EFFECT OF MILKING MANAGEMENT PRACTICES ON QUALITY OF PANDHARPURI BUFFALO MILK ON DIFFERENT ORGANIZED FARMS

By

Mr. Rathod Sanjudas Hema
(Reg. No. 04/189)

A Thesis submitted to the
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST.AHMEDNAGAR,
MAHARASHTRA, INDIA

in partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

ANIMAL SCIENCE

DIVISION OF ANIMAL SCIENCE AND DAIRY SCIENCE

COLLEGE OF AGRICULTURE,
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APPROVED BY

Prof. B.B. Khutal
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DIVISION OF ANIMAL SCIENCE AND DAIRY SCIENCE

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2007

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CERTIFICATE

This is to certify that the thesis entitled, "**EFFECT OF MILKING MANAGEMENT PRACTICES ON QUALITY OF PANDHARPURI BUFFALO MILK ON DIFFERENT ORGANIZED FARMS"**, submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **ANIMAL SCIENCE**, embodies the results of a *bona fide* research carried out by **MR. RATHOD SANJUDAS HEMA,** under my guidance and supervision and no part of the thesis has been submitted for any other degree or diploma.

Place : Pune-03 (B.B. Khutal)
Dated : / /2007.

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CERTIFICATE

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Place : Pune-5 (R.N. Sabale)
Dated : / /2007.

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Place : Pune-3 **(S.H. Rathod)**
Date : / /2007.

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LIST OF ABBREVIATIONS

c.f.u.	:	Colony forming unit
^0C	:	Degree centigrade
et al.	:	Et alli (And others)
etc	:	Et cetera
g	:	Gram (s)
i.e.	:	That is (id est)
m	:	Meter (s)
mg	:	Milligram(s)
ml	:	Mililiter (s)
No.	:	Number
SPC	:	Standard Plate Counts
T.B.C.	:	Total Bacterial Count
%	:	Per cent
/	:	Per

ABSTRACT

EFFECT OF MILKING MANAGEMENT PRACTICES ON QUALITY OF PANDHARPURI BUFFALO MILK ON DIFFERENT ORGANIZED FARMS

By

Shri. Rathod Sanjudas Hema

A candidate for the degree

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MASTER OF SCIENCE (AGRICULTURE)

in

ANIMAL SCIENCE

2007

Research Guide : Prof. B.B. Khutal

Department : Animal Science and Dairy Science

The dairy farming occupies a significant role in sharing the Indian economy. The efforts put forth for improving the dairy industry in India has shown the fruitful results and India secured 1st position in the world in total milk production. The total milk production and per capita availability of milk were 97.1 MT and 241 g, respectively during 2005-06. Though India secured first position in milk production in world, it is only in quantity and not in quality. Milking of animals should be done hygienically to preserve freshness of milk for longer time. Due to such conditions, clean milk production assumes special significance in India. Milk can be obtained hygienically by machine milking under Indian conditions as compared to hand milking.

Thus, a need was felt to study the overall effect of milking management practices on quality of Pandharpuri buffalo milk on different organized farms. Six Pandharpuri buffaloes were

selected from each farm. The milking management practices especially washing of udder was taken for the study purpose. Twelve Pandharpuri buffaloes of same stage of lactation were selected for present investigation. Out of these 6 animals were milked by machine and others 6 were milked by hand milking. During the entire experimental period all the animals were kept under similar feeding and managemental conditions. The milk samples were collected from each farm and analysed for microbial attributes i.e. standard plate count and coliform count. To test the significance of difference between the two methods simple 't' test was applied.

The average of SPC and coliform count per ml of unwashed and washed udder milk samples at Pune farm were 261 x 10^3; 36.4 x 10^3 and 38.0 x 10^2; 5.5 x 10^2, respectively. The average SPC and coliform counts of unwashed and washed udder milk samples at Kolhapur farm were 208 x 10^3; 21.3 x 10^3 and 32.4 x 10^2; 3.1 x 10^2 c.f.u. per ml, respectively. Washing of udder has shown the decreasing trend of SPC and coliform counts of raw milk.

The SPC and coliform counts of raw milk obtained from unwashed udder were significantly (< 0.01) higher than washing of udder.

The average SPC of raw milk obtained by hand milking and machine milking at Pune farm were 27.5 x 10^3 and 3.1 x 10^3 c.f.u. per ml while average of

raw milk at Kolhapur farm were 21.5 x 10^3 and 2.7 x 10^3 c.f.u. per ml, respectively. The average coliform

counts of raw milk obtained by hand milking and machine milking at Pune farm and Kolhapur farm were 35.9 x 10^2; 3.1 x 10^2 and 28.5 x 10^2; 2.1 x 10^2 c.f.u. per ml, respectively. The bacterial quality of raw milk under hand milking was significantly higher than machine milking.

The SPC and coliform counts of raw milk of Pandharpuri buffalo at Pune farm was significantly (<0.01) higher than SPC and coliform counts of raw milk at Kolhapur farm.

The SPC and coliform counts of raw milk obtained by hand milking were significantly (< 0.01) higher than machine milking.

It is concluded that, the clean and hygienic practices for milk production is directly useful to increase the microbial quality of milk. The milking by machine is useful for producing the high microbial quality of milk.

1. INTRODUCTION

The Dairy farming plays a significant role in sharing the Indian economy. India's milk production, according to Economy Survey, Govt. of India 2005-06 has reached a record 97.1 million tonnes placing the 1st position in the Worlds in total milk production. The FAO's latest food outlook attributes the growth in Indian milk production to a sustained expansion in domestic demand. In the year of independence we started with a base line milk production of 17 million tonnes per year and today we have surpassed 97.1 million tonnes, which amount to almost one million tonnes increase every year (Anonymous, 2007) with the present growth rate of 4-5 per cent per annum. India is expected to produce 220 to 250 million tonnes of milk by the year 2020, which would be more than one third of the projected global production of 520 to 650 million tonnes. At present, India produces half of Asia's milk output. Sadly, it also bears a whopping annual loss of Rs. 5,500 crores due to substandard quality of milk (Ganguli, 1999).

Though, India has secured first position in milk production in the world, it is only in quantity and not in quality. The spoilage of milk because of bacterial action is estimated to be 10 per cent of the total milk production in India (Chakraborti *et al.,* 1986). In terms of quality of milk and productivity of dairy animals, India ranks low among the major dairy nations. In comparison as against the average bacterial count of raw milk at < 1,00,000/ml in most of the European countries and USA, the average bacterial count in India is in the range of 5,00,000-10,00,000/ml. Secretary of Milk Marketing Board of England on the bacterial quality of raw milk made remarks at a press meet in 1944. His impression was that the milk sold in Bombay (Mumbai) had a bacterial count higher than the sewage at London (Kadirval, 2002).

Milk occupies a unique position in the diet of most of the people in the world. It is well accepted fact that milk is the most precious ideal liquid food in the nature, because milk contains not only various nutrients essential for human growth, but also contains these nutrients in proper proportion required by the body for maintaining the good health. The modern nutrition experts have recommended that four glasses of milk i.e. about 290 g provide approximately 100 per cent requirement of calcium, 93 per cent of riboflavin, 61 per cent of phosphorus, 49 per cent of protein, vitamin B_1, 22 per cent calories, 17 per cent

of ascorbic acid, 17 per cent niacin and 5 per cent iron for an average adult (Hathi, 1977). As such, it is the most nearly perfect food available to human beings. Milk being microbiologically 'fragile' it is to be protected from microbial fermentation to ensure its quality. Nearly all the changes, which take place in milk particularly with regard to flavour and appearance are post-secretary events and associated with the growth of the microorganisms.

The milk production in rural area by a milk producer is in the range of 2 to 5 lit per day. In India, the raw milk contains 8 to 10 million microorganisms per ml of milk as against 0.1 million microorganisms per ml in developed countries (Ogale, 1999). Milk quality is the most important aspect of dairy production. In our dairy industry, quality is viewed in the perspective of fat and SNF contents and not bacterial count, bringing it seriously under challenge for producing high quality dairy products from a raw milk supply that more often may not be satisfactory in its processing characteristics; thereby affecting exports of milk and milk products in a highly competitive market.

The contaminated milk contains number of pathogenic organisms, which cause diseases in human beings. Milk and milk products play an important role in human nutrition and at the same time they also act as an ideal medium for growth and transmission of various pathogens. A number of human epidemics like typhoid, paratyphoid, septic sore throat, scarlet fever, gastroenteritis, diphtheria, etc. are caused by the pathogens transmitted through milk.

Educational and industrial growth had developed the health consciousness among Indian people. This has resulted in demands of quality milk and milk products (Prasad, 1998). It is imperative to produce milk of very high microbiological and chemical quality (Anand and Prasad, 1997).

Increased milk production and improved infrastructure facilities for milk processing have facilitated Indian population to avail per capita consumption of milk to the extent of 241 g per day in the year 2005-06. Apart from the effort to meet the Indian Medical Council's per capita recommendation of 284 g per day, the country at present is in a 'Zero import' stage for milk and milk products but this balance may change due to adverse situations. India is also looking for export of value added dairy products. While adopting the policy of globalization and liberalization, India has signed the General Agreement on Trades and Tarrif (GATT) in July, 1993 and subsequently the country has to be an effective partner of World Trade Organization (WTO) from January, 1995.

Under such circumstances, the rules for the microbiological quality parameters of milk and milk products have to be more stringent with respect to the sanitary and phyto-sanitary requirements for overcoming non tariff barriers such as Technical Barriers on Trade (TBT) and certification of ISO-9000/14000 by the Indian dairy manufacturers following the Hazard Analysis of Critical Control Points (HACCP) during production, collection, processing, storage and marketing of milk and milk products. Non-compliance of the ISO standards would be a setback for the country in the matter of export and India elities, compared to domestically manufactured value added dairy products, may prefer imported dairy products of ISO standards (Sinha and Sinha, 1997). Also due to the liberalization at world level, there is a great potentiality for export of milk products especially milk powder, cheese and some Indian traditional milk products.

The raw milk plays an important role in maintaining quality of milk products. Hence, it is necessary to adopt certain milking management practices, which do not alter the chemical quality of milk and also extends its shelf life for a considerable lapse of time.

Manufacturing of value added products, such as cheese, necessarily demands a very high quality of milk. Poor quality milk creates great problems with processing. It is, therefore, necessary to produce clean and hygienic milk at the doors of milk producers and at milk collection centres. Keeping this view in mind, the present study was planned to study the effect of milking management practices on quality of Pandharpuri buffalo milk on different organized farms with following objectives.

i. To study the effect of milking management practices on quality of milk.
ii. To study the influence of methods of milking on quality of milk.

2. REVIEW OF LITERATURE

Milk is the complex but almost complete food available from milch animals. It is the most perfect food that the nature has produced for nourishing the newly borns. It is also an ideal medium for the growth and multiplication of various types of micro-organisms. The milking management practices plays an important role for clean and hygienic milk production. A considerable research work has been carried out on the effect of milking management practices on

quality of raw milk. The important work carried out by various research workers has been presented in this chapter.

2.1 Standard plate count

2.1.1 Milking management practices

2.1.1.1 Washing of udder

Shah and Laxminarayana (1949) studied the udder microflora of milk and they found that the bacterial number of the aseptically collected milk samples varied from 1 x 10^2 to 9.6 x 10^3 c.f.u. per ml.

Lavania and Singh (1973) studied the effect of fore milk udder and hands of the milker on clean milk production and observed that SPC of unwashed and washed udder ranged from 6 x 10^4 to 22 x 10^5 c.f.u. per ml and 11 x 10^3 to 7 x 10^4 c.f.u. per ml, respectively and concluded that maximum contamination comes from the unwashed udder.

Kumar *et al.* (1974) analysed as many as 49 milk samples collected from different sources in the Tarai region for their sanitary quality. The SPC of udder milk samples collected aseptically ranged from 330/ml to 4100/ml indicating that milk from apparently healthy udders was not sterile.

Ernest and Padmanabhan (1977) in their study of effect of Chlorine and Savlon as udder wash in producing low bacterial count milk reported that SPC was lower after washing of udder with Chlorine and Savlon.

Amala Raj and Prasad (1982) studied antibacterial effects of Chlorine, Savlon, Benzytol and Dettol as udder wash at Allahabad Agriculture Institute Dairy Farm and found that SPC per ml varied from 2.53 x 10^3 to 19.5 x 10^3.

Dhiman *et al.* (1990) reported that majority of farmers practiced washing of udder and teats with water before milking.

Koshy and Prasad (1993) studied the post milking treatments of mammary quarters with 1 : 1000 $KMnO_4$ solution. Observed bacterial count of 17.3 x 10^3 was lower than for all other treatments like untreated, udder after milking wiped off with clean towel, udder after milking wiped off with clean towel stuffed in 2 % Dettol solution and udder after milking wiped off with clean towel soaked in clean leaf extract.

Kim (1995) studied the bacteriological condition in the milking environment and found that mean SPC in the raw milk was 1.7 x 10^4 with no

washing, 1.3 x 10^4 washing with water and 4600 c.f.u. per ml after washing with disinfectant, respectively.

Malik and Nagpal (1998) found that majority of farmers practiced washing of udder and teats with water before milking.

Pandey and Prasad (2001) studied the influence of treatments of washing of hind quarters and udder on bacterial quality of raw milk and observed that mean SPC for raw milk of control, T_1, T_2, T_3 and T_4 were 163.32, 92.31, 28.72, 66.63 and 42.52, respectively.

Garg *et al.* (2005) in studies of housing, feeding and milking management practice of dairy cattle in Baran district of Rajasthan, found that majority of farmers washed udder before milking and kept their cows clean.

2.1.2 Hand milking

Verma *et al.* (1944) reported that bacterial counts for milk from city barns were in the range from 2 x 10^5 to 5 x 10^6 c.f.u. per ml and village milk barns were in the range from 5 x 10^6 to 1 x 10^7 c.f.u. per ml.

Desai *et al.* (1945) examined fresh raw milk and they found that a standard plate count of raw milk was less than 36 x 10^3 c.f.u. per ml.

Banerjee and Sen (1946) evaluated the bacteriological quality of 202 milk samples and found that 23 samples had standard plate count less than 0.2 million c.f.u. per ml and 107 samples had counts more than of 5 million c.f.u. per ml.

Sen and Laxminarayana (1948) studied the raw milk quality and found that SPC of raw milk samples were 16 x 10^3 c.f.u. per ml.

Shah and Laxminarayana (1949) observed that the bacterial number of the aseptically collected milk samples varied from 1 x 10^2 to 9.6 x 10^3 c.f.u. per ml.

Naik *et al.* (1950) reported SPC of milk which varied from 10.4 x 10^3 to 41.2 x 10^4 c.f.u. per ml in buffalo farm. Varma *et al.* (1950) observed that cow milk produced in an organized dairy farm had average bacterial count 3659 and 14210 c.f.u. per ml during winter and summer, respectively.

Naidu *et al.* (1965) observed that average total bacterial count was 17.02 x 10^5 c.f.u. per ml in cow milk and 31.23 x 10^5 c.f.u. per ml in buffalo

milk.

Pal and Sinha (1965) found that average standard plate count for 224 milk samples obtained in Ludhiana was 4.47 million per ml.

Jain and Saraswat (1968) observed SPC for raw milk which ranged from 65 x 10^3 to 18 x 10^5 c.f.u. per ml with an average of 76 x 10^4 c.f.u. per ml.

Singh (1968) collected milk samples of buffalo milk from an University Dairy Farm, Anand. He found that SPC ranged from 12.1 x 10^4 to 28.65 x 10^5 c.f.u. per ml with an average of 14,77,840 c.f.u. per ml. Corresponding figures for cow milk were 10.1 x 10^5 c.f.u. per ml with an average of 25 x 10^5 c.f.u. per ml and for mixed milk 41.3 x 10^5 to 76.2 x 10^5 c.f.u. per ml with an average of 55.3 x 10^5 c.f.u. per ml.

Vijai and Saraswat (1968) examined 85 samples of raw milk from the Udaipur College Dairy Farm and found the number of samples with total counts were more than 1 x 10^6 c.f.u. per ml.

Yadav (1968) found SPC count from 121 x 10^3 to 28.65 x 10^5 c.f.u. per ml in buffalo milk with an average of 14.77 x 10^5 c.f.u. per ml. While, it ranged from 10.1 x 10^5 to 57.25 x 10^5 c.f.u. per ml with an average of 25.51 x 10^5 c.f.u. per ml in cow milk.

Thomas and Laxminarayan (1972) studied the incidence of Enterococci in milk at Karnal and showed that the average total bacterial counts for 20 samples each of cow and buffalo milk were 15.5 x 10^5 (2.25 x 10^5 to 45.5 x 10^5) and 19.6 x 10^5 (12.25 x 10^5 to 26.95 x 10^5) c.f.u./ml, respectively.

Singh *et al.* (1974) studied the bacterial quality of milk in Kanpur city. They found an average SPC of 2,825 per ml for aseptically collected samples of milk from individual cow at the Dairy farm Institute of Agriculture Science, Kanpur.

Suryanarayana Rao *et al.* (1974) found that raw milk samples from organized dairy farms Karnal had SPC ranging from 22.1 x 10^3 to 870 x 10^3 c.f.u. per ml.

Gahlot *et al.* (1975) studied counts of farm produced milk samples of University Farm (15) and a Government Livestock Farm (17) in Hissar, Haryana. The average counts of SPC in winter and summer seasons of university farm samples was 13 x 10^4 (3 x 10^4 to 41 x 10^4) c.f.u. per ml and 118 x 10^4 (35 x 10^4

to 248 x 10^4) c.f.u. per ml, respectively. Corresponding figures for samples from Government Livestock Farm were 492 x 10^4 (76 x 10^4 to 108 x 10^4) c.f.u. per ml and 77.1 x 10^4 (92 x 10^4 to 189 x 10^5) c.f.u. per ml, respectively. The SPC counts was higher in Government Livestock Farms than University Farms.

Gujar (1975) studied the bacteriological quality of milk samples of AICRP on cattle, M.P.K.V., Rahuri and reported that SPC in winter and summer varied from 2.81 x 10^5 to 4.85 x 10^5 c.f.u. with an average of 3.76 x 10^5 c.f.u. and 3.90 x 10^5 to 6.15 x 10^5 c.f.u. with an average of 4.80 x 10^5 c.f.u. per ml in respectively.

Suryanarayana Rao *et al.* (1975) studied three bulk raw milk samples from a buffalo herd in Bangalore region and found that SPC varied from 14.5 x 10^3 to 29.1 x 10^5 c.f.u. per ml with an average of 10.1 x 10^5 c.f.u. per ml.

Dwivedi (1976) studied the bacteriological quality of market milk in Rewa city and observed that the SPC for organized dairies milk samples ranged from 13 x 10^4 to 50 x 10^4 c.f.u. per ml with average of 40 x 10^4 c.f.u. per ml in summer season. Corresponding figures for samples from stable dairies were ranging from 22 x 10^4 to 150 x 10^4 c.f.u. per ml with an average of 100 x 10^4 c.f.u. per ml. Higher SPC was observed in stable dairies than organized dairies.

Suryanarayan Rao *et al.* (1976) studied 25 bulk samples of milk in the Bangalore city region. The results revealed that SPC was in range of 6.5 x 10^3 to 35.3 x 10^5 c.f.u. per ml with an average of 42.7 x 10^4 c.f.u. per ml of milk.

Rangasamy (1980) observed that SPC in milk samples from small dairy herd in Mauritius ranged from 13.9 x 10^4 to 5.97 x 10^5 c.f.u. per ml.

Desai and Natarajan (1981) assessed 124 milk samples from societies for microbiological qualities and found that the SPC was in the range of 4 x 10^5 to 1.8 x 10^9 c.f.u. per ml.

Natrajan and Ranganathan (1981) reported that 30 samples of village milk produced had average SPC of 41.8 x 10^5 c.f.u. per ml which ranged from 24 x 10^4 to 99 x 10^5 c.f.u. per ml.

Reddy *et al.* (1984) analyzed 30 samples of raw milk from college dairy farm in Tirupati, Andhra Pradesh and found that the average SPC count was 5.47 $\pm$ 0.4 x 10^4 c.f.u. per ml.

Ramanjaneyulu and Vyas (1985) reported a mean SPC of 41.29 x 10^5 c.f.u. per ml in a mixed bulk milk from an University dairy farm.

Dandekar (1985) studied the bacteriological quality of milk produced and distributed in and around Dapoli town and found that standard plate count for milk in mansoon, hot humid and winter season were 23.71 x 10^5, 32.8 x 10^5 and 14.88 x 10^5 c.f.u. per ml, respectively with an average of 22.9 x 10^5 c.f.u. per ml.

Yadava *et al.* (1985) observed SPC of 2.23 x 10^5 c.f.u. per ml for 42 raw milk samples from an organized dairy farm, Ranchi.

Khan and Natrajan (1986) reported that the average SPC in milk samples from organized dairy farms was 2.8 x 10^6 c.f.u. per ml.

Misra and Kulla (1989) while studying the bacteriological quality of market milk in Calcutta (Kolkata) city observed that SPC for milk samples from organized dairy farm ranged from 96 x 10^3 to 25 x 10^5 c.f.u. per ml with an average of 51 x 10^4 c.f.u. per ml. Reddy *et al.* (1989) observed that farm bulk raw cow milk stored for 9 hrs at 25 to 30 ^{0}C had average value for SPC 7.25 x 10^5 c.f.u. per ml.

Lakhani *et al.* (1990) in their studies of 'bacteriological qualities of raw milk obtained by machine versus hand milking in buffaloes' at dairy farm, Jabalpur, observed that average SPC were significantly higher in hand milking (21.0 x 10^3 c.f.u. per ml) than machine milking (26.92 x 10^2 c.f.u. per ml).

Rai *et al* (1990) studied the bacteriological quality of milk supplied in Kanpur city by different sources and they found that SPC of raw milk were ranged from 12 x 10^5 to 59.5 x 10^5 for C.S. Azad University Dairy, Kanpur, 9 x 10^4 to 65 x 10^4 for milk board; 25.8 x 10^5 to 27.5 x 10^5 for Howker's and 17.5 x 10^5 to 85.6 x 10^5 c.f.u. per ml for Town dairies (Ghosies) milk, respectively.

Senapoty *et al.* (1991) observed SPC of raw milk samples collected from organised sector (Composite Livestock Farm, J.N. Agricultural University, Jabalpur) ranged from 14.33 x 10^5 to 90.33 x 10^5 c.f.u. per ml. Where as in milk samples collected from unorganized sector ranged from 21.33 x 10^5 to 190 x 10^5 c.f.u. per ml with an average of 49.89 x 10^5 c.f.u. ml. Significantly higher SPC

was observed in unorganized sector than organized sector. The SPC in unorganized sector at different distances showed non-significant differences.

Gosavi (1992) studied the microbiological quality of raw milk sold in Bombay city and he found that standard plate count and direct microscopic count for milk from organized dairy farms as 5.23×10^5 per ml and 6.43×10^5 per ml; from unorganized dairy farms, 2.18×10^6 per ml and 2.33×10^6 per ml; from vendors, 8.02×10^6 and 8.12×10^6 per ml and for milk from bottling plant 12×10^6 per ml and 12.2×10^6 per ml, respectively.

Shinde (1992) studied the bacteriological quality of raw milk samples at All India Co-ordinated Research Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri and found that SPC per ml of milk ranged from 3.05×10^5 to 6.15×10^5 c.f.u. per ml.

Bagal (2000) in his study indicated that the milk sample from college dairy farm, Dapoli had an average SPC of $11.85 \pm 0.39 \times 10^5$ per ml. The milk sample from local vendor had an average SPC of $24.43 \pm 1.06 \times 10^5$ per ml. The packaged milk had an average SPC of $11.43 \pm 0.55 \times 10^5$ per ml.

Deshmukh (2000) studied the bacteriological quality of raw milk samples from All India Co-ordinated Research Project on Cattle, Mahatma Phule Krishi Vidyapeeth, Rahuri and reported that standard plate count per ml of milk ranged from 2.11 to 3.11×10^5 (average 2.41×10^5) c.f.u. per ml.

Kandalkar (2000) in his study of microbiological quality of raw milk in relation to clean and hygienic milk production practices at Agriculture College Dairy Farm, Pune recorded average of SPC per ml of organized and unorganized sector as 16.5×10^3 and 20.1×10^5, respectively.

Pathak *et al.* (2004) reported that the somatic cell count of buffaloes and cow's under hand and machine milking systems average 0.72×10^5 and 0.76×10^5 c.f.u. per ml and 0.85×10^5 and 1.04×10^5 c.f.u. per ml.

2.1.3 Machine milking

Thomas and Anantakrishnan (1949) reported that bacterial count of raw milk was higher in hand milking than in machine milking.

Shaw and Nambudripad (1964) studied the bacterial quality of milk obtained by different methods of milking and they found that the average SPC of

raw milk obtained from parlour system of machine milking and hand milking were 4051 (1965 to 8347) per ml and 5689 (2761 to 11720) per ml, respectively.

Sunderasan *et al.* (1964) reported higher bacterial count of freshly drawn raw milk in hand milking than in machine milking.

Waghmore and Karnani (1977) studied the bacteriological quality of raw milk obtained by different methods and they found that bacterial count of raw milk was significantly higher in hand milking than in machine milking.

Tsenkov *et al.* (1980) studied hygiene conditions of machine milked and hand milked milk and observed that total bacterial count of milks after milking and staining were 6784000 and 4884000/ml. Milk obtained by machine was of better quality than that obtained by hand milking.

Petrova (1982) studied microbial content of ewes milk obtained by hand milking and by milking with an Alfa-Laval machine cleaned with different preparations and the bacteriological examination of 40 hand milked samples and 38 machine milks samples showed that milk obtained by machine milking had a lower microbial content than hand milked samples. The lower count of coliform in milk obtained by machine milking was of importance in cheese making.

Hassan and Badran (1986) studied the quality of buffalo milk obtained by hand and machine milking from 26 lactating Egyptian buffaloes, to compare bacteriological quality of buffalo. Milk obtained by milk machine had lower total bacterial counts ($3.2 \times 10^4 - 6.0 \times 10^5$/ml) than ($6.3 \times 10^4 - 2.6 \times 10^6$/ml) with that obtained by hand milking.

Lakhani *et al.* (1990) in their studies on bacteriological qualities of raw milk obtained by machine versus hand milking in buffalo at dairy farm, Jabalpur, observed that average standard plate count (log/ml) of raw milk obtained by machine milking were 3.430, 5.355 and 8.234 at 0, 4, 8 hours of storage at room temperature, respectively.

Lakhani and Jogi (1996) studied the comparative quality of raw milk obtained by machine milking vs hand milking with regard to total yield, composition and bacteriological qualities in Murrah buffaloes. Raw milk was obtained from 20 Murrah buffaloes in the early stage of lactation and found that standard plate count of raw milk obtained by machine milking vs hand milking were 26.91×10^2 c.f.u. per ml and 33.2×10^3 c.f.u. per ml, respectively.

Lakani and Singh (1998) studied keeping quality of raw milk by machine versus hand milking in buffaloes at dairy farm, Jabalpur and they observed that SPC of milk obtained by machine milking and hand milking were 26.96×10^2 and 13.2×10^3 c.f.u. per ml, respectively. The keeping quality of raw milk obtained by machine and by hand respectively averaged 10.70 and 9.20 h on the basis of various bacteriological tests.

Wojtyra (2003) studied the influence of milking system on the quality of raw milk. The investigation was carried out on 3480 farms delivering raw milk to the dairy plant. Cows were milked manually in 1693 farms and mechanically in 1787 farms. The study revealed that milking method had a huge impact on the quality of milk from among the farms using mechanical milking, 75 % delivered extra class milk, whereas 27 % was observed from those applying hand milking.

Mahendra and Dang (2004) studied the machine milking of dairy animals and reported that advantages and disadvantages of machine milking and way to improve its utilization in dairy cow and buffaloes for quality milk.

Pathak *et al.* (2004) studied the microbiological quality of milk and they found that the somatic cell count of buffaloes and cows under hand and machine milking systems was 0.72×10^5 and 0.76×10^5 c.f.u. per ml and 0.85×10^5 and 1.04×10^5 c.f.u. per ml, respectively.

2.2 Coliform Count

2.2.1 Milking management practices

2.2.1.1 Washing of udder

Lavania and Singh (1973) studied the effect of washing of udder and dipping of teats in dipping solution on clean milk production and concluded that maximum contamination comes from the unwashed udder.

Kim (1995) studied the contamination of raw milk by various components of the milking environment of dairy farm. Coliform count determined in raw milk was 290 cfu/ml with no washing, 250 cfu/ml after washing with water and 15 cfu/ml after washing with disinfectant. Bacterial counts of udder reduced by washing with water and significantly reduced or eliminated by washing with disinfectant and these decreased counts were reflected in lower counts of microbes in the raw milk.

Ogale (1999) studied clean milk production; a key to quality management in dairy industry reported that bacterial count of raw milk was reduced by washing of udder with disinfectant.

Pandey and Prasad (2001) studied the influence of treatment of washing of hind quarters and udder on bacterial quality of raw milk and observed that mean coliform count of control T_1, T_2, T_3 and T_4 were 17.45, 25, 0, 7.5 and 2.0, respectively.

2.2.2 Hand milking

Gopalkrishna and Laxminarayana (1949) studied in detail, the incidence of coliform in milk produced under different

conditions in Bangalore. In the samples of milk from organized dairy farm a majority of the individual cow and buffalo milk samples shown coliform Counts (CC) below 1 x 10^3 c.f.u. per ml. The log mean counts per ml of cow and buffalo milk for coliform count were 466 and 1264 c.f.u. per ml, respectively. About 75 per cent of herds, bulk samples had Coliform Count ranging from 101 to 10 x 10^3 c.f.u. per ml. In village samples taken from individual producers, a wide variation (<100 c.f.u. to > 10^4 c.f.u. per ml) in the Coliform Count was observed. Higher Coliform Count was observed in village samples (unorganized farms) than organized dairy farm.

Naik *et al.* (1950) observed higher incidence of Coliform in farm buffalo milk.

Venkatswami (1963) studied coliform bacteria in milk from Madras city and they reported that 25 per cent of 56 raw milk samples from Madras City showed presumptive coliform test as high as one in 10^5 dilution.

Seshiah *et al.* (1965) studied on coli organisms in milk in Madras city and found average coliform counts 6.6 x 10^2 (4 x 10^2 to 9.9 x 10^2) and 9.7 x 10^3 (47 x 10^2 to 4.8 x 10^4) c.f.u. per ml of cow and buffalo milk, respectively.

Vijai and Saraswat (1968) found the coliform count of 500 c.f.u. per ml of raw milk collected from Udaipur city.

Kumar *et al.* (1974) studied the sanitary analysis of milk and milk samples collected aseptically and directly from cows udder. The average coliform count for udder samples in winter and summer season were 60 c.f.u. and 100 c.f.u. per ml, respectively.

Singh *et al.* (1974) observed coliform Count of 13.1 x 10^2 c.f.u. per ml in raw milk collected from Kanpur city.

Gahlot *et al.* (1975) obtained samples from an University farm (915) and a Govt. Live Stock Farm (GLSF) (17) in Hissar city, Haryana. The average counts for Coliform Count in winter and summer periods for University farm samples were 16 x 10^2 c.f.u. per ml (40 to 8 x 10^2 c.f.u. per ml) and 99 x 10^2 c.f.u. per ml (8 x 10^2 to 29.5 x 10^3 c.f.u. per ml), respectively. Corresponding figures for samples from GLSF were 23.5 x 10^3 c.f.u. (250 to 95 x 10^4 c.f.u.) and 66.4 x 10^3 c.f.u. (2 x 10^3 to 21.5 x 10^4 c.f.u.) per ml, respectively.

Suryanarayana Rao *et al.* (1976) observed that out of 25 bulk farms and private milk samples collected from Karnal of which 23 were shown positive for presumptive coliform test in 0.01 ml.

Desai and Natarajan (1981) assessed 124 milk samples from producer societies and observed coliform count from 3.1 x 10^4 to 1.1 x 10^6 c.f.u. per ml.

Natrajan and Ranganathan (1981) obtained that 30 samples of village produced milk had average coliform count of 1,23,950 c.f.u. per ml. The range of coliform count observed was 14 x 10^3 to 42.4 x 10^4 c.f.u. per ml.

Dandekar (1985) studied the bacteriological quality of milk produced and distributed in and around Dapoli town. He found that *Coli aergones* counts for monsoon, hot humid and winter season as 67.27, 56.87 and 45.25 per ml, respectively (average 55.34 per ml).

Yadava *et al.* (1985) collected 105 samples from Kasauli and analysed them at Central Research Institute, Kasauli to study the bacterial flora of market milk and its public health importance. They examined 105 samples in which 78.0 per cent samples showed *E. coli.*

Palanniswami *et al.* (1988) reported mean coliform count per ml of individual milk samples collected from apparently healthy udders and pooled milk samples from cans and its respective coliform count per ml of farms maintaining poor, moderate and high standards of hygiene was 10 and 39 x 10^3; 10 and 27 x 10^2 and 4 and 30, respectively. Only individual milk samples from farm maintaining high standard of hygiene was satisfactory. High coliform count was observed in farm maintaining poor and moderate standards of hygiene.

Misra and Kulla (1989) studied the bacteriological quality of market milk in Calcutta (Kolkata) city and they observed that average coliform count for

15 milk samples from organized dairy farms ranged from 27 x 10^1 to 9 x 10^3 c.f.u. per ml.

Hamama (1990) studied microbiological quality of raw milk in Morocco and reported that average coliform counts of 1.8 x 10^5 c.f.u. per ml.

Rai *et al.* (1990) observed average coliform counts of 1000-4500 c.f.u. per ml for C.S. Azad University Dairy at Kanpur.

Senapoty *et al.* (1991) studied bacteriological quality of raw milk organized sector (Composite Livestock Farm, J.N. Agriculture University, Jabalpur) and found the coliform count varying from 6 x 10^3 to 32 x 10^3 c.f.u. per ml with average of 14.68 x 10^3 c.f.u. per ml and coliform count of unorganized sector varied from 9.66 x 10^3 to 156.66 x 10^3 c.f.u. per ml with average of 30.64 x 10^3 c.f.u. per ml. Significantly higher coliform count was observed in unorganized sector than organized sector.

Shinde (1992) studied the bacteriological quality of raw milk samples for all India Co-ordinated Research Project on Cattle, M.P.K.V., Rahuri and found that coliform counts of raw milk samples ranged from 3 x 10 to 9.3 x 10 c.f.u. per ml with average of 9 x 10 c.f.u. per ml.

Siva *et al.* (1993) observed average coliform count in cow and buffalo milk samples were 0.63 $\pm$ 0.31 x 10^4 and 0.28 $\pm$ 0.18 x 10^4 c.f.u. per ml, respectively.

2.2.3 Machine milking

Shaw and Nambudripad (1964) studied the bacteriological quality of milk obtained by different methods of milking and found that the average coliform count of raw milk obtained from parlour system of machine milking and hand milking were 144 (65 to 202) c.f.u. per ml and 91 (51 to 160) c.f.u. per ml, respectively.

Ojeda and Sahagun (1973) in their studies of milk quality obtained by machine milking of Mancha ewes. They observed that ewe's milk obtained using an Alfa-laval machine, contained 1356 coliform/ml compared with 3.5 x 10^5 coliform/ml for milk obtained by hand at the same farm.

Tsenkov *et al.* (1980) studied hygiene conditions of machine milked and hand milked milk and observed that milk obtained by machine milking was of better quality than that obtained by hand milking.

Hassan and Badran (1986) observed that coliform count of raw milk obtained by machine was ($8.0 \times 10^2 - 2.7 \times 10^4$/ml) lower than hand milking ($1.4 \times 10^3 - 2.6 \times 10^5$/ml), respectively.

Lakhani *et al.* (1990) in their study of bacteriological qualities of raw milk obtained by machine versus hand milking in buffaloes at dairy farm, Jabalpur and observed that average coliform count of raw milk obtained by machine milking were (2.319 $\pm$ 0.130/ml), (3.189 $\pm$ 0.120/ml) and (5.337 $\pm$ 0.120/ml) at 0, 4, 8 hours of storage at room temperature.

Lakhani and Jogi (1996) in their study of keeping quality of raw milk by machine vs hand milking in buffaloes at dairy farm, Jabalpur and they found that coliform count of milk obtained by machine and hand milking were 20.8×10^1 and 19.36×10^2 c.f.u. per ml, respectively.

3. MATERIALS AND METHODS

The materials and methods adopted for studying the effect of milking management practices on quality on Pandharpuri buffalo milk on different organized farms have been presented in this chapter.

3.1 Collection of raw milk samples

The milk samples were collected from the Agriculture College Dairy Farm, Pune and Agriculture College Dairy Farm, Kolhapur for the present investigation.

3.1.1 Milking management practices

The milking management especially washing of udder was taken for the study purpose. Twelve Pandharpuri buffaloes were selected for present investigation on each farm. The main treatment was washing of udder. In that

first sub-treatment was unwashed udder with tab water while second washed udder with 0.5 % $KMnO_4$ solution. The 18 milk samples were collected aseptically in sterile glass container from each treatment for each farm and analysed immediately.

3.1.2 Methods of milking

Twelve Pandharpuri buffaloes were selected for present investigation. Out of these, 6 animals were selected at each location for each milking method. During the entire study period all the animals were kept under similar feeding and managemental conditions. The milking machine employed in this experiment was Impulsa Direct to can milking, installation. The 18 milk samples were collected from each method on two location in sterilized conical flask plugged with cotton. The milk samples were anlaysed for microbiological quality i.e. standard plate count (SPC) and coliform counts (CC).

3.2 Preparation of microbiological media

3.2.1 Preparation of standard plate count agar

The following ingredients were used for preparation of standard plate count agar (IDF, 1987).

Yeast extract	=	2.5 g
Tryptone	=	5.0 g
Glucose ($C_6H_{12}O_6H_2O$)	=	1.0 g
Skimmed milk powder	=	1.0 g
Agar	=	15.0 g
Distilled water	=	1000 ml

The above ingredients were weighed accurately and dissolved in a small quantity of distilled water in a stainless steel container. Then the volume was made to one litre by adding distilled water and it was brought to boiling over a gas flame. The pH was adjusted to 7. The final volume was adjusted to 1 litre by adding distilled water. After filtration with the help of muslin cloth, the 300 ml media transferred into 500 ml conical flasks and sterilized by autoclaving at 121 ^{0}C at 15 psi for 15 minutes. One ml of sterile skim milk was added to each 100 ml of above melted media prior to using the media.

3.2.2 Preparation of violet red bile agar (VRBA)

The following ingredients were used for the preparation of violet red bile agar (ISO, 1986).

Peptone	=	7.0 g
Yeast extract	=	3.0 g
Lactose ($C_{12}H_{22}O_{11}.H_2O$)	=	10.0 g
Sodium chloride	=	5 g
Bile salts	=	1.5 g
Neutral red	=	0.03 ml
Crystal violet	=	0.002 ml
Agar-Agar	=	15 g
Distilled water	=	1000 ml
pH	=	7.4 $\pm$ 0.1 at 25 ^{0}C

The above ingredients were weighed accurately and dissolved in 1 litre of distilled water and pH was adjusted to 6.9. Care was exercised not to overheat the media which would otherwise affect the selectivity of the medium. Then 150 ml media is transferred into 250 ml conical flask (previously sterilized) and properly plugged.

3.3 Preparation of dilution blanks

3.3.1 Phosphate buffer (stock solution)

The potassium dihydrogen orthophosphate (KH_2PO_4) 34 g was dissolved in 500 ml of distilled water. The pH was adjusted with 1.N., NaOH solution so that after sterilization it would be 7.2. Then total volume was made to 1000 ml with distilled water (ISO, 1962).

3.3.2 Phosphate buffer dilution blanks

For use as dilution water, 1.25 ml of stock phosphate buffer solution was made upto 1 litre with distilled water and transferred in 9.3 ml quantities into glass test tubes (18 x 150 mm) and then sterilized at 15 psi for 15 minutes.

3.4 Enumeration of micro organisms

3.4.1 Enumeration of standard plate count

The standard plate count agar was used for enumeration of total bacterial counts of raw milk sample. The samples were properly diluted by using 9 ml phosphate buffer (ISO, 1962). Then 2nd to 5th dilutions were taken in duplicate into the petri plates and the standard plate count agar was added and mixed well. The plates were allowed to solidify. All the plates were incubated at 37 ^{0}C for 48 hrs and number of colonies developed were counted as c.f.u. per ml.

3.4.2 Enumeration of Coliform Count

The 0, 1st and 2nd dilution of samples in duplicate were taken in petri plates and then VRBA was added and mixed well. The plates were allowed to solidify. The plates were again over layered with same VRBA and allowed to solidify. Then the plates were incubated at 37 ^{0}C for 24 hrs and number of coliform colonies developed were counted as c.f.u. per ml.

3.5 Statistical analysis

After collecting research data, it was tabulated and statistically analysed by using 't' test as described by Snedecor and Cochran (1967).

4. RESULTS AND DISCUSSION

In this investigation, an attempt has been made to study the effect of milking management practices on quality of Pandharpuri buffalo milk on different organized farms. The milk samples for analysis were collected after washing of udder methods of milking from Pune and Kolhapur farms.

Twelve Pandharpuri buffaloes of same stage of lactation were selected from each farm for present investigation. Out of these 6 animals were milked by machine and others 6 were milked by hand milking methods. The milk samples collected from both farms were subjected for microbiological quality i.e. standard plate count (SPC) and coliform count (CC). The data regarding observations of microbiological quality of milk are presented in this chapter.

4.1 Effect of washing of udder on microbial quality of milk

4.1.1 Standard plate count

The data regarding observation of standard plate count of raw milk are presented in Table 1.

It was observed from Table1 that, the average SPC in milk samples of Pandharpuri buffalo from unwashed udder and washed udder at Pune Farm

were 261 x 10^3 (60 x 10^4 to 40 x 10^4) c.f.u. per ml and 36.4 x 10^3 (7 x 10^3 to 47 x 10^3) c.f.u. per ml, respectively.

Table 1. Effect of washing of udder within farm on standard plate count of raw milk of Pandharpuri buffalo

Treatments	Standard plate count (cfu/ml)	Mean (cfu/ml)	S.E.±	t cal.
Pune				
Unwashed udder	6 x 10^4 to 40 x 10^4	261 x 10^3	0.950	3.052*
Washed udder	7 x 10^3 to 47 x 10^3	36.4 x 10^3	1.120	
Kolhapur				
Unwashed udder	4 x 10^4 to 30 x 10^4	208 x 10^3	0.80	3.982*
Washed udder	6 x 10^3 to 35 x 10^3	21.3 x 10^3	1.135	

* $p<0.05$

It was observed from Table 1 that, the average SPC in milk samples of Pandharpuri buffalo from unwashed and washed udder at Kolhapur Farm were 208 x 10^3 (4 x 10^4 to 3 x 10^5) c.f.u. per ml and 21.3 x 10^3 (6 x 10^3 x 35 x 10^3) c.f.u. per ml, respectively.

Verma *et al.* (1944) found SPC of raw milk ranged from 2 x 10^5 to 5 x 10^6 c.f.u. per ml. Desai *et al.* (1945) observed that SPC of fresh milk was less than 36 x 10^3 c.f.u. per ml.

Lavania and Singh (1973) reported that SPC of raw milk from unwashed and washed udder were ranged from 6 x 10^4 to 22 x 10^5 c.f.u. per ml and 11 x 10^3 to 7 x 10^4 c.f.u. per ml, respectively

The present results of SPC of raw milk from unwashed udder were lower than the results of Verma *et al.* (1944) and Lavania and Singh (1973).

Koshy and Prasad (1993) found that the SPC of raw milk was 17.3 x 10^3 c.f.u. per ml which was lower than the present results of SPC of raw milk of Pandharpuri buffalo at both farms.

It is seen from the Table 1 that, washing of udder resulted in decreasing of standard plate count of raw milk.

Analysis of variance and treatmentwise mean of standard plate count of Pandharpuri buffalo milk are given in Table 2 and 3.

Table 2. Analysis of variance for standard plate count of raw milk of Pandharpuri buffalo

Sources of variation	df	Sum of squares	Mean squares	F cal
Treatments	3	5.294	1.765**	21762.93
Farm (A)	1	0.163	0.163**	2014.24
Udder washing (U)	1	5.104	5.104**	62942.54
Interaction (AU)	1	0.027	0.027	332.02
Error	20	0.002	0.00008	
Total	23	5.3		

**** p<0.01**

It was observed from Table 2 that, the farms, washing of udder and interaction of farm and treatments had significant effect on standard plate count of raw milk of Pandharpuri buffalo.

It was seen from the Table 3 that, the standard plate count of raw milk of Pandharpuri at Pune farm (9.8×10^4) was significantly (< 0.01) higher than standard plate count of raw milk at Kolhapur farm (6.7×10^4).

Table 3. Treatmentwise and farmwise means of standard plate count (SPC x 10^4 cfu/ml) for raw milk of Pandharpuri buffalo

Particulars	Udder		Mean	SE ±	C.D. at 5 %
	Unwashed	Washed			
	10^4	10^4	10^4		
Farm					
Pune	26.1^a	3.6^b	9.8^a	0.003	0.008
Kolhapur	20.8^a	2.1^b	6.7^b	0.003	0.008
Mean	22.3^a	2.8^b	8.1		
SE ±	0.003	0.003			
C.D. at 5 %	0.008	0.008			

Similar superscript in rows and columns within treatment did not differ significantly from each other

It was observed from the Table 3 that, the standard plate count of raw milk obtained from unwashed udder (22.3 x 10^4) was significantly (< 0.01) higher than washing of udder (2.8 x 10^4).

4.1.2 Coliform count

The data regarding observations of coliform counts of raw milk are presented in Table 4.

It was observed from Table 4 that, the average coliform count in milk samples of Pandharpuri buffalo from unwashed and washed udder at Pune Farm were 38.0 x 10^2 (24 x 10^2 to 60x 10^2) c.f.u. per ml and 5.5 x 10^2 (5 x 10^1 to 90 x 10^1) c.f.u. per ml, respectively.

Table 4. Effect of washing of udder within farm on coliform counts of raw milk of Pandharpuri buffalo

Treatments	Coliform count (cfu/ml)	Mean (cfu/ml)	S.E.±	t cal.
Pune				
Unwashed udder	24 x 10^2 to 60 x 10^2	38.0 x 10^2	1.079	3.226*
Washed udder	5 x 10^1 to 90 x 10^1	5.5 x 10^2	1.346	
Kolhapur				
Unwashed udder	29 x 10^2 to 50 x 10^2	32.4 x 10^2	1.055	3.110*
Washed udder	2 x 10^1 to 80 x 10^1	3.1 x 10^2	1.330	

* $p<0.05$

It was revealed from Table 4 that, the average coliform counts of milk sample of Pandharpuri buffalo from unwashed and washed udder at Kolhapur farm were 32.4 x 10^2 (29 x 10^2 to 50 x 10^2) c.f.u. per ml and 31.3 x 10^1 (2 x 10^1 to 80 x 10^1) c.f.u. per ml, respectively.

Gopalkrishna and Laxminarayana (1949) found that the coliform counts of milk samples were ranged from 101 to 10 x 10^3 c.f.u. per ml.

Seshiah *et al.* (1965) found average coliform count 4.2 x 10^3 (4.7 x 10^2 to 4.8 x 10^4) c.f.u. per ml for buffalo milk in Madras city.

The present results of coliform counts of raw milk from unwashed udder were lower than the results of Gopalkrishna and Laxminarayana (1949) and Seshiah *et al.* (1965).

Misra and Kulla (1989) observed that average coliform count for 15 milk samples from organized dairy farms ranged from 27 x 10^1 to 9 x 10^3 c.f.u. per ml.

Rai *et al.* (1990) found that average coliform count of milk samples were ranged from 1000-4500 c.f.u. per ml.

The present results of coliform counts of raw milk from washed udder at both farm were lower than the results of Rai *et al.* (1990) and Kim(1995).

It is seen from the Table 4 that the SPC and coliform counts of raw milk samples from unwashed udder were higher (<0.05) than washing of udder.

Analysis of variance and treatmentwise mean of coliform count of Pandharpuri buffalo milk are given in Table 5 and 6.

Table 5. Analysis of variance for coliform count of raw milk of Pandharpuri buffalo

Sources of variation	df	Sum of squares	Mean squares	F cal
Treatments	3	5.364	1.788**	43448.98
Farm (A)	1	0.148	0.148**	3592.02
Udder washing (U)	1	5.17	5.17**	125634.15
Interaction (AU)	1	0.461	0.461	1120.78
Error	20	0.0008	0.00004	
Total	23	5.37		

** p<0.01

It was revealed from Table 5 that, the farms, washing of udder and interaction of farm and treatments had significant effect on coliform count of raw milk of Pandharpuri buffalo.

Table 6. Treatmentwise and farmwise means of coliform count (CC x 10^2 cfu/ml) for raw milk of Pandharpuri buffalo

Particulars	Udder		Mean	SE ±	C.D. at 5 %
	Unwashed	Washed			
	10^2	10^2	10^2		

Farm					
Pune	38.0^{a}	5.5^{b}	14.4^{a}	0.002	0.005
Kolhapur	32.4^{a}	3.1^{b}	10.0^{b}	0.002	0.005
Mean	35.1^{a}	4.1^{b}	12.0		
SE ±	0.002	0.002			
C.D. at 5 %	0.005	0.005			

Similar superscript in rows and columns within treatment did not differ significantly from each other.

It was seen from the Table 6 the coliform counts of raw milk of Pandharpuri at Pune farm (14.4×10^2) was significantly (< 0.01) higher than coliform count of raw milk at Kolhapur farm (10.0×10^2). Rai *et al* (1990) reported that the farm differed ($p<0.01$) for coliform counts of raw milk.

It was observed from Table 6 that, the coliform count of raw milk obtained from unwashed udder (35.1×10^2)was significantly (< 0.05) higher than washing of udder(4.1×10^2). These results were lower than the results of Rai *et al* (1990). They reported that average coliform count of raw milk was 76.7×10^2 c.f.u. per ml.

4.2 Effect of methods of milking on microbial quality of milk

4.2.1 Standard plate count

The data regarding observations of standard plate counts of raw milk are presented in Table 7.

Table 7. Effect of methods of milking within farm on standard plate count of raw milk of Pandharpuri buffalo

Farm	Treatments	Standard plate count (cfu/ml)	Mean (cfu/ml)	S.E.±	t cal
Pune	Hand milking	11×10^3 to 69×10^3	27.5×10^3	1.061	3.130*
	Machine milking	2×10^3 to 6×10^3	3.1×10^3	1.473	
Kolhapur	Hand milking	6×10^3 to 54×10^3	21.5×10^3	1.179	4.860*
	Machine milking	1×10^3 to 4×10^3	2.7×10^3	1.246	

* $p<0.05$

It was observed from Table 7 that, the SPC of raw milk obtained by hand milking and machine milking at Pune farm ranged from 11×10^3 to 69×10^3 c.f.u. per ml and 2×10^3 to 6×10^3 c.f.u. per ml, respectively. The average

SPC of raw milk obtained by hand and machine milking at Pune farm were 27.5 x 10^3 c.f.u. per ml and 3.1 x 10^3 c.f.u. per ml, respectively.

Shaw *et al.* (1964 found that the SPC of raw milk produced by hand and machine milking were ranging from 27.6 x 10^2 to 11.7 x 10^3 c.f.u. per ml and 19.6 x 10^2 to 83.4 x 10^2 c.f.u. per ml, respectively.

Lakhani *et al.* (1990) found that average SPC of raw milk obtained by machine Vs hand milking were 26.9 x 10^2 c.f.u. per ml and 21 x 10^3 c.f.u. per ml, respectively, which were lower than the present results.

It was revealed from Table 7 that, the average SPC of raw milk produced by hand milking and machine milking at Kolhapur farm were 21.5 x 10^3 (6 x 10^3 to 54 x 10^3) c.f.u. per ml and 2.7 x 10^3 (1 x 10^3 to 4 x 10^3) c.f.u. per ml, respectively.

Sundaresan *et al.* (1964) reported that average SPC of raw milk produced by hand milking versus machine milking were 29.3 x 10^3 c.f.u. per ml and 43.3 x 10^2 c.f.u. per ml, respectively.

The present results of SPC of raw milk of Pandharpuri buffalo at Pune farm were lower than the results of Sundaresan *et al.* (1964).

It is seen from the Table 7 that SPC of raw milk was significantly higher in hand milking than machine milking. The results of SPC of milk samples are corroborated with finding of Shaw and Nambudripad (1964), Sundaresan *et al.* (1964) and Lakhani *et al.* (1990).

Analysis of variance and treatmentwise mean of standard plate count of raw milk are given in Table 8 and 9.

Table 8. Analysis of variance of standard plate count of raw milk of Pandharpuri buffalo

Sources of variation	**df**	**Sum of squares**	**Mean squares**	**F cal**
Treatments	3	5.419	1.716**	3992.3
Farm (A)	1	0.041	0.041**	95.93
Milking method (M)	1	5.105	5.105**	11873.87
Interaction (AM)	1	0.003	0.003	7.11
Error	20	0.009	0.0004	
Total	23	5.158		

** $p<0.01$

Table 9. Treatmentwise and farmwise means of standard plate count (SPC x 10^3 cfu/ml) for raw milk of Pandharpuri buffalo

Particulars	Milking methods		Mean	SE ±	C.D. at 5 %
	Hand	Machine			
	10^3	10^3	10^3		
Farm					
Pune	27.5^a	3.1^b	9.3^a	0.006	0.017
Kolhapur	21.5^a	2.7^b	7.7^b	0.006	0.017
Mean	24.3^a	2.9^b	8.4		
SE ±	0.006	0.006			
C.D. at 5 %	0.02	0.02			

Similar superscript in rows and columns within treatment did not differ significantly from each other

It was observed from Table 8 that, the farms, method of milking and interaction of farm and treatments had significant effect on standard plate count of raw milk of Pandharpuri buffalo.

It was seen from the Table 9 that, the standard plate count of raw milk of Pandharpuri buffalo at Pune farm (9.3 x 10^3) was significantly (<0.01) higher than standard plate count of raw milk at Kolhapur farm (7.7 x 10^3).

It was observed from the Table 9 that, the standard plate count of raw milk obtained by hand milking (24.3 x 10^3) was significantly (<0.01) higher than machine milking (2.9 x 10^3).

4.2.2 Coliform counts

The data regarding observations of coliform counts of raw milk was presented in Table 10.

Table 10. Effect of methods of milking within farm on coliform count of raw milk of Pandharpuri buffalo

Farm	Treatments	Standard plate count (cfu/ml)	Mean (cfu/ml)	S.E.±	t cal
Pune	Hand milking	3 x 10^2 to 51 x10^2	35.9 x 10^2	1.640	5.56*
	Machine milking	5 x 10^1 to 60 x 10^1	3.1 x 10^2	1.162	
Kolhapur	Hand milking	3 x 10^2 to 46 x 10^2	28.5 x 10^2	1.459	3.299*
	Machine milking	7 x 10^1 to 40 x 10^1	2.1 x 10^2	1.141	

*p<0.05

It was observed from Table 10 that, the average coliform counts of raw milk obtained hand milking and machine milking at Pune farm were 35.9 x 10^2 (3 x 10^2 to 51 x 10^2) c.f.u. per ml and 3.1 x 10^2 (5 x 10^1 to 60 x 10^1) c.f.u. per ml, respectively.

Shaw and Namburdripad (1964) found that average coliform counts of raw milk obtained by hand milking and machine milking were 91 (51 to 160) c.f.u. per ml and 144 (65 to 202) c.f.u. per ml, respectively.

Lakhani *et al.* (1990) reported that the average coliform counts of raw milk produced by hand milking versus machine milking were 38.4 x 10^2 c.f.u. per ml and 20.8 x 10^1 c.f.u. per ml, respectively.

The present results of coliform counts of raw milk obtained by hand milking at Pune farm was lower than the results of Lakhani *et al* (1990).While results of coliform counts of raw milk obtained by machine milking was higher than the results of Lakhani *et al* (1990).

It was revealed from Table 10 that, the average coliform counts of raw milk obtained by hand milking and machine milking at Kolhapur farm were 28.5 x 10^2 (3 x 10^2 to 46 x 10^2) c.f.u. per ml and 2.1 x 10^2 (7 x 10^1 to 40 x 10^1) c.f.u. per ml, respectively.

Lakhani and Jogi (1996) reported that the average coliform counts of raw milk obtained by hand milking and machine milking were 19.36 x 10^2 c.f.u. per ml and 20.8 x 10^1 c.f.u. per ml, respectively.

The present results of coliform counts of raw milk obtained by hand milking and machine milking at Kolhapur farm were higher than the results of Lakhani and Jogi (1996).

It is seen from the Table 10 that, coliform counts of raw milk was significantly higher in hand milking than machine milking. The results of coliform counts of raw milk are corroborated with findings of Shaw and Nambudripad (1964), Lakhani *et al.* (1990) and Lakhani and Singh (1998).

Analysis of variance and treatmentwise mean of coliform counts of raw milk are given in Table 11 and 12.

Table 11. Analysis of variance for coliform counts of raw milk of Pandharpuri buffalo

Sources of variation	df	Sum of squares	Mean squares	F cal
Treatments	3	7.4113	2.4704**	49462.67

Farm (A)	1	0.1129	0.1129**	2262.15
Milking method (M)	1	7.2896	7.2896**	145921.25
Interaction (AM)	1	0.0087	0.0087	174.61
Error	20	0.001	0.00005	
Total	23	7.4123		

** p<0.01

It was observed from Table 11 that, the farms, method of milking and interaction of farm and treatments had significant effect on coliform count of raw milk of Pandharpuri buffalo.

Table 12. Treatmentwise and farmwise means of coliform counts (CC x 10^2 cfu/ml) for raw milk of Pandharpuri buffalo

Particulars	**Milking methods**		**Mean**	**SE ±**	**C.D. at 5 %**
	Hand	**Machine**			
	10^2	10^2	10^2		
Farm					
Pune	35.9^a	3.1^b	10.5^a	0.002	0.006
Kolhapur	28.5^a	2.1^b	7.7^b	0.002	0.006
Mean	31.8^a	2.5^b	9.0		
SE ±	0.002	0.002			
C.D. at 5 %	0.006	0.006			

Similar superscript in rows and columns within treatment did not differ significantly from each other.

It was seen from the Table 12 that, the coliform count of raw milk of Pandharpuri buffalo at Pune farm (10.5 x 10^2) was significantly (< 0.01) higher than coliform count of raw milk at Kolhapur farm (7.7 x10^2).

It was seen from the Table 12 that, the coliform count of raw milk obtained by hand milking (31.8 x10^2) was significantly (< 0.01) higher than machine milking (2.5 x10^2).

5. SUMMARY AND CONCLUSION

In this investigation, an attempt has been made to study the effect of milking management practices on quality of Pandharpuri buffalo milk on organized farms. The milking management practices especially washing of udder and methods of milking were seen under two farms i.e. Pune farm and Kolhapur farm. Raw milk samples of Pune farm and Kolhapur farm were subjected for microbiological quality study i.e. standard plate count (SPC) and coliform counts (CC). The results emerged out of the study are summarized below.

5.1 Microbial quality of raw milk

5.1.1 Effect of washing of udder on microbial quality of milk

5.1.1.1 Standard plate count

Average SPC of raw milk of Pandharpuri buffalo from unwashed and washed udder at Pune farm were 261 x 10^3 and 36.4 x 10^3 c.f.u. per ml, respectively. The average SPC of raw milk samples of Pandharpuri buffalo from unwashed and washed udder at Kolhapur farm were 208 x 10^3 and 21.3 x 10^3 c.f.u. per ml, respectively.

The SPC of raw milk of Pandharpuri at Pune farm (9.8 x 10^4) was significantly (< 0.01) higher than standard plate count of raw milk at Kolhapur farm (6.7 x 10^4).

It was observed that the SPC of raw milk obtained from unwashed udder (22.3 x 10^4) was significantly (< 0.01) higher than washing of udder (2.8 x 10^4).

5.1.1.2 Coliform count

It was noticed that the average coliform counts of raw milk of Pandharpuri buffalo from unwashed and washed udder at Pune farm were 38.0 x 10^2 and 5.5 x 10^2 c.f.u. per ml, respectively.

The average coliform counts of raw milk samples of Pandharpuri buffalo from unwashed and washed udder at Kolhapur farm were 32.4 x10^2 and 3.1 x10^1 c.f.u. per ml, respectively.

It was observed that the coliform counts of raw milk of Pandharpuri at Pune farm (14.4 x 10^2) was significantly (< 0.01) higher than coliform count of raw milk at Kolhapur farm (10.0 x 10^2).

The coliform count of raw milk obtained from unwashed udder (35.1 x 10^2) was significantly (< 0.05) higher than washing of udder (4.1 x 10^2).

5.1.2 Effect of methods of milking on microbial quality of milk

5.1.2.1 Standard plate count

It was found that the average SPC of raw milk of Pandhapuri buffalo obtained by hand and machine at Pune farm were 27.5 x 10^3 and 3.1 x 10^3 c.f.u. per ml, respectively. While average of raw milk at Kolhapur farm were 21.5 x 10^3 and 2.7 x 10^3 c.f.u. per ml, respectively.

The SPC of raw milk of Pandharpuri buffalo at Pune farm (9.3 x 10^3) was significantly (<0.01) higher than standard plate count of raw milk at Kolhapur farm (7.7 x 10^3).

It was observed that the SPC of raw milk obtained by hand milking (24.3 x 10^3) was significantly (<0.01) higher than machine milking (2.9 x 10^3).

5.1.2.2 Coliform counts

The average coliform count of raw milk of Pandhapuri buffalo obtained by hand and machine at Pune farm were 35.9 x 10^2 and 3.1 x 10^2 c.f.u. per ml respectively. While average coliform count of raw milk at Kolhapur farm were 28.5 x 10^2 and 2.1 x 10^2 c.f.u. per ml, respectively.

It was indicated that SPC and coliform count of raw milk produced by hand milking was significantly (< 0.05) higher than machine milking.

The coliform count of raw milk of Pandharpuri buffalo at Pune farm(10.5 x 10^2) was significantly (< 0.01) higher than coliform count of raw milk at Kolhapur farm(7.7 x10^2).

It was observed that the coliform count of raw milk obtained by hand milking (31.8 x10^2) was significantly (< 0.01) higher than machine milking (2.5 x10^2).

From the present investigation, it is concluded that, the clean and hygienic practices for milk production is directly useful to increase the microbial quality of milk. The milking by machine is useful for producing high microbial quality of milk.

6. LITERATURE CITED

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* **Originals not seen.**

7. APPENDIX-I

Raw milk : BIS standards

A. Standard plate count (SPC) (IS : 1479-1977, Part-III)

Count/ml	Bacteriological quality/grade

< 2,00,000	Very good
2,00,001 to 10,00,000	Good
10,00,001 to 50,00,000	Fair
> 50,00,001	Poor

B. Coliform count (IS : 1479-1977, Part III)

Absent in 1:100 dilution indicates satisfactory grade/ quality.

8. VITA

SANJUDAS HEMA RATHOD

A candidate for the degree

Of

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