

## Design and manufacturing a washing unit for teat cups in the bucket milking system and its effect on the produced milk quality

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### ABSTRACT

The study aims to show the importance of the washing process for the bucket milking system and its effect on the produced milk. Using a new design and manufacturing washing unit for teat cups in bucket milking system and study the relationship between the efficiency and quality of the washing process in the milking system, and bacterial count found in milk tank and teat cup surface. The new washing system cleaning in place (CIP) system is an alternative effective solution for washing liners and cluster. Washing units consists of two washing set. Each washing set consists of four outlets designed to wash one cluster a five types of washing sets have been tested during this Study. Using the new system to cleaning the bucket milking system led to the provision of some environmental advantages, than traditional system such as; reducing the consumption of chemicals in cleaning of milking machine by about 35 %, also save 66 % of the amount of water consumed in cleaning, and saving 0.55 kW electric energy used to operate the pump; and 1.4 kW electric energy consumed in heating water. Time of cleaning operation was also saved by 50%. The cleaning efficiency in traditional cleaning method is 42.9 %. While it's increased to 93.1 % with using a Jetter rod at new cleaning system. For traditional cleaning system total bacterial count in milk sample was  $81 \times 10^4$  cfu/ml it classified at grade II ( $> 2,00,000 - 1,000,000$  cfu/ml). While for the new cleaning system with different types of washing set the total bacterial count was between  $33 \times 10^3$  to  $66 \times 10^3$  cfu/ml .which classified at grade I ( $< 2,00,000$  cfu/ml).

**Key words:** washing unit for teat cups, Bucket milking system, Cleaning, Bacterial quality, CIP, Sanitation, Energy, bulk tank milk

### INTRODUCTION

Recently, bucket milking for cows and buffaloes are the ideal solution for the small farms in the developing countries like Egypt, the suitable bucket milking machine is milking 10-15 cow/h. (F.A.O.,1989). A small animal production herd less than 30 cows using manual disinfection. In cleaning milking machines. The cleaning and disinfection process of the milking machine is one of the most important operation in milking processing. Any shortening in it leads to increase in the number of bacteria and contamination of the milk production, and this is the result of milk waste and washing water remaining in the teat cup or milk lines in milking equipment's, support the growth of a variety of microorganisms, the sources of these microorganism are the soil and manure on the teats and udder surfaces. Bacteria count provides indications of cleanliness of teat preparation before milking. Milking machines may contain (Organic residues from milk, Mineral deposits mainly from water, Bacterial films and Chemical residues) Cleaning solutions. Improving cleaning milking efficiency allow to improve the milk quality. (Reinemann et al., 2003; Holm et al., 2004 Murphy, 2007; Bava et al., 2009; Gleeson, 2009) Cleaning of milking machine objective is achieve the following terms which used to define the degree of cleanliness; \*Physical cleanliness (removal of all visible dirt from the surface); \*Chemical cleanliness (remove milk soils, organic and mineral solids that form on equipment surfaces after the milk is removed) \*Bacteriological cleanliness Kills and removes bacteria attained by disinfection) \*Minimizes time and energy required are safe for human and environment. (Jones, 2009; Gösta, 2012; Frewen, 2018) Recommended cleaning and sanitizing practices are a balance between the cleaning water temperatures, cleaning chemical concentration, contact time and

mechanical action. These parameters are interconnected and depending on each other. Cleaning milking system routine is. 1. Washing to rinse a clusters with 14 liters of worm water per/unit (25-30°C) to remove milk remaining in the system .2- Using alkaline detergent (Sodium hydroxide concentrations of 3%–5%) in hot water (70-80°C) 9 liters water for milking unit- Circulate for 10 min to remove organic soils.3- Rinse a clusters immediately after main wash with 14litres/unit of worm water(25-30°C) to remove residual cleaning chemicals from the milking machine..5. Ensure the system is drained before milking. Weekly (one time) hot wash routine 1. Rinse plant with 14 liters of cold water. 2. Circulate an approved milk stone remover (acid detergent) in 9 liters of cold or hot water per cluster for 5 to 10 min. 3. Flush plant with 14 liters of cold water per cluster. Water flow-rate of 3 l/min sufficient for most milking systems, and 5-6 l/min for systems with jars /milk meters. **(FAO1989; Reinemann, 2000; thomas ,2002; Reinemann et al. ,2001; Gleeson,2009; Menzies ,2014 ; Tetra pak, 2015 and Frewen 2018).**

The most common parameter to determine the bacterial quality of bulk tank milk is the Standard Plate Count (SPC), Some factors such as cleanliness of cows' environment, effectiveness of teat preparation before milking and efficacy of sanitization of milking equipment cause the bacterial count to rise. Rubber as a source of bacteria if rubber ware gets older it starts to pit and crack, allowing bacteria to live in it and protected from hot water and chemicals **(Reinemann et al., 2003; Murphy, 2007; Gleeson, 2009)**. A collected milk from clean, healthy cows generally has Standard Plate Count (SPC) values of less than 1,000(cfu). Total Bacterial Count was performed with the colony counter.(colony forming units (cfu)). There are 3 grades. grade I i.e. < 2,00,000 ( $2.0 \times 10^5$ ) cfu /ml, ( grade II i.e. < 2,00,000 – 1,000,000 ( $2.0 \times 10^5$  –  $1.0 \times 10^6$ ) cfu/ml, and grade III i.e. <1,000,000 - 2,000,000 ( $1.0 \times 10^6$  -  $2.0 \times 10^6$ ) cfu/ml. **( Murphy, 2008 and Ugochukwu, 2019)**. There are several environmental implications. such as the discharge of cleaning chemicals into the environment , the energy used for heating and pumping water , reuse the final rinse water as the first flush in subsequent CIP cycles and reducing chemical concentrations or temperatures. water efficiency .CIP has advantages over manual cleaning methods, reduced water and chemical consumption .The less heating required the less cost. Some systems use specially formulated alkali detergents at temperatures of between 30-50°C. Reuse water is an integral part of a Green Cleaning system. It saves on heating, chemicals and water. Re-use can save as much as 60% of the water needed for cleaning. **(AgVet Projects, 2011; Reinemann et al., 2003; EREK ,2018; Envirowise , 2019).**

Traditional cleaning of the bucket milking machine which done. Once milking operation is finished everything must be cleaning. (the teat cups, the claw, the tubes and the milk bucket,) as following

- 1- Dip the cups (cluster) into a pail containing 10 liters of washing water (25-30°C) as and turn on the pump. Then lift and lower the cluster repeatedly .So that water and air enter the liners, through the claw and tubes into the milk bucket. Once the water has flushed turn off the pump. and empty the water out of the milking bucket.
- 2- Washing : To Clean the Claw add 75 gr relative detergent in a pail for 10 liter of hot water (70-80°C), and turn on the pump .Then submerge the claw with make a dipping motion as the claw runs the cleaning solution into the bucket. Once the solution has been transferred to the milking bucket turn off the pump, and empty the cleaning solution out of the bucket and use it to clean anther equipment.

- 3- Final Rinse: Rinse with normal water 10L. After it's flushed through, the bucket turn off the pump, shake it and dump out the water, as shown in photo (1).



photo (1) Traditional cleaning of the bucket milking machine . Dipping the cups (cluster) into a pail containing 10 liters of washing water.

- 4- Pout the claws on the relative hooks located on the end of the arms on the trolley so that they can dry out. Turn the bucket upside down so that any water can drain off.

At the end of every week can use ACID Rinse: After rinsing the equipment cleaner off .This will remove traces of alkaline cleaner and prevent mineral deposits (Milk Stone) from milking system, even on stainless steel. Do not rinse again, set to dry.

**(Reinemann et al., 2003; InterPuls, 2011,).**

cleaning-in- place system (CIP) has advantages over manual cleaning methods, The mechanical force increases the velocity of the water by pumping. The flow velocity should be at least 1.5 m/s to have an adequate mechanical force. **(Tetra, 2015).**

## MATERIAL AND METHODS

The study aims to clear fey the importance of the washing process for the bucket milking system and its effect on the milk produced quality. Using a new washing unit for teat cups in bucket milking system. The relationship between the efficiency and quality of the washing process in the milking system and bacterial count found in milk tank and teat cup surface were also studied and evaluated. The new washing system is cleaning in place (CIP) system which is an alternative solution for washing liners and cluster.

Using different types of washing set, washing water temperature, water flow, and duration of each washing phases.

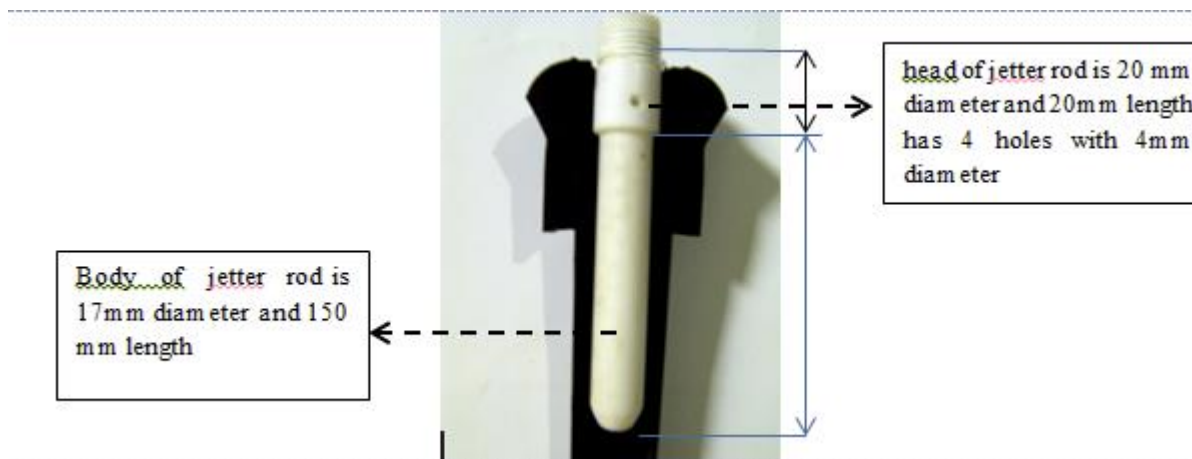
The experimental steps was conducted as follows:

**Design and testing a new washing unit for teat cups of bucket milking system** the new washing unit was designed in Agric. Eng. Research Institute (AEnRI) and tested for mobile bucket milking machine was used for milking caw. The experiment of work was applied at (Al qurashia station) Livestock Research Station el Gharbea government in (ARC). The new washing system (cleaning in place CIP System ) alternative cost effective solution for washing liners and cluster. it is designed and fabricated to be adapted to all kind of bucket milking system.

The operation of cleaning process should be operated by manually to change some relevant hoses and valves as shown in fig .1. The washing system was consists of 3 component units:

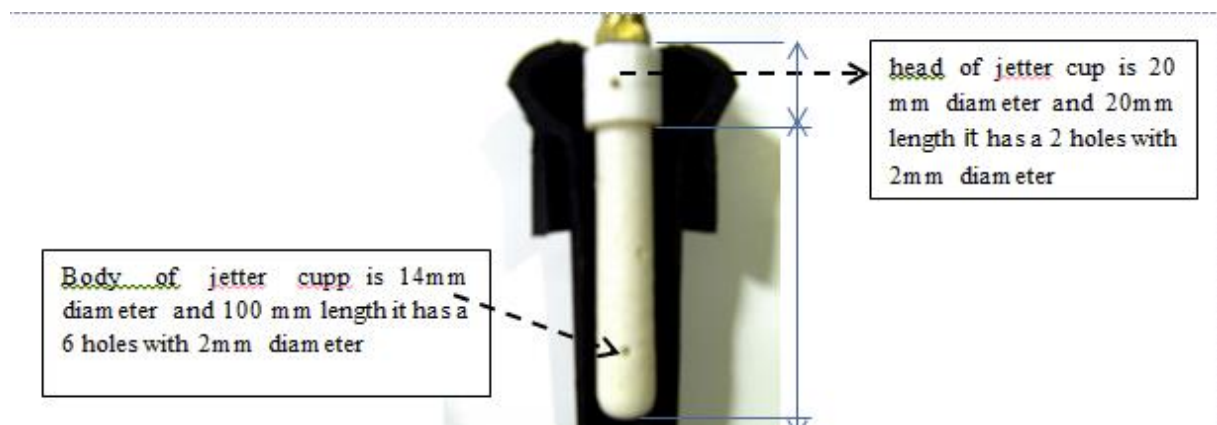
- 1- A machine frame: the frame consists of 4 partitions (a) the frame body was fabricated from aluminum square tube (4×4 cm) ,with dimensions were 75cm length ,50 cm, width and 150 cm heigh.(b) Stainless Steel washing sink in the middle of frame fixed a Included one drain

- 2- hose 2 " the sink dimensions are 70 cm length , 40cm Width and 20cm deep (c) two stands in front of upper part of frame fixed made from metal plate fabricated with 4 special holes to hanging a milking clusters easily during washing operation (d) water pressure pump and two water tanks in lower part of frame.
- 3- Washing water circulation Including, (a) water pressure pump it is motor Power 0.37kW with water flow rate 26 L/m, (b) two water tanks its capacity 20 liters (made from pvc material ) one tank for cold water and the other for hot water. Water filling by electric solenoid valve controls by electric timer to adjustment water volume. Water heating by electric heater Coil pipes 2000 watt inside tank. Hot water temperature auto control by thermostat. Washing water circulation time controlled by electric timer. Adding detergent chemical (acid/alkaline) to hot water tank by manual. washing circulation start from two storage water tanks
- 4- supplying water to the pressure pump, through two valves and pipes . a pump push the water to the washing unit set through pipes and houses .
- 5- Washing units consists of two washing sets to cleaning two milking cluster. Washing set is consists of four outlets. made to wash one cluster ,there are five different Washing set types (1- Jetter rod for H manifold 2- jetter cup, 3- internal shower plug for H manifold , 4- internal Jetter plug and 5- rubber cup ) were tested and evaluated . The specifications of the tested washing set types are summarized as follow:
  - 1) Jetter rod for H manifold manufactured from teflon material using a lathe machine. the head of jetter rod is 20 mm diameter and 20mm length, it has 4holes with 4mm diameter, as shown in Photo (2).

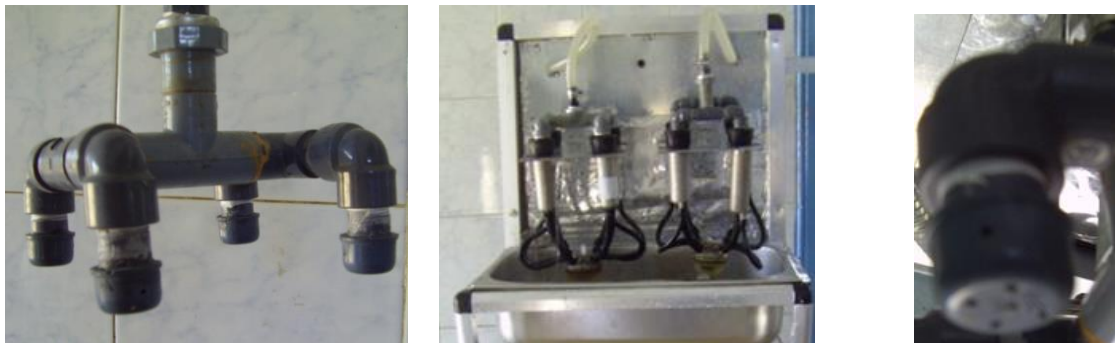


**Photo (2): Jetter rod for H manifold manufactured from Teflon material**

- 2) Jetter cup Manufactured from teflon material using a lathe machine, head of jetter cup is 20 mm diameter and 20mm length it has 2 holes with 2mm diameter. The body of jetter cup is 120 mm diameter and 100 mm length it has a 6 holes with 2mm diameter 4 at middle and 2 at the end fixed in rubber cup with SS Jetter distributor as shown in Photo (3).

**Photo(3): Jetter cup Manufactured from teflon material using a lathe machine.**

- 3-Internal shower plug H manifold manufactured from PVC material pipe and Fitting 1/2 " there are 2 holes it is diameter 2mm in the side of plug and 5 holes in the front, as shown in Photo (4).

**Photo (4): Internal shower plug H manifold manufactured from PVC material.**

- 4- Internal Jetter plug with plastic Jetter distributor dispenser purchased from local Market .the head of internal Jetter plug has 4 holes with 2mm diameter as shown in Photo (5).



**Internal Jetter plug**



**Jetter plug**



**distributor dispenser**

5-Rubber cup open design with SS jetter distributor dispenser purchased from local market. The head of rubber cup has one hole with 10 mm diameter as shown in Photo (6).



**Rubber cup set**

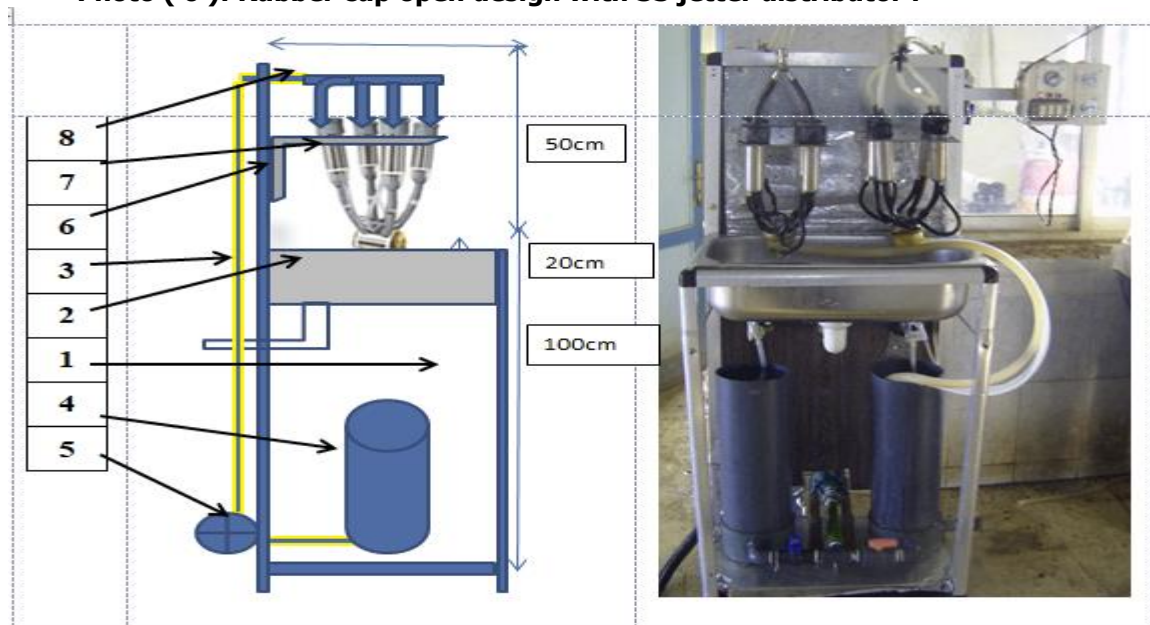


**Rubber cup**



**SS jetter distributor**

**Photo ( 6 ) : Rubber cup open design with SS jetter distributor .**



**1 Frame body**

**2 Washing sink**

**3 Water pipe**

**4 Water tank**

**5 Water pump**

**6 Cluster holding**

**7 Milking cluster**

**8 Washing set**

**Fig (1): Drawing for cleaning machine components.**

### Test procedure & Measurements

The cleaning routine in the new system for cleaning two milking clusters (3 stages).After milking operation was finished , bring the milking clusters unit and hold it on holding plate at the cleaning machine to start the cleaning operation in three stages,( Pre -rinse stage, detergent stage and post-rinse stage) as follow:

1. Pre rinsing stage: To remove most of the residual milk remaining in the system fill the container (no1) with 20 L worm water (25-30°C), open the shutoff valve. Then turn on water pump and adjustment the pump operation timer for rinse time requirement. The rinse water will be pushed into the washing unit to the milking cluster. Once the water comes out to the sink, and water pump shut off, a rinse water discarded after a single pass through the system and drained to the sewage.
2. Detergent stage: To remove organic material .Fill the container (no 2) with cleaning solution (20 L hot water 70-80°C and 60 ml liquid alkaline detergent). Open the shutoff valve. Then turn on water pump and adjustment the operation timer for washing hot water circulation to 5 min. with water flow rate 25 L/min .The cleaning Solution circulation will be start from hot water container to water pump then pushing into a set of washing unit throw pipes and hoses to the milking cluster and return bake to the container. and continue the circulation until finished the washing time.

Cleaning solution was used in this study a commercial alkaline detergent was commonly used in dairy farms (pH value 12 and a concentration was 0.5% (v/v)) according to manufacturer's recommendations.

3. Post- rinsing stage: To remove residual cleaning chemicals from the milking machine. fill the container ( no1) during a washing phase operating to save time with 20 L worm water (25-30°C ), open the shutoff valve. Then turn on water pump and adjustment the pump operation timer for rinse time requirement (25sc). The rinse water will be pushing into the washing unit to the milking cluster, and put a hose of cluster in container (no1), let water return bake to the container. To reuse the final rinse water as the first rinsing in second washing operation. Once a water comes out to the sink and water pump shut off, the water will be drained to the sewage. Reuse the final rinse water as the first flush in subsequent CIP cycles.

One time per week use a liquid acid detergent for washing the system to remove iron. (Acid solutions pH value is 1.0 and a concentration was 2.0% (v/v)) according to manufacturer's recommendations.

### Measurements:

- water flow rate,  $V_w$  was measured using a bucket and stopwatch to measure how much time ( $\Delta t$ ) it takes to fill up a container of known volume, ( $V$ ) and calculate the volume flow rate.

Volume flow rate through a hose = container of known volume / time, as shon in photo (7).

$$\underline{V_w} = V/\Delta t \quad \text{L/min} \quad \text{-----} \quad (\text{Cimbala,2009} ),$$

Photo ( 7 ) : Measuring water flow rate using bucket scale .



### **Bacteriological analysis:**

Sample analysis: Samples were analyzed in Department of Mastitis and Neonatal Diseases, in Animal Reproduction Research Institute through SPC (Standard Plate Count) to determine bacteria that might have contaminated teat cups surface and milk as follows:

#### **a) Collecting of samples:**

Teat cups were swabbed before and after the cleaning of milking equipment. Cotton swabs were prepared from non-absorbent cotton with length of 2 cm and thickness of 0.5 -1 cm. On stiff stainless steel wire. The swabs were kept in their tubes which contain 10 ml of quarter strength Ringer's solution then autoclaved (**Harrigan 1976**). Teat cups: From the four teat cups, the samples were taken using a sterile cotton swab as one sample.

Bulk (tank) milk samples: Samples of milk from the bulk milk tank were collected in a sterile bottles 250 ml

#### **b) Bacteriological examination:**

Preparation of 10-fold serial dilution. One ml

of the milk sample as well as swabbing solutions was added to 9 ml of sterile saline solution and thoroughly mixed to make a dilution of 1 :10, from which decimal dilution were prepared. (**APHA, 1992**) Total Colony Count. The standard plate count technique was used for all samples. One ml of each dilution from the previously prepared samples was plated in duplicate plates. About 10 ml standard plate count agar medium at 40-45 °C were poured into each plate was mixed by gentle rotation to achieve adequate dispersion of inoculum. Inoculated and control plates were incubated at 32°C for 48 hrs. plates showing growth of colonies (30-300) were selected, counted and register (APHA,1992).

### **Experimental procedures:**

Efficiency of cleaning of milking system: The efficiency of cleaning the milking system could be evaluated by microbiological analysis of sample for the swabbed teat cup rubber and bulk tank milk,

#### **Traditional cleaning of the bucket milking machine.**

The experimental of traditional cleaning operation for bucket milking system 6 units.

Starting once the milking operation finished.

The cleaning operation doing in 3 steps as follow:

- Step one: pre rinse a milking unite,(the teat cups, the claw, the tubes and bucket ) dip the cups (cluster) into a pail containing 15 liters of washing water (25-30°C ) and turn on the pump. Then lift and lower the cluster repeatedly .So that water enter the teat cup, through the claw and tubes into the milk bucket. Once the water has flushed turn off the pump. and empty the water out of the milking bucket.
- Step two: washing with detergent the milking unit, prepared a cleaning solution by add 50 mL relative detergent (as supplied recommendation) into 15 liter of hot water (70-80°C) in a pail. and turn on the pump .Then submerge the claw with make a dipping motion as the claw runs the cleaning solution into the bucket. Once the solution has been transferred to the milking bucket turned off the pump, and empty the cleaning solution out of the bucket and put it in the pail , to use it for cleaning next milking unit
- Step three: final Rinse of milking unit. dip the cups (cluster) into a pail containing 15 liters of tape water and turn on the pump. Then lift and lower the cluster repeatedly .So that water and air enter the liners, through the claw and tubes into the milk bucket. Once the water has flushed turn off the pump. and empty the water out of the milking bucket.

After finished cleaning operation Put the claws on the relative hooks located on the wall at milking equipment's room so that they can dry out. Turn the bucket upside down so that any water can drain off.



### Calculating water consumption in the traditional cleaning operation to clean 6 milking units:

- Step one: pre rinse, we have 6 unit. every unit consumed 15 liters of water.  
total water consumption equal  $6 \times 15 = 90$  liters
  - Step two: washing detergent of milking unit, every 2 units consumed 15 liters of cleaning solution from hot water (70-80°C) .total water consumption equal  $3 \times 15 = 45$  liters
  - Step three: final Rinse of milking unit. we have 6 unit every unit consumed 15 liters of water .total water consumption equal  $6 \times 15 = 90$  liters  
total water consumption in 3 steps equal ,  
 $90 + 45 + 90 = 225$  liters / one time
3. Calculating a detergent consumption for 6 units. two units consumed 50 gr relative detergent. total detergent consumption equal  $3 \times 50 = 150$  mL detergent.
4. Calculate time consumed in the cleaning operation for 6 milking unites.

Operation	Time M: Sec
Pre rinse	3:40
Washing	3:50
final Rinse	3:15
Washing time for one unit	10:45
Total time for 6 units	64:30 min ~ one hour

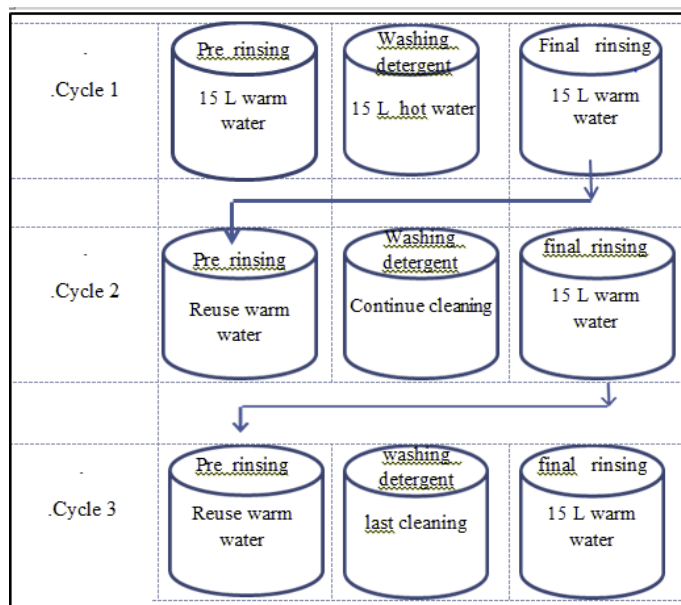
Total time consumed in the cleaning operation for 6 milking unites is about one hour.

5. Calculating of electricity power consumed in cleaning operation:  
Vacuum pump motor power is 0.75 kW and a time of cleaning operation is one hour, electricity power consumed is 0.75 kW /h.  
the electrical water heater have capacity 50 L water, consumed electricity 2 kW / h  
water consumption is 45 L Hot water and 90 L warm (equivalent 40 L hot water) total hot water consumed was 85L , electricity power consumptions for heating of water is 3.4 kW.  
Total electricity power consumed in the cleaning operation was  $3.4 + 0.75 = 4.15$  kW

### Cleaning operation using new system to clean 6 units of bucket milking machine.

1. Cleaning program after milking operation was finished, bring the two milking clusters units and hold it on holding plate at the cleaning machine to start the cleaning operation as follow:
  - Pre rinsing phase : Fill the container(no1) with 20 L warm water (25-30°C). open the shutoff valve. Then turn on water pump and adjust the pump operation timer (25 sec) for rinsing time requirement. water comes out to the sink , a rinse water discarded after a single pass through the system and drained to the sewage.
  - Detergent phase: Fill the container (no 2) with cleaning Solution (20 L hot water 70-80°C and 60 mL liquid alkaline detergent). and adjustment the operation timer for washing hot water circulation to 5 min. the circulation start from the container to the cluster and return back to the container. and continue until finished the washing time. Cleaning detergent was used in this study was a commercial alkaline detergent commonly used in dairy farms (pH value 12 and concentration 0.5% (v/v).
  - Post- rinsing phase : Fill the container during a washing phase operating to save time with 20 liters warm water (25-30°C), and adjustment the timer for rinse time (25sec ); and put a hose of cluster in container (no1) let water return back to the container. To reuse the final rinse water as the first rinsing in second washing operation. After finished post rinsing phase for cycle one start cleaning operation for cycle two to clean another two clusters as shown in Fig (2).

2. Calculate of water consumption for cleaning operation to clean 6 milking unit:  
 Every two clusters unit cleaning in one cycle. Diagram Fig (2) shows water consumption in cycle one consumed 30 L warm water and 15L hot water .in cycle two consumed 15 L warm water only in final rinsing .in cycle three consumed 15 L warm water only. Total water consumption 60L warm water and 15L hot water.



**Fig (2): Diagram of water cleaning cycle.**

3. Calculate detergent consumption in cleaning operation for 6 units. In cycle one consumed 60 ml liquid alkaline detergent. And in cycle two add 20 ml of alkaline detergent and in third cycle add 20 ml to adjustment chemical concentrations in cleaning chemical solutions. Total detergent is  $60+20+20= 100$  mL of liquid alkaline detergent.

4. Calculate time consumed in the cleaning operation for 6 milking unite.

Operation	Time M: Sec
Preparing machine	3:00
Pre rinse	0:30
Washing	5:00
final Rinse	0:20
Washing time for 2 units	8:50
Total time for 6units	26:30

Total time consumed in the cleaning operation for 6 milking unite is about 30 min

5. Calculating of electricity power consumed in cleaning operation:

A. Water pump motor power is 0.37 kW and the time of cleaning operation is almost half hour. Electricity power consumed is about 0.20 kW /h

B. Heating water for 50 L, consumed electricity 2 kW / h

Total electricity power consumed in cleaning operation is 2.20 kW

## RESULTS AND DESCUATION

The results of experimental work as previously mentioned show that, cleaning-in- place system (CIP) has advantages over manual cleaning methods, water flow rate for different types of the tested washing sets for the new cleaning system

### Measuring the water flow rate:

water flow rate for the studied types of washing sets are shown in Table (1) and fig (3), The results show that the internal shower plug recorded the lowest water flow rate 11 L/min ,while the jetter cup the highest water flow rate 13.6 L/min . This means that ,all tested types recorded water flow rate over the recommended cleaning processing use 9 l/min for one milking unit according to **Reinemann 2000, Gleeson2009, John M. Cimbala 2009,Menzies 2014 , Tetra pak 2015 and Frewen 2018).**

**Table (1): water flow rate for different types of the tested washing sets**

Types of the tested washing sets	water flow rate L/min	
Jetter rod for H manifold	12.8	
jetter cup	13.6	
internal shower plug H manifold	12.2	
internal jetter plug	11	
rubber cup	12	

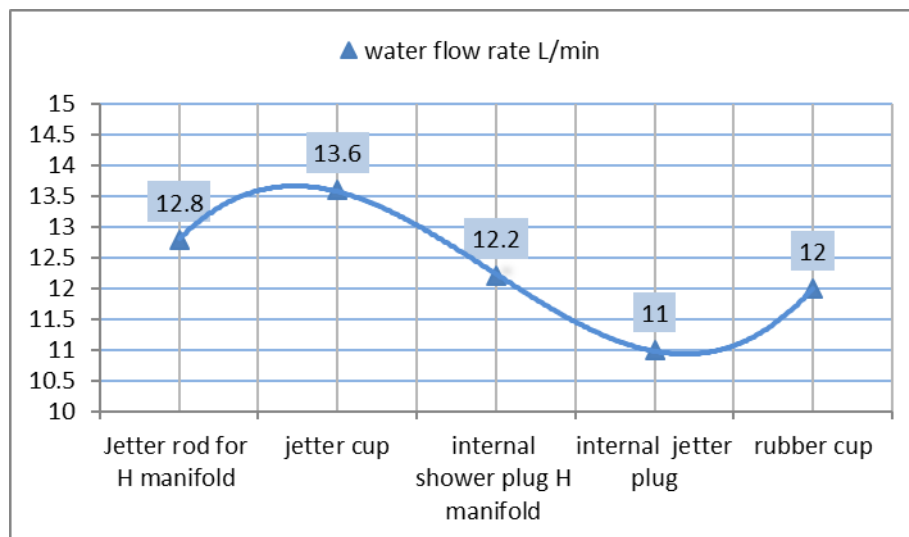


Fig (3): water flow rate for different types of washing set for new cleaning system.

**Comparing between traditional cleaning method and the new cleaning system.** A comparison study for water consumption, detergent consumption, time consumed and electricity power consumed was conducted and presented in Table (2)

**Table (2): comparing between traditional cleaning method and new cleaning System**

Comparing factors	Traditional cleaning method	New cleaning system
water consumption	225 L	75L
detergent consumption	150ml	100 mL
time consumed	64:30 min	26:30 min
electricity power consumed in pump operation	0.75kW	0.20 kW
Electricity power consumptions for heating of water	3.4 kW	2.0 kW
Total electricity power consumed in cleaning operation	4.15kW	2.20 kW

As shown in table (2) using the new system to cleaning the bucket milking system led to the provision of some environmental advantages, such as reducing the consumption of chemicals in cleaning of milking machine by 35% .and saving 66% of the amount of water consumed in cleaning . and saving 0.55 kW electric energy used in operating the pump and 1.4 kW electric energy consumed in heating water. time in cleaning operation saved by 30 min. The saving in all these factors will reduce the cost of cleaning operation according to (AgVet Projects 2011, Reinemann et al, 2003; EREK 2018; Envirowise 2019).

**Bacterial quantity of bulk tank milk,** The most common parameter to determine the bacterial quantity of bulk tank milk is the Standard Plate Count (SPC), Some factors such as cleanliness of cows' environment, effectiveness of teat preparation before milking and efficiency of sanitization of milking equipment cause the bacterial count to rise. Improving milking cleaning efficiency allow to improve milk quality.

Total bacterial count at teat cup liner was performed with the colony forming units (cfu) to determine bacteria that might have contaminated teat cups surface. according to (Murphy and Boor, 2007, Gleeson, 2009). The milking machine was washed to achieve the following objectives: physical hygiene, chemical cleanliness, bacteriological cleanliness according to. (Jones 2009; Gösta 2012; Frewen 2018). The new washing system has advantages over the traditional cleaning methods, using mechanical force in cleaning system which increases the velocity of water by water jet. Total bacterial count was performed with the colony forming units (cfu) to indicate the difference number of bacteria in teat cups swabs samples before and after cleaning processing using different types of washing set. as shown in Fig (4) a total bacterial count for the traditional cleaning methods was ( $980 \times 10^3$ cfu/ml and  $630 \times 10^3$ cfu/ml before and after cleaning process respectively) Which it is higher than using new washing system with different types of washing set as shown in Fig (4 and 5) the cleaning efficiency in traditional cleaning method was 42.9 %.while it was 93.1% with Using a Jetter rod for H manifold at new cleaning system. Another different washing set the cleaning efficiency was 84.9%, 61.5%, 73.7% and 61.2% for jetter cup, internal shower plug for H manifold, internal Jetter plug and rubber cup, respectively.

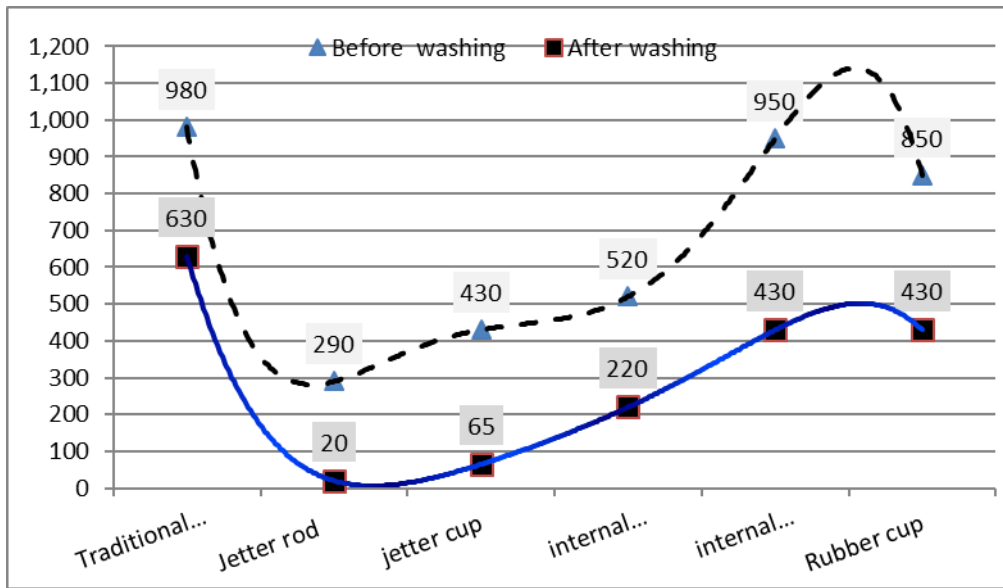


Fig (4) : Total bacterial count for the studied washing sets types before and after washing with colony forming units (cfu)  $1.0 \times 10^3$ .

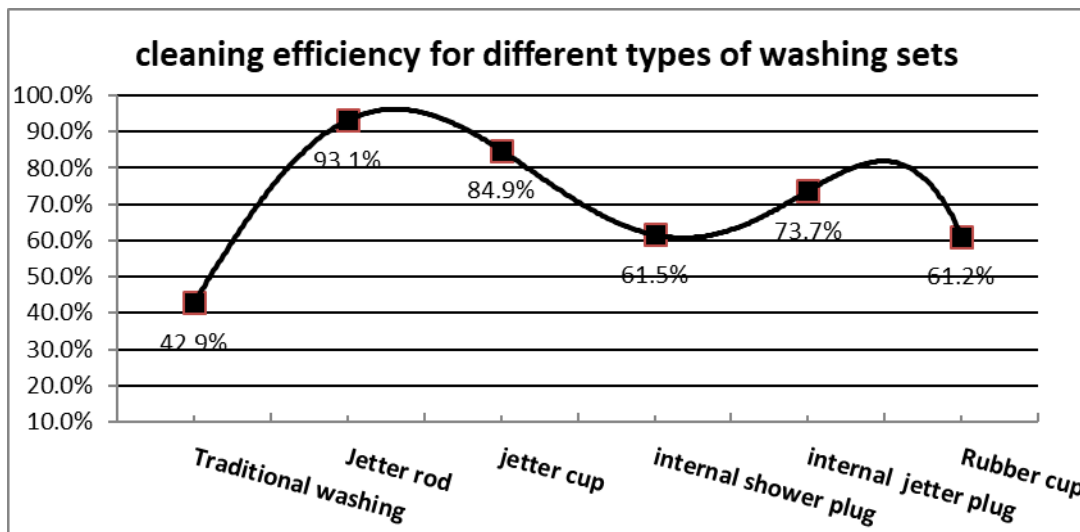


Fig (5): Comparing cleaning efficiency between traditional and new cleaning washing system using different types of washing sets.

**Effect of rubber liner as a source of bacteria:** if liner are gets older it starts to crack, and then the bacteria able to live in it and became protected from hot water and chemicals. The increasing in bacterial count is indication of the effectiveness of pre-milking udder preparation and the sterilization of milking equipment. According to (Murphy and Boor, 2007, Gleeson, 2009). as shown in Fig(6) the efficacy of cleaning in new rubber liner was ranged from 92.4% for jettors rod washing set to 64.4% for rubber cup set comparing to 78.7% for jettors rod washing set to 40.1% for rubber cup set. In old liner. Photo (8) shows cracks and contaminated milk residues inside old rubber liner. The results show the effect of more frequent use of rubber liner over the life span on the efficacy of cleaning and hygiene of milking equipment.

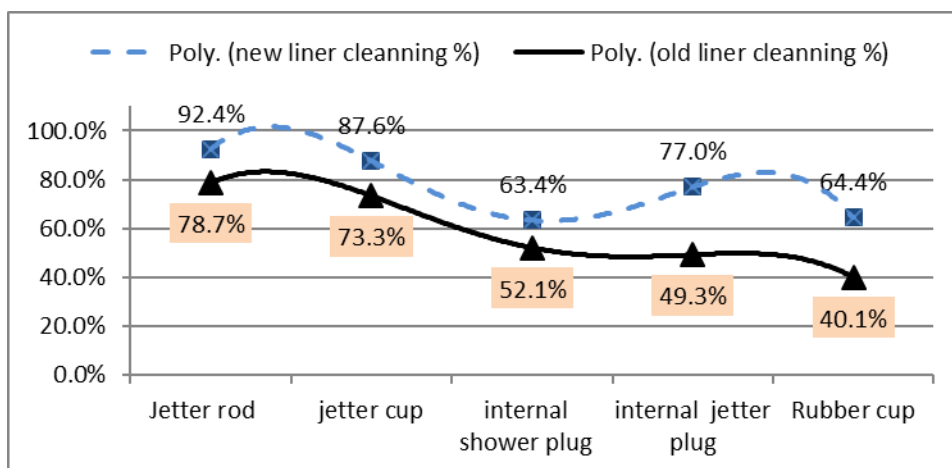


Fig (6): Effect of using rubber liner life time on the efficiency of the cleaning process with different types of washing set.



Photo (8) : A longitudinal section in a new and old rubber liner shows cracks and source of bacterial contamination inside old liner.

**Bulk tank milk samples analysis:** Samples were taken from teat cups and bulk tank milk ,As shown in Fig(7) total bacterial count in bulk milk tank performed with the colony forming units (cfu) for comparing the traditional cleaning washing system and the new cleaning washing system with different types of washing sets using old and new liner . For the traditional cleaning system the total bacterial count was  $104 \times 10^4$  cfu/ml and  $81 \times 10^4$  cfu/ml for old and new liner respectively. According to. ( Murphy 2008 ,Ugochukwu 2019) milk sample of old liner was classified at grade III ( $1.0 \times 10^6$  -  $2.0 \times 10^6$ ) and new liner sample was classified at grade II ( $< 2,00,000$  -  $1,000,000$ ) .while for the new cleaning system with different types of washing set total bacterial count was between  $55 \times 10^3$  to  $81 \times 10^3$  cfu/ml for old liner and between  $33 \times 10^3$  to  $63 \times 10^3$  cfu/ml for new liner . Milk samples for the new cleaning system classified at grade I ( $< 2,00,000$ ), as shown in Fig. (7).

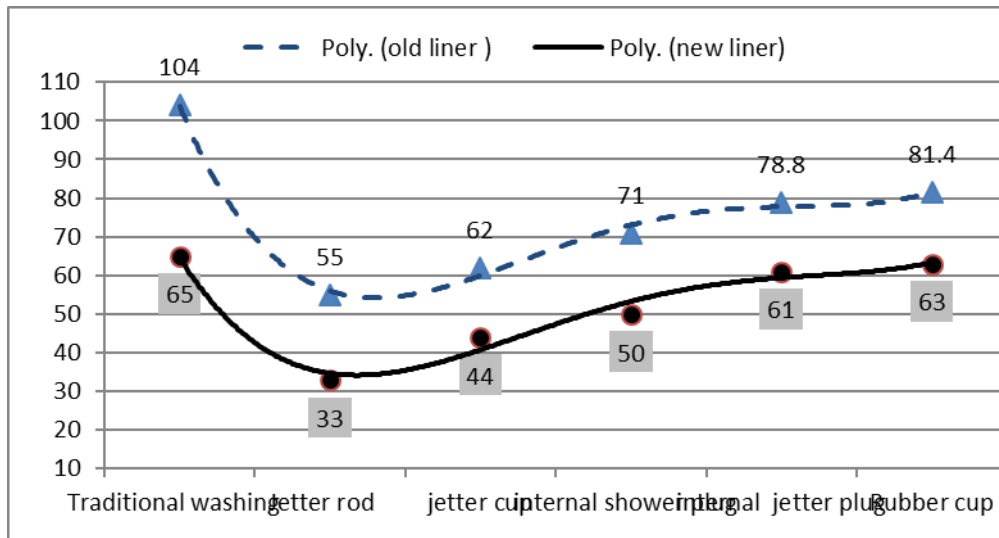


Fig (7): Bulk milk tank total bacterial count was performed with the colony forming units (cfu)  $1.0 \times 10^3$

## CONCLUSION

Using a new washing system for teat cups in bucket milking system and study the relationship between the efficiency and quality of the washing process in the milking system, and bacterial count found in milk tank and teat cup surface. The new washing system for cleaning is an alternative effective solution for washing liners and cluster. Washing units consists of two washing set, each washing set wash one cluster. During this study there are five types of washing sets have been tested. The results led to the provision of some environmental advantages, than traditional system such as; reducing the consumption of chemicals in cleaning of milking machine by about 35 %, also save 66 % of the amount of water consumed in cleaning, and saving 0.55 kw electric energy used to operate the pump; and 1.4 kw electric energy consumed in heating water. Time of cleaning operation was also saved by 50%. the cleaning. Efficiency in traditional cleaning method was 42.9 %. While its increased to 93.1 % with using a jetter rod at new cleaning system. For traditional cleaning system total bacterial count in milk sample was  $81 \times 10^4$  cfu/ml it classified at grade ii ( $> 2,00,000 - 1,000,000$  cfu/ml). While for the new cleaning system with different types of washing set the total bacterial count was between  $33 \times 10^3$  to  $66 \times 10^3$  cfu/ml. which classified at grade i ( $< 2,00,000$  cfu/ml).

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## الملخص العربي

### تصميم وتصنيع وحدة لغسيل كؤوس الحلب فى نظام الحلب ذو الأقساط وتأثير ذلك على جودة اللبن المنتج

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من المعلوم ان استهلاك طلمبة تفرغ الهواء فى عملية غسيل وحدات الحلب حوالى ساعه لغسيل لذا تم التفكير فى عمل نظام غسيل مستقل يستخدم طلمبة دفع مياه بدلاً من طلمبة تفرغ الهواء وذلك لتوفير قطع الغيار واستهلاك المياه وايضاً أداء افضل لعملية الغسيل حيث يتم الغسيل يدويا باستخدام قسط من الماء ويتحكم العامل فى عملية النظافة . ويهدف البحث الى تصميم وتصنيع نظام مستقل لغسيل مجمع اللبن فى نظام الحلب ذو الأقساط يعمل بنظام دفع الماء بمضخه وخزان للماء الساخن واخر للماء الدافى ويتم دفع الماء فى مخرجين كل مخرج متصل بوحدة غسيل بها اربعة مخارج لغسل كؤوس الحلب ويعلق مجمع اللبن على حامل مخصص لذلك ويتم ادخال وحدة الغسيل فى كؤوس الحلب. وتم اختبار خمسة اشكال مختلفه من وحدات الغسيل ويتم التحكم فى زمن الغسيل لضمان جودة عملية غسيل وتطهيركؤوس الحلب ويتم الحكم على جودة عملية الغسيل باخذ مسحات من الحلمات المطاط لكؤوس الحلب قبل وبعد الغسيل وعمل العد البكتيرى لكل مجموعة غسيل مختلفه فى النظام الجديد واخذ عينات من اللبن من تلك التجميع بعد الحلب وعمل عد بكتيرى لها للحكم على جودة اللبن .وتم اجراء الفحص للعينات فى معامل معهد بحوث التناسليات الحيوانية - قسم بحوث الضرع والنتاج .وقد اظهرت النتائج المتحصل عليها ان استخدام النظام الجديد فى غسيل كؤوس الحلب ادى إلى توفير بعض المزايا البيئية ، مقارنةً بالنظام التقليدي فى الغسيل مثل تقليل استهلاك المواد الكيميائية فى تنظيف ماكينة الحلب بنسبة 35% ، وتوفير 66% من كمية المياه المستهلكة فى التنظيف . و كذلك توفير 0.55 كيلو واط من الطاقة الكهربائية المستخدمة فى تشغيل المضخة و 1.4 كيلو واط من الطاقة الكهربائية المستهلكة فى تسخين المياه . اما الوقت المستهلك فى عملية الغسيل فقد تم توفير 50 % من زمن الغسيل بالجهاز الجديد مقارنة بالزمن المستهلك فى طريقة النظافة التقليديه . من خلال عملية العد البكتيرى تم الحكم على مدى نظافة الحلمات المطاط حيث بلغت كفاءة النظافة لكؤوس الحلب فى الطريقة التقليدية 42.9% ، بينما تراوحت كفاءة النظافة ما بين 61,2% الى 93.1 % مع استخدام وحدات الغسيل المختلفه لكؤوس الحلب فى النظام الجديد .وكانت نتائج تحليل عينات العد البكتيرى للبن فى طريقة الغسيل التقليديه 810 الف وحده بكتيريه فى واحد مليلتر و تم تصنيف عينات اللبن بانه من الفئة الثانية (يتراوح العد لبكتيرى لهذه الفئة بين 200 الف ومليون وحده بكتيريه فى واحد مليلتر) اما فى طريقة الغسيل بالجهاز الجديد فقد كانت عينات العد البكتيرى للبن تتراوح بين 33الف و66الف وحده بكتيريه فى واحد مليلتر و تم تصنيف عينات اللبن بانه من الفئة الاولى (يتراوح العد لبكتيرى لهذه الفئة اقل من 200 الف وحده بكتيريه فى واحد مليلتر) . لذلك فقد ادى استخدام الجهاز الجديد الى مميزات بيئية وصحية مقارنة بالطريقة التقليديه فى غسيل ماكينات الحلب ذو الاقساط.