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DEVELOPMENT OF MILKING SYSTEMS AND ITS IMPACT ON MILK QUALITY

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ABSTRACT

This review aims to summarise the development of milking systems, which influenced the quality of the milk and milk produced substantially, in past few decades. The milking environment is considered as one of the important factors for clean milk production. The milking systems were developed so as to keep the animal calm and comfortable while milking, which is attributed to have an advantageous effect on the quantity of the milk produced. Mechanisation of milking units has decreased the human intervention tremendously, yielding low labour requirement and reduced contamination due to human attributes. Many modernized techniques have been developed to facilitate proper and consistent milking practices. On the other hand, it has also improved the efficiency, safety and comfort of the labours involved in dairying. Quality milk production can only be achieved by adopting modern milking systems and good hygienic practices in and around the farm.

KEYWORDS: Automation, Hygiene, Milking, Milk, Quality.

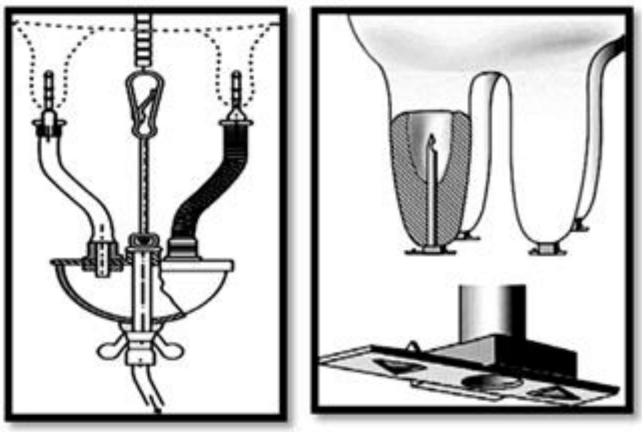
INTRODUCTION

According to the report of Department of Animal Husbandry and Dairying (2017), from a modest 17 million tonnes (MT) in the 1950s, milk production in India shot up to 163.7 MT in 2016-17. The production elevated by 20 per cent in 2016-17 compared to 2013-14. The per-capita milk availability increased from 307 grams per day in 2013-14 to 352 grams per day in 2016-17, recording a growth of 15.6 per cent. Also, the dairy farmers' income grew at the rate of 23.77 per cent during 2014-17 compared to 2011-14. Milk production of the animal directly reflects the implementation of welfare activities in a dairy farm (Sutherland et al., 2012). The adoption of milking machine has streamlined the care of animals and increased the quality of milk, but on the other hand, it may bring about many disorders of the udder (Twardon et al., 2001). With the help of milking machine, milk productivity can be increased and milking can be performed under more hygienic conditions. When the equipment is regularly maintained, it has a positive impact on udder and teat health, Somatic Cell Count (SCC) and ultimately on milk quality (Dang and Anand, 2007). On the other hand, if not used properly, a milking machine can significantly influence new infection rate. The dairy farmers are shifting towards advancements not only to reduce the farm labour requirement but also to improve the microbial quality of milk (Munyoro, 2014).

History of Milking Machines

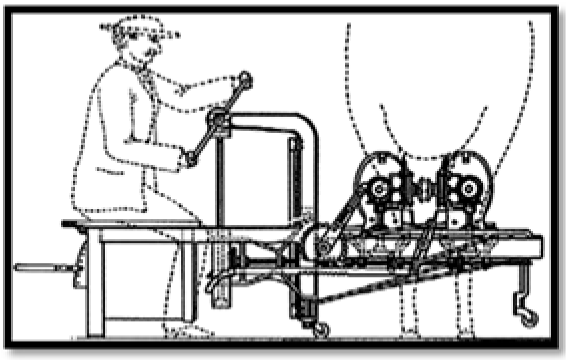
Since the domestication of dairy animals, milking was done only by hand which prevailed for many centuries. First effort to circumvent the sphincter muscles of the teat was carried out in Egypt during 400 BC using quill feathers (Roginski et al., 2003). Real earnest work along the route of milking machines began in 1878. Milk extraction was based on three principles upon which the milking machines were fashioned, namely, Catheter Principle, Pressure Principle and Vacuum Principle.

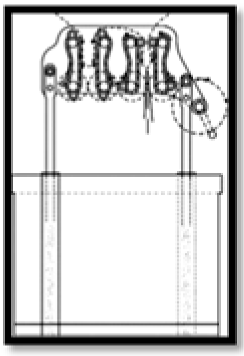
Catheter Principle



The machines were developed based on the principle of using a catheter, inserted into the teat duct, which allowed the milk to drain from the udder. Although this system is practical, in some instances, as in udder diseases, it becomes hazardous and impractical for average conditions (Roginski et al., 2003) as it is essential to sterilize that part of the device which is to be inserted into the teat canal.

Pressure principle





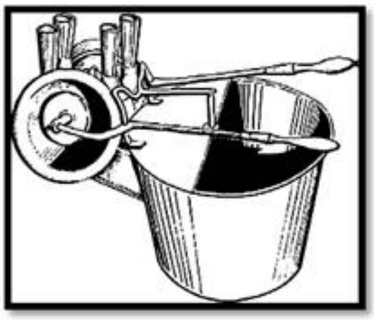
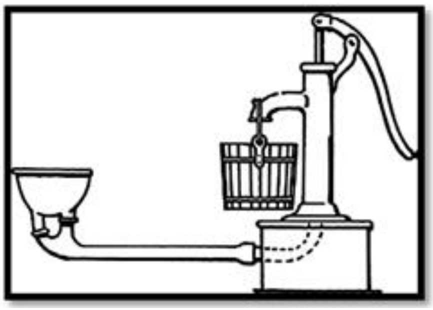
The machines were developed based on the principle of duplication of the technique of hand milking. The pressure was applied on the teat, at the attachment of the udder, closing the duct of the teat and a continuous downward pressure was applied to force the milk out of the teat cistern. Mechanically, hydraulically or pneumatically driven plates, bars, belts and rollers were used to simulate the action of hand milking (Roginski et al., 2003).

Some reasons for the failure of this design were, slower rate of milking compared to hand milking, lower milk yield, Teat injuries and high degree of operator skill required to operate these machines.

Vacuum principle

This principle employs the use of vacuum (suction) to imitate the sucking action of the calf. This principle worked on the basis of suction or negative pressure on the teat, the teats were placed in cups, from which the air was removed, producing a vacuum. Hence, the negative pressure of the air on the udder forced the milk into the teat and emptied into the vacuum chamber. The principle could be similar to that of the calf sucking the teat (Van, 1998). The initial idea of using a vacuum to extract milk from a cow is attributed to Hodges & Brocken den, in 1851. The actual principle of duplicating the action of the calf on the teat was not invented until suction pressure was produced at intervals. These intervals are called as pulsations. The intervals produced by the calf during feeding are due to an obvious reason that the calf is obliged to take its breath and continue to swallow. In the year 1895-96, first “Pulsator” was invented by Dr. Alexander Shields of Glasgow, Scotland (Thistle Mechanical Milking Machine Company).

The single-chambered teat cups pulsated between -15 to -50kpa, in a “swinging vacuum” milking machine

(Van, 1998). In 1892, Struthers and Weir from Scotland introduced a double chambered teat-cup. This device was claimed to produce an intermittent pressure on the teat using a rubber diaphragm to neutralize the influence of vacuum on the teat. In 1918, Carl Patrik Gustaf de Laval invented the bucket milking machine – first commercially produced and marketed machine (Roginski et al., 2003).

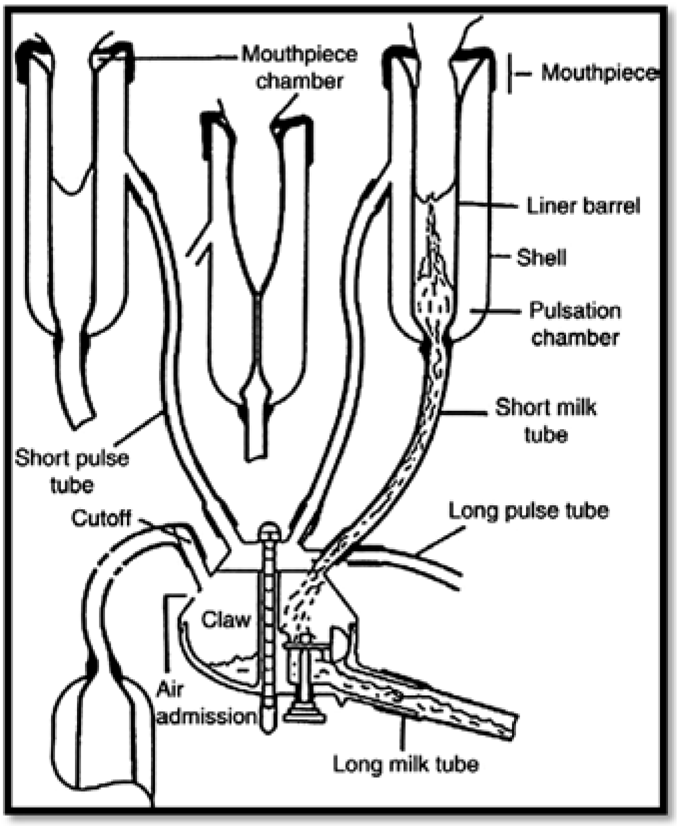
Milking machines

For machine milking to be economical, a minimum of 10 high yielder cows or buffaloes should be available at the farm. The principle behind the machine is generation of negative pressure or suction with the help of a vacuum pump.

Parts of a standard milking machine

Milking unit

A milking unit is the actual functional part in a milking machine. A typical milking unit consists of, 4 teats cups, short milk tube, short pulse tube, claw, long milk tube (hose) and a long pulse tube (hose). Teat cup is a double-chambered cup containing rigid outer shell made of stainless steel or plastic that holds a soft inner liner. The teat is inserted through the mouthpiece into the teat cup liner, where continuous partial vacuum is maintained. This whole set is combined to be called the "teat cup assembly" and the space between the liner and shell is called the "pulsation chamber". Normal atmospheric pressure and vacuum is alternated in this chamber by means of a "pulsator" through short pulse tubes branched out of a long pulse tube. Claw forms a junction for the milk collected from all the four teats, which is drained through short milk tubes, it also has a cut off to relieve the teats from the continuous partial vacuum after completion of milking. The milk is conducted through the long milk hose into the pail or container.



Pulsator

It is an air valve which alternately introduces vacuum and air at atmospheric pressure into the pulsation chamber. When vacuum is applied between the liner and shell, the rubber liner inflates allowing the milk to flow out of the teat, and when the chamber is filled with atmospheric pressure, the inflated rubber liner collapses, as a result, the teat is compressed and massaged (Howard, 1943).

Vacuum pump

A vacuum pump is a wane pump used to remove air from the milking system. It creates the necessary negative pressure.

Vacuum regulator

The vacuum level is controlled by vacuum regulation system. A typical vacuum regulator maintains a balanced vacuum level in the system by allowing air into the system (through detached milking units, air leaks, or other means) with the quantity of air being expelled by the vacuum pump. If more air is entering the system than being expelled, the vacuum level is dropped and the regulator closes. If more air is being expelled than entering, the vacuum level is increased, and the regulator opens to admit air.

Vacuum gauge

Every milking system is fitted with an accurate vacuum gauge. It is helpful in knowing the amount of vacuum maintained at any point of the time. The gauge must be visible to the operators during milking.

Factors influencing the efficiency of milking machine

Various factors must be considered for proper milking of animals without inflicting any pain or discomfort to the animal during milking process.

Vacuum level

The amount of vacuum in a milking system during milking can be expressed in terms of millimetres of Hg or inches of Mercury/kilo pascal (mmHg or inHg/kpa) differential quantified from atmospheric pressure and directed by the vacuum gauge. It must ideally be (-) 352mm Hg in Cattle and (-) 400mm Hg in Buffaloes (Rasmussen et al., 2003).

Pulsation rate

It is the number of cycles of alternating vacuum and atmospheric air which take place per minute. It may ideally vary between 40 to 60 cycles per minute in most of the machines (Akam et al., 1989).

Milking or Pulsation ratio

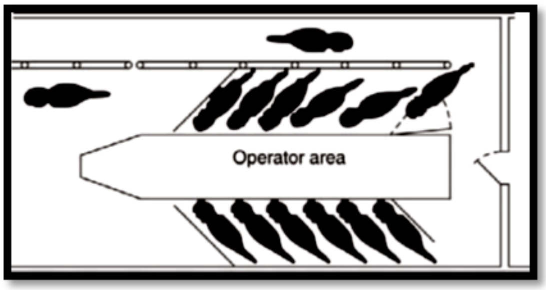
The duration of time spent under vacuum and atmospheric air and is usually maintained between 1:1 and 2:1 (Akam et al., 1989).

Milking Parlors

A milking Parlor is a building where the milking operation alone is carried out. Cows are brought to the milking Parlor to be milked and are then returned to a resting area. Milking parlours are classified based on whether the cows are raised above the person upon a platform, while milking (flat parlour or elevated parlour) the type of stall used, and entry and exit methods of the animals. The important types of milking parlours are discussed further.

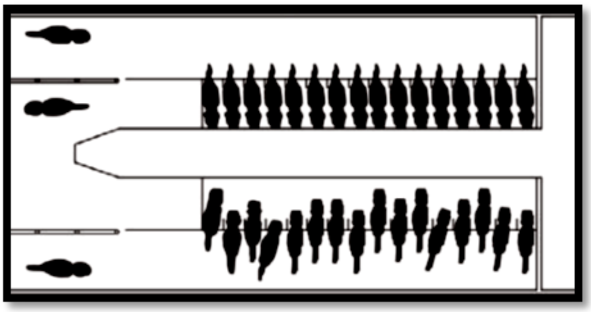
Herringbone

In herringbone (or fishbone) parlours, cows stand on raised platforms on either side at an angle of 45^{0} to the operator’s area. This alignment allows the operator to access the side of the cow for its preparation and unit attachment. In bigger parlours the two rows of stalls can be arranged in a wedge or “V” formation (Fig.6), providing a wider operator area on the opposite end away from the Parlor entrance. This enhances the visibility of units and cows from the opposite side of the operator area (Reinemann, 2013). Cows enter the parlour in groups according to the number of stalls on each side of the Parlor. The end portion of a herringbone stall is usually arranged in "S" configuration to position the caudal end of the cow in near proximity to the milking unit. The anterior end of herringbone stalls can be fitted with indexing stall and may use either standard or rapid exit.



Parallel

In parallel or side-by-side parlours, cows stand on raised platform at a 90º angle to the operator area. This alignment allows the operator to access the udder for cow preparation and unit attachment in between the cows' hind legs (Fig.7). It is impractical to fit parallel stalls with arm type Automatic Cluster Removers (ACR) because of the restricted access to the udder (Roginski et al., 2003). Parallel stalls are generally fitted with indexing front ends and rapid exit along with dual return lanes. On comparison, the parallel configuration facilitates a shorter operator's area, reducing the distance walked by operators, than provided by herringbone parlours (Reinemann, 2013).



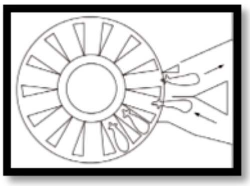
Side open or Tandem

In tandem stalls, cows stand in an end-to-end conformation during milking and milking units are attached from the side. This Parlor type is not affected by disparities in individual cow milking times when compared to herringbone or parallel parlours (Roginski et al., 2003), as cows move one at a time rather than in groups.

This Parlor also provides maximum view and access to cows for the operator during milking. This Parlor is ideally suited to situations in which individual care to the cows may be provided in individual cow milking times, as cows move one at a time rather than in groups.

Rotary or Carousel

In rotary or carousel parlours, cows stand on a rotating milking platform one after the other. An operator performs cow preparation and unit attachment functions. The stalls in rotary parlours may vary from 10 to 80 or more. Rotary parlours aid an orderly and constant milking routine in large parlours (Roginski et al., 2003).



Robotic Milking system

Automatic Milking Systems (AMS), also called Voluntary Milking Systems (VMS), have been commercially available since the early 1990s. Automated milking is also called robotic milking systems as these rely on the use of computers and special herd management software (Spahr and Maltz, 1997). Voluntary milking allows the cow to decide her own milking time and interval. It requires complete automation of the milking operation as the cow may choose to be milked at any time. When cow tries to enter the milking unit, a cow Radio Frequency Identification Device (RFID) sensor reads an identification tag attached to the cow and passes the cow's ID to the control system (Artmann, 1997). This is to avoid frequent access to highly palatable feed that is provided in the milking unit (Prescott et al., 1998). The automatic gate system directs the cow out of the milking unit if the cow is milked too recently (Hermans et al., 2003; Bach et al., 2009). If the cow is to be milked, automatic teat cleaning, teat cup application, milking, and antiseptic spraying on teat occurs. Concentrated feed is fed to the cow, as an incentive to attend the milking unit (Wierenga, 1991; Madsen et al., 2010). Management Information System (MIS) can be used to process data of milk ability, udder health and overall health of cow and correlate the performance of each cow, making it simpler to take farm management decisions. This ensures that each cow is attaining its full production potential and efficient utilisation of all the resources (Devir et al., 1997). Normal capacity of an AMS is 60-80 cows per milking unit/day (André et al., 2010). AMS usually achieves milking frequencies between 2 to 3 times per day (Klei et al., 1997). To achieve optimum efficiency through AMS various factors have to be considered such as milk yield, milking frequency, inter-milking period, time required for milking, cow traffic control and teat cup attachment (Gygax et al., 2007). During the milking, the animals are housed in the box. It is impossible to make the cow stand still and hence the position of the teat continuously. The relative teat positions should not vary more than 0.5-1cm in a given system and teat structure (Rossing & Hoeger, 1997). AMS is not compatible to all the cows in the herd due to the varied teat positions and udder structure. The farmers are guided by the manufacturer as to which animals will be suitable for AMS and therefore, the cows should be selected based on it. In general, on an average, an AMS is not suitable for 5-15 per cent of the animals in a prevailing herd, primarily because of udder shape and teat position (Rotz et al., 2003). The milk collected in AMS has lower Somatic Cell Count (SCC) and Electric conductivity (EC) when compared to the conventional milking systems (Berglund et al., 2002; Kamphuis et al., 2010). This is due to the number of milking frequencies (2 to 3) achieved in AMS (Campos et al., 1994; Dahl et al., 2004; Garcia and Fulkerson, 2005) and hence lower bacterial counts seen in the milk of AMS milked animals (Hillerton, 1991; Speicher et al., 1994) as the bacterial population is reduced or nullified upon frequent milking of animals. The decreased bacterial load can also be attributed to the rinsing of the teat cups between each cow (Berglund et al., 2002). The teat dip used after milking helps in the closure of teat sphincter and avoids the dryness of the teat skin apart from the sanitisation of teat opening.

CONCLUSION

Milking of cows has transformed from the simple method of hand milking to robotic milking systems. The technological development has not only resulted in increase in the quantity of milk, but also in the quality of milk. Automation of milking has paved way for the establishment of mega dairy farms where milking operations is practiced round the clock. Automation in cell counting has resulted in deviation of milk with high SCC, from the milk pool, improving the quality of milk. Automation in parlours has also improved the environmental hygiene around the animal during milking. Though in the last decade, we have seen Hi-tech technologies from milking machine to AMS, most of these technologies could not be adopted by majority of the farmers in developing countries like India due to high initial cost. Therefore, development of economical and efficient milking system has become the need of the hour.

REFERENCES

1. Akam, D.N., Dodd, F.H. and Quick, A.J. 1989. Milking, milk production hygiene and udder health. FAO. Retrieved from http://www.fao.org/docrep/004/T0218E/T0218E00.htm#TOC.
2. André, G., Berentsen, P., Engel, B., De Koning, C. and Oude Lansink, A. (2010). Increasing the revenues from automatic milking by using individual variation in milking characteristics. Journal of Dairy Science, 93, 942-953. DOI: 10.3168/jds.2009-2373
3. Artmann, R. (1997). Sensor systems for milking robots. Computers and electronics in agriculture, 17(1), 19-40. DOI: 10.1016/S0168-1699(96)01231-8
4. Bach, A., Devant, M., Igleasias, C., and Ferrer, A. (2009). Forced traffic in automatic milking systems effectively reduces the need to get cows, but alters eating behavior and does not improve milk yield of dairy cattle. Journal of dairy science, 92(3), 1272-1280. DOI: https://doi.org/10.3168/jds.2008-1443
5. Berglund, I., Pettersson, G., and Svennersten-Sjaunja, K. (2002). Automatic milking: effects on somatic cell count and teat end-quality. Livestock Production Science, 78(2), 115-124. DOI: https://doi.org/10.1016/S0301-6226(02)00090-8
6. Bhagat, S. S., Sastry, N. S. R., and Yadav, R. S. (1992). Studies on the efficiency of milker in relation to milk ability of Murrah buffaloes. Indian Journal of Animal Production and Management, 8, 244-245.
7. Borghese, A., Rasmussen, M., and Thomas, C. S. (2007). Milking management of dairy buffalo. Italian Journal of Animal Science, 6(sup2), 39-50.
8. Bruckmaier, R. M., and Blum, J. W. (1998). Oxytocin release and milk removal in ruminants. Journal of dairy science, 81(4), 939-949. DOI: https://doi.org/10.3168/jds.S0022-0302(98)75654-1
9. Bruckmaier, R. M. (2005). Normal and disturbed milk ejection in dairy cows. Domestic animal endocrinology, 29(2), 268-273. DOI:https://doi.org/10.1016/j.domaniend.2005.02.023
10. Campos, M. S., Wilcox, C. J., Head, H. H., Webb, D. W., and Hayen, J. (1994). Effects on Production of Milking Three Times Daily on First Lactation Holsteins and Jerseys in Florida1. Journal of Dairy Science, 77(3), 770-773. DOI: https://doi.org/10.3168/jds.S0022-0302(94)77011-9

11. Dahl, G. E., Wallace, R. L., Shanks, R. D., and Lueking, D. (2004). Hot topic: Effects of frequent

1. milking in early lactation on milk yield and udder health. Journal of Dairy Science, 87(4), 882-885. DOI: https://doi.org/10.3168/jds.S0022-0302(04)73232-4

12. Dang, A. K., and Anand, S. K. (2007). Effect of milking systems on the milk somatic cell counts and composition. Livestock Research for Rural Development, 19(6), 1-9.