

**EFFECT OF DIFFERENT DOSES OF OXYTOCIN
ADMINISTRATION ON LET-DOWN TIME AND
COMPOSITION OF MILK IN BUFFALOES**

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A decorative border of asterisks surrounds the text. The border consists of a top row, a bottom row, and two vertical side rows, all made of small, stylized asterisks.

DEDICATED TO

MY PARENTS

BROTHERS

AND

SISTERS


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This is to certify that the thesis entitled "EFFECT OF DIFFERENT DOSES OF OXYTOCIN ADMINISTRATION ON LET-DOWN TIME AND COMPOSITION OF MILK IN BUFFALOES" submitted by MR. VIJAI PRAKASH MAURYA in partial fulfilment of the requirement for the Award of the MASTER OF SCIENCE IN DAIRYING (ANIMAL PHYSIOLOGY) of the National Dairy Research Institute (Deemed University), Karnal (Haryana), India, is a bonafide research work carried out by him under my supervision and guidance and no part of the thesis has been submitted for any other degree or diploma.

Dated: 4th June 1990.


(R.S. LUDRI)
GUIDE

It is said that :-

* BEFORE YOU CAN SOLVE A PROBLEM YOU MUST
FIRST UNDERSTAND IT *

However, my experience with this work has shown that the moment you start understanding a problem, new challenges appear which create further new problems and make scientific research a never ending, thrilling and exciting path.

This way it is better to say :-

* AFTER YOU SOLVE A PROBLEM BE PREPARED
TO FACE MANY MORE *

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" All the grace of God cannot be acknowledged "


3.6.90
Vijai Prakash Maurya

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LIST OF ABBREVIATIONS USED IN THE TEXT

ANOVA	=	Analysis of variance
d.f.	=	Degree of freedom
P	=	Probability
\pm	=	Standard error
%	=	per cent
min.	=	minute
sec.	=	Second
hr.	=	hour
mg.	=	milligramme
g.	=	gramme
kg	=	Kilogramme
IU	=	International unit
Meq	=	Milli equivalent
Na ⁺	=	Sodium
K ⁺	=	Potassium
Cl ⁻	=	Chloride
l	=	litre
Anon.	=	Anonymous
S.No.	=	Serial number
mu	=	Milli unit

INTRODUCTION

According to the neurohormonal theory of milk ejection proposed by Ely and Petersen in 1941, the nervous stimulus as a result of palpation of teat and suckling reaches the central nervous system and causes the posterior pituitary to release oxytocin into the blood stream. The oxytocin through blood causes the contraction of myoepithelial cells surrounding the alveoli and thus forces the milk from the alveoli down into the ducts and gland cistern. This results in a let-down of milk which can be easily removed by applying a suitable milking method. During the process of milking all the milk present in the udder cannot be removed. The milk left in the udder after a normal milking is generally referred to as "residual milk". The amount of residual milk is constant for an individual animal and hence can be a suitable indicator of the completeness of milking.

It has been reported that buffaloes generally take more time for milk let-down (Aliev, 1969; Gupta et al, 1974; Gangwar, 1976 and Ludri, 1980) than the cows (Lohr and Troger, 1977). The problem of delayed milk let-down in buffaloes sometimes is so acute that it results in complete failure of milk let-down in some of the cases. Under such circumstances the animals

are milked with the help of oxytocin. Exogenous oxytocin when administered to cows (Wheelock et al., 1965) and goats (Linzell and Peaker, 1971) results in significant changes in the composition of milk, where, lactose and potassium decrease and sodium and chloride increase.

Literature on the effect of dose level of oxytocin on milk let-down and milk composition in cows is plenty but barring a few reports on milk let-down and milking time in buffaloes (Thind and Gangwar, 1974; Gangwar and Gupta, 1975), no information on the effect of different doses of oxytocin on composition of milk is available.

The present investigations were planned with a view to study the effect of different doses of synthetic oxytocin on the milk let-down response, milking rate and milk composition. Since buffalo is a nervous animal, the injections of oxytocin were given intramuscularly to avoid unnecessary stress on the animal at the time of milking. The results of these studies are expected to yield information of practical utility to the dairy farmers as well as basic information on the compositional aspect of milk.

REVIEW OF LITERATURE

Milk let-down time

Major portion of milk present in the udder comes out from the alveoli and small ducts by the activation of a neurohormonal reflex. Ely and Petersen (1941) were perhaps the first to report that letting down of milk was caused by increased intramammary pressure in the presence of blood oxytocin, which was responsible for the contraction of myoepithelial cells, surrounding the alveoli. The failure in let-down was due to the presence of adrenaline in the blood which prevents the muscle contraction. The "letting down" of milk by a cow is more or less conditioned by the milker, the environment and the manner in which a cow was milked (Kenneth and Petersen, 1941). They also reported that a change in routine cause decrease in milk production. Manipulation of udder by washing or stripping for 20 minutes before the beginning of milking caused an appreciable decrease in milk and specially fat production due to incomplete let-down.

Bilek and Dalezalek (1954) emphasized the need for the preparation of udder where they noticed that the washing of udder by warm water for 2 minute before milking and 1 minute before stripping cause a significant increase in milk yield and butter fat percentage.

Aliev (1969) demonstrated that the latent period of the reflex in buffaloes was longer than the cows. In buffaloes average latent period was varying from 2 minute to 6 minute under normal milking conditions. Moreover, he also indicated that factor which increased the milk yield, shortened the latent period of milk ejection leading to complete evacuation of udder. Aliev (1970) further reported that the massage of the teats and washing of the udder with warm water gives satisfactory results. Change in environmental condition causes an anti effect on milk ejection in buffaloes (Aliev 1971).

Gupta et al. (1974) observed that the early and late weaned buffaloes take 133 - 172.5 and 84.6 - 100 seconds, respectively for average milk ejection. In variation of milk ejection time, the milker also has an appreciable contribution. Dash et al. (1976) indicated that milk ejection time increased alongwith an increase in temperament score in buffaloes. This increase was at the rate of 24.41 seconds for one point increase in the temperament score. Gupta and Mishra (1979) also reported a significant correlation of 0.79 between temperament score and let-down time.

Gangwar (1976) divided 15 murrah buffaloes in 3 groups viz; group I (47 days-early), group II (99 days-middle) and group III (241 days- late), which were milked by an expert milker for a period of 15 days. The management and feeding practice was same for all animals. He concluded that there was a significant increase in the let-down time with the increase in the stage of lactation and the lowest let-down time was obtained in group I (94.9 seconds). All 3 groups were having an average let-down time of 94.9, 98.60 and 135.29 seconds respectively. Contrary to these findings Ludri (1980) did not find any effect of stage of lactation on milk let-down time.

Lohr and Troger (1977) studied the let-down time in 486 German Black Pied cows and reported the average milk let-down time as 1.05 minute (0.33- 2.56 minute). In 85 per cent cases, the let-down time was found to be not more than 1.20 minutes. The let-down time was observed to be not significantly influenced by stimulation method, age of the cow and time of milking.

Bilek and Janovsky (1956) emphasized their research on the dose effect of oxytocin on let-down time. They injected 0.05 IU oxytocin intravenously in cows and obtained slight decrease in the latent period. By increasing the dose of oxytocin from 0.05 to 2.0 IU, the let-

down time was decreased. In support of their findings, Donker (1958) demonstrated that 0.12 to 0.25 IU oxytocin caused normal ejection but 10 IU were more effective. Injection of 0.001 to 0.01 oxytocin caused milk ejection, as measured by intramammary pressure, in amounts similar to those observed in udder massage (Martinet and Denamur, 1960).

Sagi et al. (1980) observed intravenous injection of 0.1 IU oxytocin induced an effective milk ejection in Holstein cows. Barowicz and Grega (1982) indicated that let-down time depends upon the strength of the oxytocin doses. They injected different doses of oxytocin viz. 0.05, 0.1 and 0.20 IU and concluded that 2.0 IU was more effective in cows.

Chandiramani et al. (1968) described 4 cases, in which short term or continuous intramuscular injection of oxytocin was successful in stimulating milk ejection and in continuing the lactation of different Murrah buffaloes. A minimum dose of 10 IU oxytocin for once daily milking was found to be more adequate.

Caruolo (1971) reported that milk production response of exogenous oxytocin injection is dependent both on amount of oxytocin administered and intensity of the suckling.

Thind and Gangwar (1974) injected 20 IU oxytocin in murrah buffaloes and obtained less milk let-down time than the controls.

Milking time and Milking rate

Time taken from initiation of milking to complete removal of milk from the udder is known as milking time.

Gangwar and Gupta (1975) carried out an experiment on 48 buffaloes ranging in lactation from 1 - 9. They divided the buffaloes in 3 groups of 16 each viz. early weaned (34 days after calving), late (7-9 months after calving) and unweaned. Milking time in early weaned group was highest (423.35 sec.) with very wide range (209.7 - 829.7 sec.). They concluded that weaning significantly increases the milking time in buffaloes.

Jurco and Frtus (1975) reported that the udder preparation directly affects milking time. In their experiment Czech Pied cows from a herd were milked twice daily at 12 hr. interval using 60 sec., 40 sec. and 20 sec. udder preparation period or no preparation. The milking times were 221, 241, 250 and 267 seconds, respectively.

Morag (1968) injected 5 IU of oxytocin in ewes before milking and observed that milking time of oxytocin treated ewe was less than the controls.

Thind and Gangwar (1974) reported that 12.5 IU oxytocin when injected intramuscularly in buffaloes, influenced milking time. The minimum milking period in control animals was 557 sec. and in oxytocin treated buffaloes it was 109.6 sec. In support to the above findings Sagi and Gorewit (1980) injected 0.3 IU oxytocin in lactating cows intravenously and observed shorter milking times (4.6 - 5.6 min.), which had no significant effect on milk yield.

Weinmann (1972) while experimenting on ninety-five cows revealed that at mean milk yield of 10.11 l and mean duration of milking 11.5 min. the average yield per minute was 0.97 l and mean maximum yield/min. was 1.41 l. The correlation coefficients (r) between average yield/min. and maximum yield / min. were 0.520, 0.758 and 0.681 respectively.

Solovev and Lanavskaya (1974) reported that milk yield and milking rate had a significant correlation. For hundred Russian cows, yield at the morning, mid day and afternoon milking 2nd, 3rd month of lactation was averaged 5.47, 4.13 and 3.19 kg and milking rate 1.73,

1.47 and 1.23 kg/min. The correlation coefficient between milk yield and milking rate at 3 month time were 0.47, 0.40 and 0.35 respectively.

Danilchenko (1978) took forty Russian Simmental cows and divided them in 2 groups. One group was milked twice and other was milked thrice daily. Average milk yield for 1st group was 4.8 kg for first milking, 4.4 for second milking while for second group it was 3.8, 3.0 and 2.5, respectively. Milking rate for first group was 1.1 and 0.9 kg/min. for second group it was 0.8, 0.6 and 0.5 kg/min. Correlation between daily milk and milking rate was 0.87 and 0.73 which was greatly significant. In support to the above finding Swaid (1980) observed milking rates in the range of 1.00 to 1.32 kg/min. in 85 cross bred cows.

Intra jugular injection of 20 IU oxytocin immediately before milking did not affect the rate of milk flow of slow milking cows but resulted in increase in the rate of flow in some fast milking cows. However, treatment changes were small compared with difference in rate of flow between cows (Hupp et al , 1959).

Sagi et al.(1980) injected different doses of oxytocin (0.02, 0.05, 0.10 and 0.30 IU) intravenously to see the milk flow rate. Regarding variation in doses

there was much fluctuation in milk flow, however, he found 0.30 IU to be more effective.

Residual milk and its fat percentage

Gerster (1977) reported that the mode of administration of oxytocin (intramuscular Vs subcutaneous) had no significant effect on the amount of residual milk. On the basis of literature and experimental results he obtained, it was concluded that residual milk is a useful guide for assessing the degree of milking out.

While working on crossbred cows and buffaloes Hanna et al.(1979) indicated that method of oxytocin administration had no effect on the yields of residual milk or its chemical composition. In both species residual milk yield was not affected by milking time. Fat percentage of residual milk was higher than in normal milk.

Gore, et al and Sagi (1984) injected five doses of oxytocin via 0.5 IU, 1.0 IU, 1.5 IU, 2.0 IU and 3.0 IU subcutaneously in Holstein Friesian cows, one minute before machine attachment. After removal of normal milk 10.0 IU of oxytocin were given via milk vein for measurement of residual milk. An additional 10.0 IU of oxytocin was given fifteen minutes later for estimation of residual milk. Finally, they reported that milk yield was slightly

higher for cows receiving 2.0 IU and 3.0 IU due to reduction in residual milk.

Injection of oxytocin increases the fat percentage of residual milk (Adams and Allen, 1948), Johansson(1949) injected heifers, second to third lactation cows and fourth to seventh lactation cows with 50 IU of oxytocin after normal milking and milked again one to two minute following the injection. The average quantity of residual milk obtained per cow in the respective groups were 0.67, 1.01 and 1.29 kg with the average fat percentages of residual milk being 11.12, 13.06 and 12.76 respectively.

While working on Friesian and Jersey cows, Swanson and Hinton (1951) observed that intra-jugular injection of one ml of pitocin had increased the residual milk. The average of all the residual milking was 3.85 lb milk containing 14.75 per cent butter fat but comparatively Jersey breed was having high percentage of butter fat.

Donker et al.(1952) did their experiment on monozygous twin heifers. They were brought to normal in the second lactation by intravenous injections of oxytocin after each milking to obtain the residual milk.

The butter fat contents of the regular and residual milks were 1.23 and 6.56 per cent respectively.

Koshi and Petersen (1955) injected 10 IU oxytocin intravenously in cows just after machine milking and milked out after ten minutes. The mean yield of residual milk was 1.7 lb (range 0.1- 13.3 lb) and its percentage of the total yield (percentage residual milk) was 11.3 (range 1.2-70.9) and its butter fat content 13.2 per cent (range 5.1- 22.5%).

Moreover, Velitok (1963) reported that in cows average fat content of residual milk was 10.02 % ranging from 3-19.8 %. Daily injection of oxytocin for five days brought an average increase of 6.6 % in milk yield and 0.6 to 0.8 % in fat content.

Natzke and Schultz (1967) administered 10 IU oxytocin in cows and observed that fat was higher ($P < .01$) in residual milk than in normal milk and supported a positive correlation ($P < .01$) between the normal and residual milk.

Carroll et al. (1968) reported that after normal milking, intravenous injection of 10 IU oxytocin gives rise to a significant increase in residual milk yield

in cows. Average values of residual milk in the oxytocin treated and control group was 28.2% and 14.7%.

Anderson et al. (1968) injected 20 IU oxytocin subcutaneously to obtain residual milk. Milking time for the residual milk was standardized to five minutes. The residual milk and percent residual milk had increased when delay time was more than five minutes. The average percent residual milk for cows was 16.8% and was higher in low producer than in medium producer. Oxytocin treated residual milk was also having an increased value of fat percentage.

Ludri et al. (1982) injected 10 IU oxytocin intravenously in eighteen sahiwal and thirty six Brown Swiss x Sahiwal cross breeds during peak lactation. Cows were hand milked at 6.00, 12.00 and 19.00 hrs. In Sahiwals and crossbreds with daily milk yield of approximately eight and fourteen kg, residual milk averaged 17.54, 8.8 and 10.21 % of total yield respectively. In all females the amount but not the percentage of residual milk was correlated with total yield (0.38-0.59). The amount and percentage of residual milk were independent of the yield of alveolar milk. There was no correlation between the percentage of residual milk and milk let-down time.

The rate of milk secretion was significantly lower in the morning than at mid-day or evening.

Al-aggam and Hassan (1983) demonstrated that 20 IU oxytocin injection showed a significant increase in residual milk yield and fat percentage.

Effect of Oxytocin injection on Fat content of normal milk

In Murrah buffaloes (Parekh and Gangwar, 1968) average fat content of normal milk was in the range of 6.53 to 7.70 %. But according to Albonica et al. (1969) it reached to 8.55 % by thirty first day of lactation.

Jurco and Frtus (1975) milked Czech Pied cows twice daily at 12 hr. interval using 60 seconds, 40 seconds and 20 seconds udder preparation and no preparation. The milk fat percentage was 3.63, 3.56, 3.58 and 3.56 % respectively.

Dalaly et al. (1976) analysed buffalo milk samples collected from a private herd within the mousel area and observed that average fat percentage was 8.28 %.

Dash et al. (1978) reported that fat percentage of normal milk of Haryana cattle was 5.33 ± 0.12 % .
Soni et al. (1980) studied the effect of environmental cooling on fat percentage in buffalo milk. Forty five

normal lactating buffaloes were grouped into group I (control), Group-II (shower) and Group-III (wallowing). It was conducted in May-June as period I (hot and dry) and July-September as period II (hot and humid). The average value of fat percentage were 7.59, 7.65, 7.43, 7.98 and 7.70 respectively.

Sprain et al. (1952) injected 10 IU oxytocin to cows for alternate fourteen days intervals through out lactation. The butter fat content of oxytocin treated milk was 0.25 per cent higher than normal one. Further Donker et al. (1954) studied the effect of oxytocin on milk production and fat percentage in milk. They took one set of identical twin cows. One mate was used as a control while oxytocin was administered to the other in amounts varying from 3.0 to 1.5 IU per injection just after normal milking. The residual milk was removed. The experimental animal produced 5.7% more milk and 5.6% more butter fat compared to her mate. In contradiction to his own findings further, in 1958, he reported that oxytocin treatment was not having any effect on fat content of milk.

In support of Donker's findings Jurco (1967), injected 10 IU oxytocin in cows but did not observe any

significant change in fat percentage in oxytocin treated milk. Hynek and Coufalikova-Hatleova (1968) reported that intravenous injection of 10 IU oxytocin had a significant change in fat content of the milk. The average fat content of normal and experimental milk was 1.6 -3.7% Vs 5.7-15.4 %.

Lane et al.(1970) indicated that four successive intravenous injections of 20 IU oxytocin at twenty minute interval gave more fluctuation in fat contents. Milk fat percent increased through the first oxytocin treated sample and then decreased to approximately the fat content of milk obtained by normal milking process.

Graf et al.(1973) reported that oxytocin injection cause an adverse effect on fat content of milk, that is, fat content was decreased.

Sagi et al.(1980) injected 0.02, 0.05, 0.10 and 0.30 IU of oxytocin and demonstrated that 0.10 and 0.30 IU of oxytocin was comparatively more effective for increasing the fat content of milk. While working on cows Hodgson et al.(1985) injected 50 IU oxytocin intramuscularly. The oxytocin significantly increased fat percentage.

Ludri and Singh (1987) studied the effect of 10 IU oxytocin on milk fat yield. They reported that milk fat yield was 0.35 ± 0.01 and 0.38 ± 0.03 kg in control and oxytocin treated groups.

Lactose

Albonica et al. (1969) reported that in buffaloes which were loose housed and fed on a balanced diet the average lactose concentration was 4.4%. Dalaly et al. (1976) collected milk samples from forty-nine individual buffaloes of a private herd and estimated milk lactose. They reported an average value of 5.17%. Similarly Akhundov and Farzalieva (1979) obtained a value of 4.95% for lactose in buffalo milk.

Ponce and Bell (1984) stated that lactose concentration in the milk of Holstein Friesian cows was 4.80 ± 0.15 g/100 ml. According to them lactose and sodium were having negative correlations.

Wheelock et al. (1965) reported that after the injection of oxytocin and removal of residual milk, the milk obtained at next milking had decreased content of lactose. They suggested that the decrease in lactose content was due to a direct effect of oxytocin on the

permeability of mammary epithelium. Linzell (1967) did his experiment on fed and fasted goat and injected 50-400 mu oxytocin prior to each milking for complete milk removal. After analysis of oxytocin treated sample he got less percentage of lactose than in normal. Further, he injected (2500 mu) and observed proportionally more decrease in lactose content. Thereafter, in support of these findings Linzell and Peaker (1971) reported a broad spectrum view about the permeability of lactose through alveolar membrane. A subsequent injection of 50-100 mu oxytocin intravenously in goats and milked them hourly got more or less same change in lactose content. Deshmukh (1985) reported that in crossbred cows 10 IU of oxytocin when administered intravenously resulted in decreased SNF and lactose content of milk.

In contradiction to above reports, Swanson and Claycomb (1968) stated that 5 IU oxytocin injection did not cause any change in lactose concentration. They (Swanson and Claycomb, 1969) reported similar effects of oxytocin in other study also of Holstein Friesian cows.

Sodium

Linzell (1967) studied the normal concentration of sodium in milk of fed and fasted goats and reported

that values were 18 ± 1.5 meq/l and 17 ± 2.0 meq/l, respectively.

Albonica et al. (1969) did their experiment on buffaloes which were loose housed and fed a balanced diet. They reported that on an average the sodium content in milk was 45 mg/100 ml.

Saavedra et al. (1979) took monthly milk samples from nineteen red and white and black and white Holstein Friesian cows in first lactation. The normal sodium concentration was 47.5 mg/100 ml. Ponce and Bell (1984) observed sodium content as 57.7 ± 0.33 mg/100 ml in Holstein Friesian and Zebu breeds.

Larsen and Werner (1984) analysed whole milk and skim milk and obtained the sodium content in the range of 0.042-0.046 %. Wheelock et al. (1965) reported that injection of oxytocin had a considerable change in sodium content of milk in the range of 46.9 to 74.8 mg/100 ml. Thereafter, they demonstrated that there was fluctuation in sodium content in different quarters of the udder. The increase in sodium content was due to an increase in permeability of mammary epithelium.

Barry and Rowland (1953) observed that the increase in sodium concentration occurred due to an increase in entry of a transudate from blood plasma.

Linzell (1967) injected 50 -400 mu oxytocin in goats prior to each milking for the complete removal of milk. Further, he injected 2500 mu oxytocin which resulted in more increase in sodium concentration. Thereafter, in support of their own findings, Linzell and Peaker (1971) injected 50-100 mu oxytocin in goats and got similar results as in previous experiment.

Swanson and Claycomb (1968) took eleven pairs of Holstein dry cows and injected 5 IU oxytocin intravenously twice daily until parturition and reported no change in sodium content of the milk from treated cows.

Potassium

Albonica et al. (1969) took buffaloes which were loose housed and fed through out lactation on silage of Oats, Maize and Lucerne. The average potassium concentration of different samples was 139 mg/100 ml.

Sindhu and Roy (1974) reported that in buffaloes potassium level in milk ranged from 78 to 88 mg/100 ml. In support of their own findings Sindhu and Roy (1976) further reported a value of 94.71 mg/100 ml for potassium in normal buffalo milk.

Ponce and Bell (1984) determined the potassium content of milk in Holstein Friesian, Zebu and Crossbreds. During a four year period potassium was determined in monthly individual milk samples. Potassium content in 3/4 HF x 1/4 Z cows was 166.1 ± 0.85 mg/100 ml. They correlated to potassium with different other milk constituents and observed that there was positive correlation between lactose and potassium.

Zaks et al., (1965) reported that a significant decrease in potassium content occurred on frequent milking and was characteristic of freshly secreted alveolar milk. These changes were more affective when very large dose of oxytocin was given.

Wheelock et al., (1965) demonstrated that administration of oxytocin decreases the potassium concentration in milk but the decrease was very less in comparison to lactose. They also observed that when residual milk was removed from right fore quarter only in second milking right hind was having more potassium content than right fore quarter. The decrease in potassium content was due to the decrease in permeability of potassium from blood plasma to mammary gland.

Linzell (1967) while working on goats reported that decrease in potassium content in milk depends on the strength of doses of oxytocin. Injection of 50-400 mu oxytocin prior to each milking caused a decrease in potassium concentration in milk than in normal milk. In support of their own findings Linzell and Peaker (1971) administered 50-100 mu oxytocin in goat intravenously and observed decrease in potassium content.

Chloride

Konrad et al., (1969) reported that average chloride content in cow milk was 152.2 mg per 100 ml. Davide and Domingo (1971) observed that chloride concentration in Carabao milk was in range of 64.60- 107.6 mg/100 ml. Roy and Yadav (1972) estimated chloride content in cows milk and reported a value of 99.28 ± 0.53 mg per cent.

Alhonica et al., (1969) reported that in six lactating buffaloes the chloride content in milk was 71 mg/100 ml. Sindhu and Roy (1976) obtained 98.86 mg/100 ml chloride in buffalo milk. Larsen and Werner (1984) stated that chloride concentration in skim and whole milk was 0.088 - 0.097 %.

Barakat et al., (1969) determined the chloride content of fifty individual milk samples of buffalo, goat and human and thirty individual samples of cow.

After analysis they found that different milk samples of cow, buffalo, goat and human were having a mean chloride percentage of 0.1055 ± 0.015 , 0.0657 ± 0.006 , 0.1717 ± 0.019 and 0.0421 ± 0.011 respectively. With the help of "t" test they further reported that buffalo milk was having lower mean chloride content than cows milk whereas human milk showed lowest mean chloride content comparatively.

Wheelock et al. (1965) injected 20 IU oxytocin in cows for the removal of residual milk. They analysed the milk in the next milking and got an increase in the content of chloride. They further suggested that increase in chloride content was due to the direct effect of oxytocin on the permeability of mammary epithelium. While working on cows Natzke and Schultz (1967) determined the cows milk composition in mastitis screening test. The test sample had a significant increase in chloride percentage ($P < 0.01$).

Linzell (1967) emphasized on different doses of oxytocin. In his experiment he took fed and fasted goats and injected 50-400 mu oxytocin prior to each milking for the removal of complete milk. He observed an increase in chloride content. Upon further administering 2500 mu oxytocin to see the effect of higher

doses on milk composition and got very less variation in chloride content. Thereafter, Linzell and Peaker(1971) gave 50-100 mu of oxytocin intravenously in goats and reported that there was a significant increase in chloride concentration. Even 20 mu oxytocin was capable of causing change in milk composition, however, the change was not very significant.

Swanson and Claycomb (1968) injected 5 IU oxytocin intravenously in eleven pairs of Holstein cows. They analysed the milk but there was no change in milk composition.

MATERIAL AND METHODS

Selection of Animals

Twenty lactating Murrah buffaloes were selected from the institute's herd. Prior to the experiment the buffaloes had completed 46 to 193 days in lactation and were on an average in 132 days of lactation. Previous week's average milk production before the start of experiment was 9.1 kg which in different animals ranged from 4.4 to 13.0 kg. The details of experimental buffaloes are given below:

Sl. No.	Animal number	No. of lactation	Days in lactation at the start of experiment	Previous week's average milk yield(kg)
1.	377	8	149	4.4
2.	2203	6	127	9.4
3.	2312	6	156	8.6
4.	2329	4	169	7.0
5.	2434	5	135	7.8
6.	2465	5	156	6.8
7.	2701	4	77	13.0
8.	2702	3	147	11.6
9.	2829	3	193	11.0
10.	2839	2	152	9.3
11.	2877	3	90	6.7
12.	2886	2	186	8.3
13.	2930	2	107	8.5
14.	2941	2	83	12.3
15.	2966	2	171	8.1
16.	2992	2	130	10.5
17.	3011	2	75	10.5
18.	3054	2	145	10.5
19.	3072	2	142	8.2
20.	3097	2	46	9.7

Experimental design and Treatments

In replicated 4 block 5 x 5 Latin Square Design experiments involving switch over, the buffaloes were randomly distributed to 5 different treatments. Administration of no oxytocin, 1 IU, 3 IU, 5 IU and 10 IU of oxytocin constituted the experimental treatments, T-1, T-2, T-3, T-4 and T-5, respectively. The requisite quantity of oxytocin (Sigma Chemical Co., USA) dissolved in 1 ml sterile saline solution was intramuscularly administered in the gluteal region followed by hand milking. Thereafter, 10 IU oxytocin was intramuscularly administered following each milking and remilking the animal after 1.5 to 2 min. to remove the residual milk left in the udder after normal milking. The observations were always taken during evening milking. To overcome the effect of previous treatment an interval of 48 hours was given in between each treatment assigned to individual buffalo. Milk let-down time was recorded as the time taken from the start of massage of the teats and udder till the milk from alveolar cavities was let-down in the cistern of the quarter as judged by the engorgement of udder and teats.

Milking time was recorded as the time taken from the start of milking till the buffaloes were milked dry. Average milking rates were calculated after dividing the yield of milk by the time spent on milking including strippings.

Management of Animals

The buffaloes were housed under asbestos roofing with sides open and were individually fed in stalls. They were fed on a ration of green oats (Avena Sativa) and berseem (Trifolium alexandrium) fodder and concentrate mixture. The green offered was ad. libitum but the amount of concentrate mixture fed to individual buffalo was based on their milk production as practised in the institute's herd. The concentrate mixture was fed at the time of milking. Free choice fresh tapwater to all the buffaloes was offered twice daily at 9.00 AM and 3.00 PM. The buffaloes were hand milked at 5.30 AM and 5.30 PM by the expert milker and the quantities of milk from individual buffalo at each milking weighed upto the nearest of 50 g.

Representative samples of normal and residual milk were brought to the laboratory for analysis. Fat on fresh 10.75 ml milk samples (Pruthi and Bhalerao, 1968) was estimated by Gerber's (ISI, 1958) method. For the estimation of lactose, sodium (Na^+), Potassium (K^+) and Chloride (Cl^-), the milk samples were stored in freezer at -20°C till analysis. Lactose in milk was estimated by the volumetric method of Lane-Eynon (Anon, 1972).

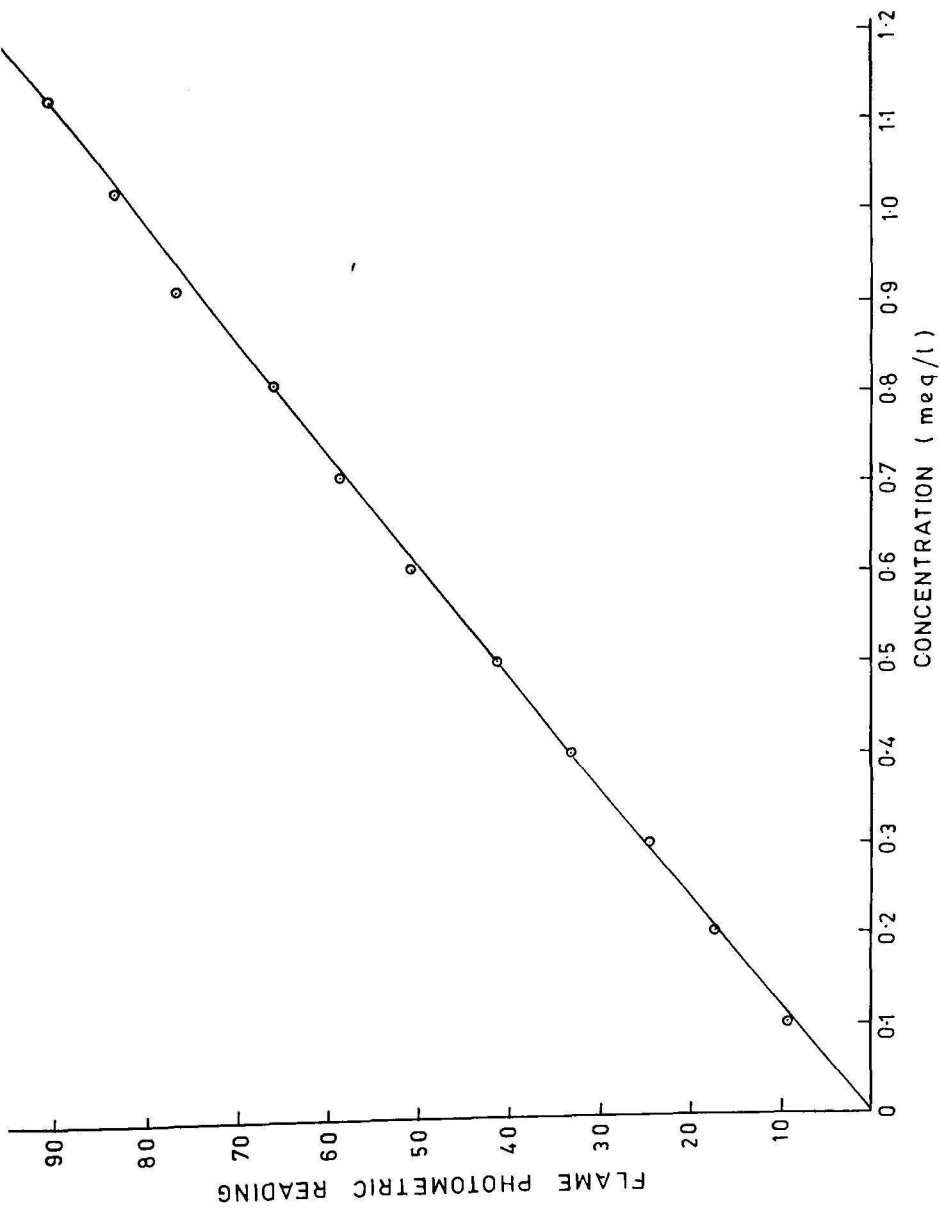


FIG. 1. STANDARD CURVE FOR SODIUM

Sodium and Potassium in milk were estimated flame photometrically according to the method of Have and Mulder (1957). For the estimation of K^+ and Na^+ milk samples were diluted with distilled water in 1:48 and 1:24 ratios, respectively. For the preparation of standard curve, stock solution for the electrolytes was prepared by dissolving 0.7456g and 0.5844g of potassium chloride and sodium chloride (BDH, Analar) respectively in a litre of double glass distilled water. Working standards of electrolytes ranging from 0.1 to 1.2 meq/l at an interval of 0.1 meq were prepared by diluting 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 ml of the stock solution in 100 ml of distilled water. Standards were read in a systronics digital flame photometer model-121 at a constant air pressure of 0.5 kg/cm^2 using indane gas as a source of fuel. First the appropriate filter (Sodium and Potassium) were set in place and the instrument was set to read zero and 100, respectively for distilled water and the standard solution containing 1.2 meq. Subsequently, the rest of the standards were read in the descending order of concentration.

The Flame Photometric readings against the concentrations (meq/l) for Na^+ have been graphically presented in Fig.-I, and for K^+ in Fig.-2. Concentrations of (Na^+) and (K^+) in milk were calculated using

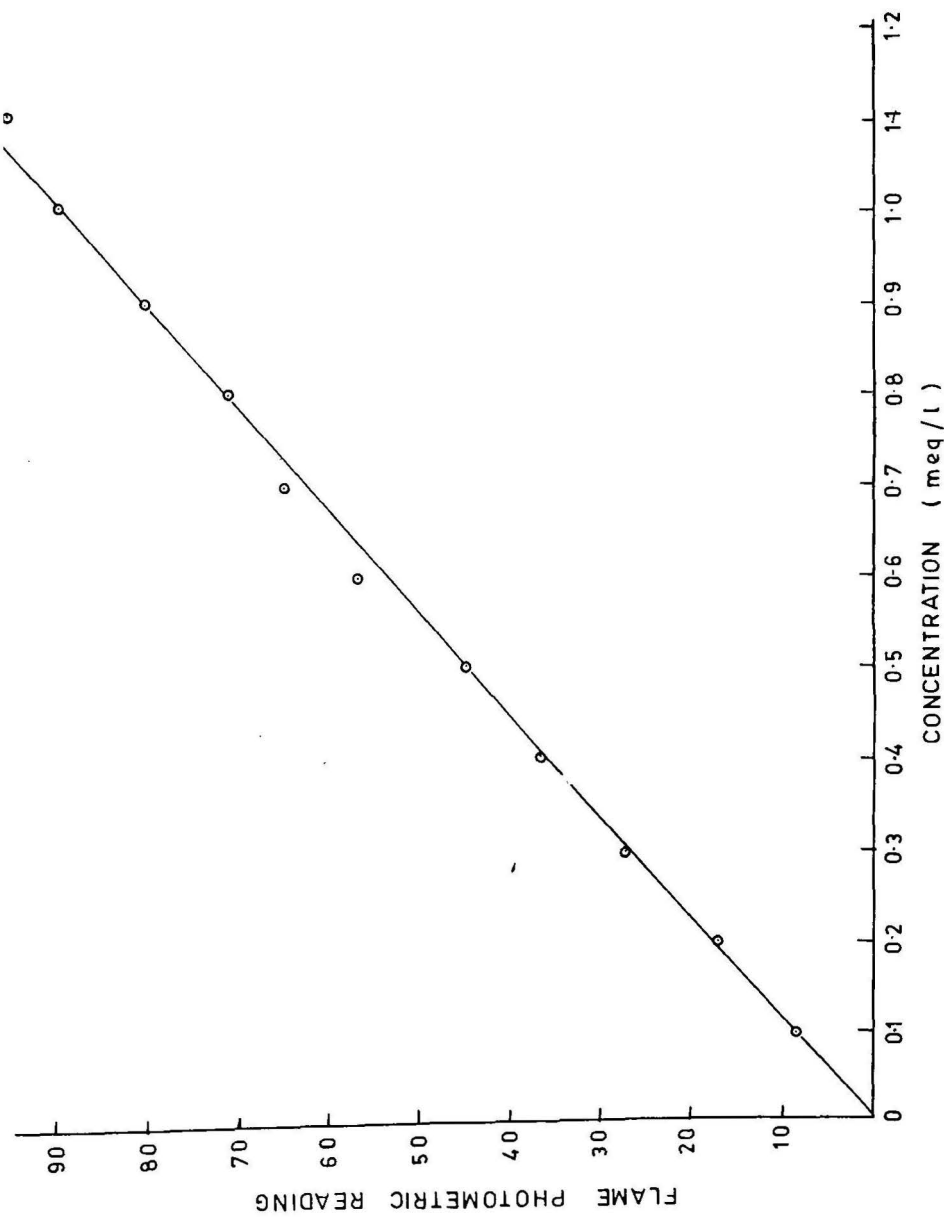


FIG. 2. STANDARD CURVE FOR POTASSIUM

these graphs and were presented as mg/100 ml. Chloride content of milk was estimated according to Anon(1964).

Statistical analysis of data was done according to Snedecor and Cochran(1967). For significant differences, the treatment averages were compared by Duncan's Multiple Range test. Values of fat, lactose, Na^+ , K^+ and Cl^- in normal and residual milk were compared by Paired 't' test.

RESULTS

Milk let-down time, milking time and milking rate

The data on the effect of different doses of oxytocin administration on milk let-down time, milking time and milking rates have been presented in Table-1 and the ANOVA of complete data in Table-2. A perusal of data indicates that milk let-down times decreased as the amount of oxytocin administered increased. As compared to T-1, where, no oxytocin was administered, the milk let-down time was significantly decreased ($P < 0.01$) when 5 and 10 IU of oxytocin was administered. However, the decrease in milk let-down times under T-2 and T-3 were not significant. The respective values of milk let-down times under T-1, T-2, T-3, T-4 and T-5 were 196, 186, 154, 131 and 79 seconds.

The time spent on milking individual buffalo on an average was 471, 478, 492, 435 and 436 seconds under T-1, T-2, T-3, T-4 and T-5 respectively. The differences in milking times under different treatments were not statistically significant.

The milking rates under T-1, T-2, T-3, T-4 and T-5 were 0.66, 0.63, 0.60, 0.68 and 0.71 kg/min., respectively. Compared to T-1, the changes in the milking rates under different treatments were not statistically

significant. But, the differences between 3 and 10 IU injections were statistically significant.

Yield of normal milk, residual milk, total milk and percent residual milk

The yields of milk obtained at normal milking under T-1, T-2, T-3, T-4 and T-5 were 5.18, 5.05, 4.89, 4.94 and 5.19 kg, respectively (Table 3). These values did not differ significantly (Table 4). Significant Period x Treatment interaction indicates that the buffaloes under different treatments during different periods behaved differently.

The absolute amount of residual milk was almost similar under different treatments and therefore, the total milk yield and the percentage residual milk also remained unchanged. The residual milk was 2.99, 2.88, 2.78, 2.94 and 1.89% under T-1, T-2, T-3, T-4 and T-5 respectively (Table 4).

Fat, lactose, chloride, sodium and potassium content of normal milk

Data regarding the fat, lactose, chloride, sodium and potassium content of normal milk have been presented in Table 5 and the ANOVA of complete data in Table 6. Compared to controls there was no difference

in the fat per cent of normal milk when 1 (T-2) and 3 IU (T-3) of oxytocin was administered, but at higher dose levels i.e. 5 and 10 IU the fat percentage of milk significantly ($P < 0.05$) increased. Significant Period x Treatment interaction indicates a differential behaviour of buffaloes under different treatments during different period. The respective fat percentages were 7.7, 7.8, 7.4, 8.2 and 8.2 under T-1, T-2, T-3, T-4 and T-5.

The lactose content of milk under different treatments was comparable to control values even when different doses of oxytocin were administered. The minor differences in the values of lactose under different treatments were not statistically significant. Chloride content of milk under T-1, T-2, T-3, T-4 and T-5 was respectively 130.7, 140.7, 137.9, 147.5 and 165.1 mg/100 ml. (Table 5) when oxytocin was administered in doses ranging from 1 to 10 IU it caused significant ($P < 0.01$) increases in chloride content of milk compared to controls. Similarly the sodium content of milk altered as a result of oxytocin administration. The increases in sodium content under oxytocin influence were highly significant ($P < 0.01$). Compared to control (43.8 mg/100 ml) the sodium content of milk was 50.9, 54.9, 53.1 and 65.2 mg/100 ml under T-2, T-3, T-4 and T-5, respectively. There was a significant ($P < 0.01$) period effect

on both (Na^+ and Cl^-) the constituents of milk which also reflected in significant ($P < 0.01$) Period x Treatment interactions.

The potassium content of milk as a result of oxytocin administration significantly ($P < 0.01$) decreased. The respective values were 129.6, 114.6, 115.8, 110.6 and 111.9 mg/100 ml under T-1, T-2, T-3, T-4 and T-5, respectively. Like sodium and chloride, the potassium content of milk also varied significantly ($P < 0.01$) during different periods of the experiment.

Fat, lactose, chloride, sodium and potassium content of residual milk

The relevant data has been presented in Table-7 and the ANOVA in Table-8. Though the fat content of residual milk during different periods of experiment varied significantly ($P < 0.01$) like that of normal milk, but there was no significant difference in the fat % of residual milk in different treatments. Under T-1, T-2, T-3, T-4 and T-5, the fat percent was 13.8, 13.7, 13.2, 14.2 and 14.0, respectively.

The lactose content of residual milk under T-2 and T-3, where 1 and 3 IU oxytocin was administered for milk let-down, was significantly ($P < 0.05$) higher than T-1, where no oxytocin was administered. In other treatment groups the lactose content did not differ significantly.

The chloride, sodium and potassium content of residual milk under all the treatment groups irrespective of whether oxytocin or no oxytocin was injected remained similar. There was significant ($P < 0.05$) period effect on the sodium and potassium content of residual milk, which reflected in significant ($P < 0.05$) Period x Treatment interaction in sodium content but not in potassium.

Comparison of normal and residual milk

A comparison of the composition of normal and residual milk under different treatments has been presented in Table 9. The values of different constituents within the group have been compared by 't' test. It is evident from the data that the fat content of residual milk under all the treatments was significantly ($P < 0.01$) higher. The lactose content of residual milk was significantly ($P < 0.01$) lowered under all the treatments. The chloride content of residual milk was higher than that of normal milk under T-1, T-2, T-3 and T-4 but not in T-5. The differences under T-1 and T-2 were highly significant ($P < 0.01$), where as under T-3, the differences were significant at 5% level only. Under T-4 and T-5 there was no significant difference.

The sodium content in residual milk was higher than that of normal milk under all the treatments. With the exception of T-5, where the differences were not statistically significant in rest of the treatments, the differences were highly significant ($P < 0.01$).

The potassium content of residual milk was always lower than that of normal milk but the degree of significance differed in different treatments.

DISCUSSION

In order to find out the effect of exogenous administration of different doses of synthetic oxytocin on milk let-down response, milking rate and composition of milk in buffaloes planned experiments were conducted. The results have been presented earlier under RESULTS.

Highest milk let-down time of 196 sec. was observed in buffaloes of control group where no oxytocin was administered. These let-down times are higher than the average values reported for cows by Lohr and Troger(1977) and confirm the report of Aliev (1969) and Ludri (1980) who reported higher milk let-down times in buffaloes than in the cows. Administration of oxytocin in doses ranging from 1 to 10 IU resulted in a dose dependent response of milk let-down time where the let-down times decreased as the dose of oxytocin increased. Bilek and Janvosky(1956) and Barowicz and Grega (1982) observed similar effects of the dose of oxytocin on milk let-down time in cows. Thind and Gangwar (1974) injected 20 IU of oxytocin in Murrah buffaloes and obtained less milk let-down times than the controls.

The time spent on milking the buffaloes was not significantly influenced by the different doses of oxytocin, however, the milking times decreased by 5 and 10 IU

of oxytocin administration. Thind and Gangwar (1974) observed shorter milking times in buffaloes when 12.4 IU oxytocin was administered intramuscularly. Morag (1968) injected 5 IU oxytocin in ewes before milking and observed that the milking time of oxytocin treated ewes was less than the controls.

The milking rates of oxytocin treated buffaloes were not significantly different from the controls but 10 IU oxytocin gave highest milking rates and these were significantly different from the 3 IU dose. Sagi et al.(1980) injected different doses of oxytocin and observed that there was much fluctuation in milk flow under different doses, Hupp et al.(1959) injected 20 IU oxytocin intravenously before milking and did not find any effect on milk flow of slow milking cows.

The yield of milk obtained at normal milking was similar to controls in all oxytocin treated groups. This means that oxytocin injection has not adversely affected the yield of milk. The absolute and relative amounts of residual milk were also not influenced by the oxytocin treatment. The values of residual milk in these experiments are similar to those reported by Ludri(1980)

and were not influenced by the oxytocin treatments for milk let-down as reported by Carroll et al., (1968) in cows. Since the residual milk is a useful guide for assessing the degree of milking out (Gerster, 1977), the results indicate that in all the treatment groups milking was effectively performed.

Oxytocin treatment at higher dose levels of 5 and 10 IU significantly increased the fat content of milk but at 1 and 3 IU levels, the fat content was comparable to controls. This means that at high dose levels oxytocin may increase in the fat content of milk in buffaloes also as reported by Sprain et al., (1952), Hynek and Caufalikova- Hatleova (1968) and Sagi et al., (1980) in cows.

The lactose content of control and oxytocin treated buffaloes was almost similar and was not influenced by the amount of oxytocin injected. Swanson and Claycomb (1968) stated that 5 IU oxytocin did not cause any change in lactose concentration in cows. However, there are reports (Linzell, 1967; Linzell and Peaker, 1971; Deshmukh, 1985) which suggest that oxytocin administration alters the permeability of mammary epithelium so that lactose content of milk decreases.

The sodium and chloride content of milk of oxytocin treated buffaloes was higher than the controls, even at 1-10 dose level oxytocin was very effective in increasing the sodium and chloride content of milk. These results on buffaloes are in conformity with the findings of Linsell (1967) and Linsell and Peaker (1971) who observed that oxytocin was very effective in increasing the sodium and chloride content of milk even in very low doses. In high doses (Wheelock et al., 1965) oxytocin definitely altered the sodium content of milk. They described these changes in sodium and chloride content of milk due to the direct effect of oxytocin on the permeability of mammary epithelium. In contrast the potassium content of milk in oxytocin treated buffaloes was significantly decreased in all the treatments, irrespective of dose levels. Similar changes in potassium content of milk after oxytocin administration have been reported by Zaks et al. (1965), Linsell (1967) and Linsell and Peaker (1971).

The fat content of residual milk was always higher than the normal milk as reported by different workers (Koshi and Petersen, 1955; Vellitok, 1963; Natske and Schulte, 1967; Ludri, 1980) in cow and buffaloes and was not influenced by the treatment.

The Lactose content of residual milk fluctuated in different treatments and did not reflect to any definite trend. The values of lactose content of residual milk were always lower than the potassium content. The sodium and chloride were always higher in residual milk than in the normal milk. When the milk composition data on normal and residual milk within the treatment groups was compared by using 't' test it was observed that, irrespective of the dose level of oxytocin injected for milk let-down the lactose and potassium content of residual milk was always lower than the normal milk and the fat, chloride and sodium content were higher. These results indicate that whatsoever changes are brought about by oxytocin at the mammary epithelium level are immediate and reflect directly into the compositional changes in milk.

SUMMARY

1. In the first chapter of this thesis importance of the problem on which the research has been carried out, is clearly defined.
2. An upto date review on the effect of oxytocin on milk let-down response, milking rate and milk composition has been presented.
3. The studies were conducted on 20 lactating Murrah buffaloes which had completed on an average 132 days in lactation and were yielding an average 9.1 kg milk/day.
4. In replicated 4 block 5 x 5 Latin Square Design experiment involving switch over, the buffaloes were randomly distributed to 5 different treatments.
Administration of no oxytocin, 1 IU, 3 IU, 5 IU and 10 IU of oxytocin constituted the experimental treatments T-1, T-2, T-3, T-4 and T-5, respectively.
5. The requisite quantity of oxytocin (Sigma Chemical Co., USA) in 1 ml sterile saline solution was administered intramuscularly followed by hand milking. Residual milk was withdrawn with the help of 10 IU oxytocin and re-milking the animal.

6. The buffaloes were hand milked by an expert milker at 5.30 AM and 5.30 PM daily. The observations were always taken during evening milking. To overcome the effect of previous treatment an interval of 48 hr. was given in between each treatment.
7. The buffaloes were housed in a shed with asbestos roofing and were fed on a balanced ration of concentrate mixture and green Berseem (Trifolium alexandrium) and Oat (Avena sativa) fodder.
8. Homogenous samples of normal and residual milk from individual buffalo were collected and the standard methods of analysis were followed without any changes in the recommended procedures.
9. The following results were obtained:
 - 1) Higher milk let-down time was observed in buffaloes of control group where no oxytocin was administered which decreased as the amount of oxytocin increased. Compared to controls, the decreases in let-down time in 1 IU and 3 IU groups were not significant but in 5 and 10 IU groups these were significant ($P < 0.01$).

- ii) Compared to controls the milking time and milking rates were not influenced by oxytocin treatment.
- iii) The yields of milk obtained at normal milking, residual milk and total milk were similar to controls in all the treatments.
- iv) There was a significant ($P < 0.05$) increase in the fat content of milk when 5 and 10 IU of oxytocin was administered for milk let-down. Lower doses did not affect it.
- v) Lactose content of milk remained similar under all the treatments and was not influenced by the amount of oxytocin injected.
- vi) Oxytocin administration in doses ranging from 1 to 10 IU caused significant ($P < 0.01$) increase in the chloride and sodium content of milk whereas the potassium significantly ($P < 0.01$) decreased.
- vii) Residual milk of control and oxytocin treated buffaloes contained similar percentage of fat.
- viii) Oxytocin had a varied influence on the lactose content of residual milk.
- ix) The sodium, chloride and potassium content of residual milk under all the treatments irrespective whether oxytocin or no oxytocin was injected remain similar.

- x) When the comparison of normal and residual milk within the same treatment groups was compared by 't' test, it was evident that the fat, sodium and chloride content of residual milk under all the treatments was significantly higher ($P < 0.01$). However, there was a significant decrease in lactose and potassium content of residual milk.

CONCLUSIONS

In balanced experiments, 20 lactating Murrah buffaloes were fed on a balanced ration of concentrate mixture and green fodder. There were 5 treatments viz. no oxytocin, 1 IU, 3 IU, 5 IU and 10 IU oxytocin administered intramuscularly. Administration of oxytocin decreased milk let-down time in a dose dependent manner but the milking rates were not affected. Oxytocin did not affect the yield of milk, however, with 5 and 10 IU of oxytocin the fat content of milk was increased. Doses of oxytocin ranging from 1 to 10 IU resulted in an increase in sodium and chloride and a subsequent decrease in potassium content of milk. In buffaloes the lactose content of milk was not decreased as a result of oxytocin administration. Residual milk from control and oxytocin treated buffaloes contained higher concentrations of fat, sodium and chloride and lower concentrations of lactose and potassium. Based on the milk let-down response, milking rate, milk yield and its composition regarding fat, sodium, chloride, lactose and potassium it appears that in buffaloes 1 IU of synthetic oxytocin is sufficient to cause milk let-down with the minimal changes in the normal composition of milk.

Table 1 : Effect of different doses of oxytocin on milk let-down time, milking time and milking rate.

Attributes	TREATMENTS					C.D. at 5% level
	T-1 (control)	T-2 (1 IU)	T-3 (3 IU)	T-4 (5 IU)	T-5 (10 IU)	
Milk let-down time (Seconds)	196 +48	186 +53	154 +38	131 +32	79 +20	51
Milking time (Seconds)	471 +112	478 +113	492 +116	435 +105	436 +63	-
Milking rate (Kg/Min.)	0.66 +0.15	0.63 +0.16	0.60 +0.16	0.68 +0.17	0.71 +0.17	0.10

Table 2 : Summary of ANOVA of complete data on milk let-down time, milking time and milking rate.

Source of variation	d.f.	Mean sum of squares		
		Milk let-down time	Milking Time	Milking rate
Between squares	3	12899.7967	87650.8900	0.0545
Between periods	4	7625.6000	22664.1175	0.0207
Between Treatments	4	45437.5750 ^{**}	12905.0650	0.1419 ^{**}
Period x Treatment	16	6467.7038	30309.6913	0.0327
Error	72	6658.4639	58084.4529	0.0258

^{**} Significant at 1 % level

Table 3 : Effect of different doses of oxytocin on yield of normal milk, residual milk, total milk and percent residual milk.

Attributes	TREATMENTS				
	T-1 (control)	T-2 (1 IU)	T-3 (3 IU)	T-4 (5 IU)	T-5 (10 IU)
Normal milk yield(kg)	5.18 <u>+1.32</u>	5.05 <u>+1.25</u>	4.89 <u>+1.19</u>	4.94 <u>+1.17</u>	5.18 <u>+1.23</u>
Residual milk yield (kg)	160 <u>+98</u>	150 <u>+88</u>	140 <u>+62</u>	150 <u>+79</u>	100 <u>+24</u>
Total milk yield (kg)	5.34 <u>+1.28</u>	5.20 <u>+1.22</u>	5.03 <u>+1.20</u>	5.09 <u>+1.22</u>	5.28 <u>+1.26</u>
Residual milk (%)	2.99 <u>+2.68</u>	2.68 <u>+1.68</u>	2.78 <u>+2.27</u>	2.94 <u>+2.04</u>	1.89 <u>+0.52</u>

Table 4 : Summary of ANOVA of complete data on normal milk, residual milk, total milk and percent residual milk.

Source of variation	d.f.	Mean sum of squares			
		Normal milk yield	Residual milk yield	Total milk yield	Percent residual milk yield
Between squares	3	9.5491 ^{**}	402534.6667 ^{**}	6.1327 [*]	413.3222 ^{**}
Between periods	4	1.9965	45393.5000	2.3489	86.4409
Between treatments	4	0.3615	10018.5000	0.2925	71.3289
Period x Treatment	16	1.9498 ^{**}	103566.6250	1.8853	58.7969
Error	72	0.8141	79569.0556	1.7067	53.7983

* Significant at 5 % level

** Significant at 1% level

Table 5: Effect of different doses of oxytocin on fat, lactose, chloride, sodium and potassium content of normal milk.

Attributes	Treatments					C.D. at 5% level
	T-1 (control)	T-2 (1 IU)	T-3 (3 IU)	T-4 (5 IU)	T-5 (10 IU)	
Fat %	7.7 <u>+1.8</u>	7.8 <u>+1.8</u>	7.4 <u>+1.7</u>	8.2 <u>+1.9</u>	8.2 <u>+1.9</u>	0.5
Lactose %	5.7 <u>+1.3</u>	6.1 <u>+1.4</u>	5.9 <u>+1.4</u>	6.2 <u>+1.4</u>	6.1 <u>+1.4</u>	--
Chloride (mg/100 ml)	130.7 <u>+29.9</u>	140.7 <u>+32.4</u>	137.9 <u>+31.8</u>	147.5 <u>+34.2</u>	165.1 <u>+38.6</u>	4.8
Sodium (mg/100 ml)	43.8 <u>+10.2</u>	50.9 <u>+11.7</u>	54.9 <u>+12.6</u>	53.1 <u>+12.3</u>	65.2 <u>+15.2</u>	2.2
Potassium (mg/100 ml)	129.6 <u>+29.9</u>	114.6 <u>+26.4</u>	115.8 <u>+26.7</u>	110.6 <u>+25.5</u>	111.9 <u>+26.1</u>	9.8

Table 6 : Summary of ANOVA of complete data on fat, lactose, chloride, sodium and potassium content of normal milk.

Source of variance	d.f.	Mean sum of squares				
		Fat	Lactose	Chloride	sodium	Potassium
Between squares	3	23.6535 ^{**}	0.8846	479.8262 ^{**}	77.7317 ^{**}	20.8630
Between periods	4	8.3165 ^{**}	0.9738	2784.4645 ^{**}	323.8406	1150.9381 ^{**}
Between treatments	4	2.1564 [*]	0.6943	3393.1613 ^{**}	1191.5584 ^{**}	1157.3006 ^{**}
Period x Treatment	16	2.5505 ^{**}	0.6980	1115.4544 ^{**}	129.9735 ^{**}	254.3994
Error	72	0.7253	0.4782	56.8825	12.2718	244.4880

* Significant at 5 % level

** Significant at 1 % level



Table 7: Effect of different doses of oxytocin on fat, lactose, chloride, sodium and potassium content of residual milk.

Attributes	TREATMENTS					C.D. at 5% level
	T-1 (control)	T-2 (1 IU)	T-3 (3 IU)	T-4 (5 IU)	T-5 (10 IU)	
Fat %	13.8 <u>+ 3.2</u>	13.7 <u>+3.3</u>	13.2 <u>+3.1</u>	14.2 <u>+3.4</u>	14.0 <u>+3.3</u>	--
Lactose %	4.9 <u>+1.1</u>	5.3 <u>+1.2</u>	5.1 <u>+1.2</u>	5.2 <u>+1.2</u>	4.9 <u>+1.1</u>	0.3
Chloride (mg/100 ml)	152.4 <u>+35.4</u>	157.9 <u>+36.6</u>	151.6 <u>+35.0</u>	154.3 <u>+35.9</u>	160.5 <u>+37.6</u>	--
Sodium (mg/100 ml)	68.8 <u>+16.1</u>	69.8 <u>+16.2</u>	68.3 <u>+15.8</u>	70.1 <u>+16.3</u>	71.8 <u>+16.9</u>	---
Potassium (mg/100 ml)	105.9 <u>+24.4</u>	107.7 <u>+24.9</u>	103.8 <u>+24.1</u>	104.2 <u>+24.0</u>	102.0 <u>+23.5</u>	---

Table 8: Summary of ANOVA of complete data on fat, lactose, chloride, sodium and potassium content of residual milk.

Source of Variation	d.f.	Mean sum of square				
		Fat	Lactose	Chloride	Sodium	Potassium
Between squares	3	36.3556*	0.2259	348.7169**	440.9771*	945.3333**
Between periods	4	61.6324**	0.4359	6556.8258	414.9656*	645.2663*
Between treatments	4	3.0666	0.7327*	674.7063	38.0264	147.0955
Period x treatments	16	8.7112	0.2827	335.2029	262.4622*	83.0873
Error	72	12.9424	0.2912	79569.0556	145.1695	192.2469

* significant at 5 % level

** significant at 1 % level

Table 9 : Comparison of fat, lactose, chloride, sodium and potassium content of normal and residual milk.

Attributes	TREATMENTS					
	T-1 (control)	T-2 (1 IU)	T-3 (3 IU)	T-4 (5 IU)	T-5 (10 IU)	
Fat %	Normal Milk	7.7 <u>+1.8</u>	7.8 <u>+1.8</u>	7.4 <u>+1.7</u>	8.2 <u>+1.9</u>	8.2 <u>+1.9</u>
	Residual Milk	13.8 <u>+3.2</u>	13.7 <u>+3.3</u>	13.2 <u>+3.1</u>	14.2 <u>+3.4</u>	14.0 <u>+3.3</u>
	Value of 't'	8.3 ^{**}	6.4 ^{**}	8.8 ^{**}	5.6 ^{**}	6.1 ^{**}
Lactose%	Normal Milk	5.7 <u>+1.3</u>	6.1 <u>+1.4</u>	5.9 <u>+1.4</u>	6.2 <u>+1.4</u>	6.1 <u>+1.4</u>
	Residual Milk	4.9 <u>+1.1</u>	5.3 <u>+1.2</u>	5.1 <u>+1.2</u>	5.2 <u>+1.2</u>	4.9 <u>+1.1</u>
	value of 't'	5.2 ^{**}	3.7 ^{**}	5.9 ^{**}	4.8 ^{**}	6.9 ^{**}
Chloride (mg/100 ml)	Normal Milk	130.7 <u>+29.9</u>	140.7 <u>+32.4</u>	137.9 <u>+31.8</u>	147.5 <u>+34.2</u>	165.1 <u>+38.6</u>
	Residual Milk	152.4 <u>+35.4</u>	157.9 <u>+36.6</u>	151.6 <u>+35.0</u>	154.3 <u>+35.9</u>	160.5 <u>+37.6</u>
	Value of 't'	3.5 ^{**}	2.9 ^{**}	2.5 [*]	0.5	0.5
sodium (mg/ 100 ml)	Normal Milk	43.8 <u>+10.2</u>	50.9 <u>+11.7</u>	54.9 <u>+12.6</u>	53.1 <u>+12.3</u>	65.2 <u>+15.2</u>
	Residual Milk	68.8 <u>+16.1</u>	69.8 <u>+16.2</u>	68.3 <u>+15.8</u>	70.1 <u>+16.3</u>	71.8 <u>+16.9</u>
	value of 't'	3.1 ^{**}	5.9 ^{**}	4.8 ^{**}	7.1 ^{**}	1.4
Potassium (mg/100 ml)	Normal Milk	129.6 <u>+29.9</u>	114.6 <u>+26.4</u>	115.8 <u>+26.7</u>	110.6 <u>+25.5</u>	111.9 <u>+26.1</u>
	Residual Milk	105.9 <u>+24.4</u>	107.7 <u>+24.9</u>	103.8 <u>+24.1</u>	104.2 <u>+24.0</u>	102.0 <u>+23.5</u>
	value of 't'	6.9 ^{**}	1.5	3.7 ^{**}	2.4 [*]	2.1 [*]

* Significant at 5% value of 't'

** significant at 1% value of 't'

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