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NOTE

EFFECTS OF DAILY EXOGENOUS OXYTOCIN INJECTIONS ON MILK PRODUCTION AND FAT YIELD IN HOLSTEIN COWS

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ABSTRACT

Twenty one Holstein cows milked three times daily in a 3×3 replicated Latin square design were used to determine the effects of daily exogenous oxytocin on 14-d milk production. The cows were assigned to the following treatments:1) control group, receiving 1.5 ml of saline 1 min before machine attachment, 2) animals receiving 15 IU (i.m.) of oxytocin 1 min before machine attachment at each milking and 3) animals receiving 15 IU of oxytocin 3.5 - 4 min after machine attachment at each milking. Daily milk yield was recorded and milk samples were collected from each cow, biweekly, for milk fat determination. The least square means of milk production were 17.5, 20.1 and 18.8 kg for control group, oxytocin 1 min before machine attachment and oxytocin injection 3.5-4 min after machine attachment, respectively. Oxytocin significantly increased 4% fat-corrected milk production by 15.1 and 7.3 percent, respectively.

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تاثیر تزریق هورمون اکسی توسین بر تولید شیر و چربی شیر در گاوهای هولشتین

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چکیده

تاثیر تزریق ۱۵ واحد بین المللی هورمون اکسی توسین در دو زمان (یک دقیقه قبل از دوشش و۴-۳/۵ دقیقه پس از شروع دوشش) بر تولید شیر و چربی آن در گاوهای سه بار دوشش بررسی شد. برای این منظور، تعداد ۲۱ راس گاو شیری هولشتین از سه دوره شیر دهی (از هر دوره ۷ راس) انتخاب شده و شیر روزانه هر راس گاو در هر نوبت شیر دوشی به مدت ۱۴ روز به طور جداگانه رکوردگیری شد. همچنین هردو هفته یک بار از شیر سه نوبت دوشش در روز، برای بررسی تغییرات درصد چربی شیر نمونه گیری شد. نتایج حاصله نشان داد که تزریق اکسی توسین یک دقیقه قبل از دوشش و ۴-۳/۵ دقیقه پس از شروع دوشش به ترتیب سبب ۱۵/۱ و۷/۳ درصد اضافه تولید در شیر تصحیح شده بر اساس ۴ درصد چربی نسبت به گروه شاهد شد.

INTRODUCTION

Oxytocin is a nonapeptide amide released from the neurohypophysis and causes contraction of the myoepithelial cells around the alveoli and small ducts of the mammary gland (1). It is generally considered to increase milk production by enhancing milk ejection (1, 8, 9, 15, 17, 18). Results of previous studies have varied from significant increases in milk production (1) to no change in either milk (13, 18) or fat (18) yield. Disparate results can be explained by the varied experimental designs employed, small sample size, alternating treatments, variations in dosage and timing of injections, and short treatment periods. Studies have involved injections just prior to hourly milking or injections up to 1 h before milking (8, 15). Such designs do not take into account the normal physiology of lactation, in which oxytocin is released into the blood stream due to normal milking stimuli, binds to myoepithelial cell receptors in the udder, and stimulates milk ejection. The objective of the present experiment was to determine whether an injection of oxytocin before or after machine attachment three times each day has any effect on milk production and fat percentage.

MATERIALS AND METHODS

Twenty-one Holstein cows were randomly assigned to treatments at 4-5 mo after parturition for 14 d milk production study. Cows were assigned to treatments based on production, parity and calving date. During the pretest week, cows were evaluated for assignment to the study on the basis of udder confirmation, and health status. Three treatment groups were assigned. Control group, receiving 1.5 ml of saline one min before machine attachment; the group, receiving 1.5 ml (15 IU) of oxytocin one min before machine attachment (OB group) and the group, receiving 1.5 ml (15 IU) of oxytocin 3.5 - 4 min after machine attachment (OA group). The dosage of oxytocin (15 IU) was chosen to provide a rise in plasma concentration of

oxytocin that would elicit a milk ejection response during the machine milking period (10, 16, 19). Injections (i.m.) were given with disposable individual 21-gauge needles and 2-ml syringe in the thigh region.

Cows were housed together in a free stall barn and diets were formulated according to the barn average level of milk production. Cows were milked in a herring-bone parlor. Premilking udder preparation consisted only of washing the teats. Postmilking teat dipping occurred after each milking with 0.5% iodophor.

Milk weights were recorded at each milking by the use of weight jars. Daily milk weights (sum of milk weight in the morning, afternoon, and evening) were used for statistical analysis. Biweekly milk samples for three consecutive milkings were taken for each cow. Samples were analysed for fat percentage.

A 3×3 Latin square design was used to derermine treatment effects; dependent variables were milk production and fat percentage. Analysis was performed using the HARVEY (model 1) program (11).

RESULTS AND DISCUSSION

Cows (n = 21) entered the study at the 4-5 mo post-partum within a 2-week period during which 33% of the animals represented first, 33% second and 33% third lactations. Milk production was the sole factor in the model that was affected significantly ($P<0.01$) by oxytocin treatment. The least squares means and standard errors of the means for milk production, fat percentage, and duration of milking are shown in Table 1.

Although a number of studies in the literature indicated that injection of oxytocin at milking time increased milk production, considerable differences exist in the literature. The magnitude of the effect of oxytocin injection was quite variable ranging from 10 to 12% increases in milk production in some studies (15) but nonsignificant effect on milk production in others (17, 18).

The use of exogenous oxytocin did not affect lactation milk yield during prepeak and peak milk yield (15, 17), but oxytocin injection increased milk yield after peak production. In the current study, oxytocin injections were performed after peak production and increased 4% FCM production by 7.3 and 15.1% for OA and OB, respectively (Table 1).

Table 1. Least square means for milk production and fat percentage by treatments.

Teratments	Actual milk (kg)		FCM (4%)		Fat (%)		Duration of milking (min)
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
Control	19.8[a]	0.15	17.5[a]	0.2	3.30[a]	0.13	8.4
OB	22.6[a]	0.15	20.1[b]	0.2	3.02[a]	0.12	8.9
OA	21.8[a]	0.15	18.8[c]	0.2	3.04[a]	0.12	12.1
PW	-	-	-	-	-	-	6.5

a,b,c Means within the same column with similar superscripts do not differ ($P<0.05$).

Control = injection of saline (1.5 ml) 1 min before machine attachment at each milking.

OB = injection of 15 IU oxytocin 1 min before machine attachment at each milking.

OA = injection of 15 IU oxytocin 3.5-4 min after machine attachment at each milking.

PW = pretest week.

Several mechanisms have been proposed to explain the effects of oxytocin on milk yield: 1) Oxytocin may alter the involution process of alveoli during lactation (4, 15). This mechanism is supported by studies with mice and rats (6), which showed that oxytocin can maintain secretory cell integrity during late lactation (15), 2) Exogenous oxytocin may prevent a normal decline in milk yield due to changes in endogenous oxytocin secretion. With progressing lactation, the sensitivity of the neuroendocrine reflex is depressed and the amount of endogenous oxytocin in plasma for

milk ejection is insufficient (12, 15). In the present study, the sudden increase in milk production of cows treated with oxytocin was noted. The design in this study allowed for the detection of a sudden increase in milk production because the usage of exogenous oxytocin started after peak milk yield. Therefore, 3) exogenous oxytocin may cause a complete evacuation of milk from the udder at each milking (sudden production increase) (4, 15), thereby lowering intramammary pressure, which may allow for greater secretory activity between milkings. Evidence to support the udder evacuation mechanism is reported in some studies (5, 12, 20). Alternatively, the secretion of milk from the udder in goats may be limited by an unidentified chemical in the milk (15), and in cows limitation may also be by intramammary pressure feedback (20).

In agreement with other research (2, 4, 15, 18), treatment OB or OA had no significant effect on fat percentage in this study, but changes in milk fat content, were reported by others during short-term experiments (9, 17).

The cows showed no unfavorable reactions to the daily injections. Previous work (3) has shown that the use of exogenous oxytocin may affect the length of the estrous cycle when administered at 100 IU d^{-1} or greater. In this study, cows received 15 IU oxytocin at each milking (three times daily milking), but had no apparent effects such as uterus movement, increase in duration of the estrous cycle or increased abortion. However, in the current study, duration of milking was increased (Table 1).

LITERATURE CITED

1. Adams, H.P. and N.N. Allen. 1952. The effect of removal of residual milk by use of oxytocin upon the yield and fat content of subsequent milkings. J. Dairy Sci. 35:1121-1129.
2. Allen, J.C. 1990. Milk synthesis and secretion rate in cows with milk composition changed by oxytocin. J. Dairy Sci.73:975-984.
3. Armstrong, D.T. and W. Hansel. 1959. Alteration of the bovine estrous cycle with oxytocin. J. Dairy Sci. 42:533-542.

4. Ballou. L.U., J.L. Bleck, G.T. Bleck and R.D. Bremel. 1993. The effects of daily oxytocin injection before and after milking on milk production, milk plasmin, and milk composition. J. Dairy Sci. 76:1544-1549.
5. Benson, G.K. and S.J. Folley. 1957. The effect of oxytocin on mammary gland involution in the rat. J. Endocrinol. 16:189(Abst.).
6. Caruolo, E.V. 1971. Exogenous oxytocin and lactation in the mouse. J. Dairy Sci. 54:1207-1211.
7. Deoeter, E.J., N.E. Smith and J. Acedo-Rico. 1985. Three or two times daily milking of older cows and first lactation cows for entire lactation. J. Dairy Sci. 68:123-132.
8. Donker, J.D., J.H. Koshi and W.E. Peterson. 1954. The effects of hourly milking with the aid of intravenous injections of oxytocin. J. Dairy Sci. 37:1261-1268.
9. Gorewit, R.C. and R. Sagi. 1984. Effects of oxytocin on production and milking variable of cows. J. Dairy Sci. 67:2050-2054.
10. Graf, G.C. 1968. Effects of oxytocin injected intramuscularly and intravenously on milk ejection of bovine. J. Dairy Sci. 51 (Suppl.1): 628 (Abst.).
11. Harvey. W.R. 1990. User's Guide for LSMLMW and MIXMDL, PC-2 version, monograph. The Ohio State Univ., 90 p.
12. Knodt, C.B. and W.E. Peterson. 1944. The effect of complete evacuation of the mammary gland by pitocin upon milk and fat production. J. Dairy Sci. 27:449-457.
13. Koshi, J.H. and W.E. Peterson. 1955. Complementary milk and its relationship to lactation. J. Dairy Sci. 38:788-796.
14. Lefcourt. A.M. and R.M. Akers. 1983. Is oxytocin really necessary for efficient milk removal in dairy cows? . J. Dairy Sci. 66:2251-2259.
15. Nostrand, S.D., D.M. Galton, H.N. Erb and D.E. Bauman. 1991. Effects of daily exogenous oxytocin on lactation milk yield and composition. J. Dairy Sci. 74:2119-2127.
16. Premachandra, B.N., G.W. Piges and R. Von Bersvordt-Wallrabe. 1959. Comparison of the intravenous and subcutaneous injections of oxytocin in the lactating cow. J. Dairy Sci. 42:918 (Abst.).

17. Sagi, R., R.C. Gorewit and D.B. Wilson. 1980. Role of exogenous oxytocin in eliciting milk ejection in dairy cows. J. Dairy Sci. 63:2006-2011.

18. Shaw, J.C. 1942. The effect of oxytocin on milk and milk fat secretion. J. Dairy Sci. 25:1051-1055.

19. Thompson, P.D., M.J. Paape and J.W. Smith. 1972. Residual milk yield as affectecd by dose and time of injection of oxytocin. J. Dairy Res. 40:221-227.

20. Tucker, H.A., R.P. Reece and R.E. Mather 1961. Udder capacity estimates as affected by rate of milk secretion and intramammary pressure. J. Dairy Sci. 44:1725-1732.