_milk_products_31_08_2015.pdf
16. Harvey, R., Zakjour, C. and Gould, L. (2016). Foodborne disease outbreaks associated with organic foods in the United States. *Journal of Food Protection*, 79(11):1953-58.
17. Jain, N. and Srivastava, S. (2012). Study on bacteriological quality of marketed milk product (Indian cheese) in Bhopal city, Madhya Pradesh, India. *Science Secure Journal of Biotechnology*, 1: 47-51.
18. Jain, N. and Srivastava, S. (2014). Quality assurance of marketed raw milk in Bhopal city, Madhya Pradesh, India. *International Research Journal of Biological Science*, 3(11):23- 27.
19. Kohli, C. and Garg, S. (2015). Food safety in India: An unfinished agenda. *Journal of Medical Science*, 31(1):131-5.
20. Lingathurai, S. and Vellathurai, P. (2010). Bacteriological quality and safety of raw milk in Madurai South India. *Webmed Central Microbiology*, 10: 1-10.
21. Minj, A. K. and Behera, N. (2012). A comparative microbiological quality assessment of rural and urban milk samples. *African Journal of Food Science*, 6(21): 519-23.
22. Mubarak, M.H., Doss, A., Dhanabalan, R. and Balachander, S. (2010). Microbial quality of raw milk samples collected from different villages of Coimbatore district, Tamil Nadu, South India. *Indian Journal of Science Technology*, 3(1): 61-63.
23. Nema, P., Singh, R.V., Goyal, G., Gupta, B., Naik, A., Jadav K. K. and Singh, A.P. (2018). Molecular characterization of *E. coli* isolates from milk and milk products. *Journal of Immunology and Immunopathology*, 20(2): 91-97.
24. O'Brien, M., Hunt, K., McSweeney, S. and Jordan, K. (2008). Occurrence of foodborne pathogens in Irish farmhouse cheese. *Food Microbiology*, 26: 910-914.
25. Ogot, H. A., Ochuodho, H. O. and Machoka, R. (2015). Microbial analysis of raw and boiled milk sold at Baraton center in Nandi County, Kenya. *Baraton Interdisciplinary Research Journal 2nd Annual Baraton International Interdisciplinary Research Conference Proceedings 2015; Emerging Issues in Globalization*.
26. Oliver, S.P., Jayarao, B.M. and Almeida, R.A. (2005). Foodborne pathogens in milk and the dairy farm environment: Food safety and public health implications. *Foodborne Pathological Diseases*, 2: 115-129.
27. Salfinger, Y. and Tortorello, M. L. (2015). *Compendium of Methods for the Microbiological Examination of Foods*. 5th ed. American Public Health Association, APHA Press, Washington, DC.
28. Salman, A.M.A. and Hamad, I.M. (2011). Enumeration and identification of coliform bacteria from raw milk in Khartoum state, Sudan. *Journal of Cell and Animal Biology*, 5(7):121-128.
29. Sarkar, S. (2016). Microbiological safety concerns of raw milk. *Journal of Food Nutrition and Dietetics*, 1(2):1-7.
30. Singh, P., Singh, R.V., Gupta, B., Sharma, V., Tripathi S. S., Tomar K.S. and Jadav K. K. (2018). Occurrence of shiga toxin producing *E. coli* in milk and milk products collected in and around Jabalpur. *Journal of Animal Research*, 8(2): 205-211.
31. Snedecor, G. W. and Cochran, W. G. (1995). *Statistical methods* (Eighth edition). Calcutta, India: Oxford & IBH Publishing Co.
32. Tassew, A. and Seifu, E. (2011). Microbial quality of raw cow's milk collected from farmers and dairy cooperatives in Bahir Dar Zuria and Mecha district, Ethiopia. *Agriculture and Biology Journal of North America*, 2(1): 29-33.
33. Thakur, V. S., Gupta, B., Singh R. V., Nayak, A. and Meravi, S. (2019). Antimicrobial susceptibility of *S. aureus* isolates from chicken meat and ready to eat chicken products in Jabalpur City. *International Journal of Livestock Research*, 9 (12):50-58.
34. WHO (2015): WHO's first ever global estimates of foodborne diseases find children under 5 account for almost one third of deaths. <http://www.who.int/mediacentre/news/releases/2015/foodborne-disease-estimates/en/>
