

CHAPTER IV

RESULTS

Effects of bST administration on the plasma concentration of IGF-1, mammary blood flow and milk yield.

Table 1 shows the mean values of the plasma IGF-1 concentration, mammary blood flow and milk yield of late lactating dairy cattle in both control group and the treatment group. In the control group, there were no significant differences of mammary blood flow and plasma flow during the period of experiment. The daily milk yield and the ratio of blood flow to milk yield were maintained nearly at the same rate throughout the experimental period. The concentration of IGF-1 in plasma slightly decreased which was significantly different on day 8 to day 20 of the experiment. The percentage of changes of plasma IGF-1 level decreased 12 % on day 1 to 50.2% on day 20 (Figure 1).

In the treatment group, after bST injection (day 1) mammary blood flow increased stepwise throughout the study period and it increased to the maximum value on day 4 (2748 ± 371 ml/min, $P < 0.01$) as compared to the pretreatment value (1807 ± 163 ml/min). Milk yield increased significantly ($P < 0.05$) on day 8 to day 20 after bST injection. The percentage of changes of milk yield increased 5.51% on day 1 to 30.95% on day 16 (Figure 3). An increase in mammary blood flow coincided with significant increase in milk yield on day 8 to day 20 after bST treatment. The ratio of mammary blood flow to milk yield increased after bST treatment and it returned to pre-treated value on day 16 (Table 1). The mean concentration of plasma IGF-1 level before treatment was 62.67 ± 18.50 ng/ml and

the concentration of plasma IGF-1 rose steadily reaching maximum of 144.67 ± 86.58 ng/ml on day 8 after treatment (Table 1). The percentage of changes of plasma IGF-1 level increased approximately 41.5% on day 1 to 134.5% on day 8 (Figure 1).

In comparison between groups, the mean values of mammary blood flow in animals treated with bST was higher than those of control animals throughout the experimental period. There were significantly higher ($P < 0.01$) in mammary plasma flow in animals treated with bST on day 4 to day 20 of the experiment than those animals in the control group. The mean concentration of plasma IGF-1 in bST-treated cows was higher than that of the control group and significantly higher ($P < 0.05$) on day 4 of the treatment period. The marked change in the percentage of the plasma IGF-1 level of animals treated with bST after treatment is showed in Figure 1 which coincides to an increase in mammary blood flow (Figure 2) and milk yield (Figure 3).

Effect of bST administration on the concentrations of arterial plasma glucose.

Table 2 shows the mean values of the concentrations of arterial plasma glucose, plasma A-V difference, extraction ratio and mammary glucose uptake. In the control group, there were no significant differences of arterial glucose concentration, A-V difference, extraction ratio and mammary glucose uptake throughout the experimental period when compared to the pre-treated period.

In the treatment group, there were no significant changes in the arterial plasma concentration of glucose, mammary A-V difference and the mammary extraction ratio of glucose during treatment period. The concentrations of arterial plasma glucose decreased on day 4, day 8 and day 12 after bST injection ($2.56 \pm$

0.28, 2.37 ± 0.15 and 2.35 ± 0.23 mmol/l, respectively) in compared to pretreated period (2.70 ± 0.41 mmol/l). Mammary glucose uptake significantly increased ($P < 0.01$) from 951 ± 355 μ mole/min to 1581 ± 269 μ mole/min on day 4 after treatment.

In comparison between groups, the concentration of arterial plasma glucose in bST-treated animals was lower (2.35 ± 0.23 mmol/l) than that of the control group (2.80 ± 0.29 mmol/l) on day 12. The mammary extraction ratio of glucose significantly increased on day 4 ($31.7 \pm 5.9\%$, $P < 0.01$) after bST injection in compared to these of the control group ($20.7 \pm 5.3\%$). Mammary glucose uptake also increased on day 4 (1581 ± 269 μ mole/min, $P < 0.01$) of the treated group when compared to that of the control group (819 ± 294 μ mole/min).

Effect of bST administration on milk compositions.

Table 3 shows the mean values of the concentration of milk protein, milk fat and milk lactose. In the control group, there were no significant differences of the concentration of lactose and protein concentrations in milk while milk fat concentration tended to decline during the study period.

In the treatment group, milk protein concentration increased a few day after treatment and decreased from 3.42 ± 0.43 gm% in pretreated period to 3.04 ± 0.47 gm% on day 16 ($P < 0.05$) while milk fat concentration tended to increase during bST treatment. The concentration of lactose in milk increased on day 8 (4.01 ± 0.4 gm%) and significantly increased on day 12 (4.01 ± 0.07 gm%, $P < 0.05$) in compared to the pretreated period (3.81 ± 0.19 gm%).

In comparison between groups, the concentration of milk protein in bST-treated animals was significantly lower on day 16 (3.04 ± 0.47 gm%, $P < 0.05$) than these of the control group (3.72 ± 0.44 gm%). The concentration of milk lactose in the bST-treated animals was significantly higher on day 4 (3.66 ± 0.13 gm%, $P < 0.05$) and day 12 (4.01 ± 0.07 gm%, $P < 0.01$) than these of the control group (3.85 ± 0.08 gm% and 4.22 ± 0.11 gm%, respectively).

Effect of bST administration on the concentrations of arterial plasma triglyceride.

Table 4 shows the mean values of the concentration of arterial plasma triglyceride, plasma A-V difference, mammary extraction ratio and mammary triglyceride uptake. In the control group, the concentration of arterial plasma triglyceride increased from 0.57 ± 0.08 mmol/l in pretreatment period to 0.64 ± 0.05 mmol/l on day 1 and significantly increased on day 4 (0.71 ± 0.03 mmol/l, $P < 0.01$). There were no changes in the mammary A-V difference, the extraction ratio and the mammary uptake of triglyceride throughout the experimental period.

In the treatment group, the concentration of arterial plasma triglyceride declined gradually during bST treatment and significantly decreased ($P < 0.05$) on day 4 (0.41 ± 0.03 mmol/l) and day 8 (0.45 ± 0.08 mmol/l) after bST injection in comparison to the pretreated value (0.54 ± 0.08 mmol/l). There were no significant difference of mammary A-V difference, the extraction ratio and mammary uptake of triglyceride throughout the study.

In comparison between groups, the concentration of plasma triglyceride in the treatment period in treated animals was lower than that the control animals throughout experimental period. Mammary triglyceride uptake in animals treated

with bST was higher than those of control animals throughout the experimental period.

Effect of bST administration on the concentrations of arterial plasma β -hydroxybutyrate.

Table 5 shows the mean values of the concentration of arterial plasma β -hydroxybutyrate, plasma A-V difference, mammary extraction ratio and mammary β -hydroxybutyrate uptake. The concentration of arterial plasma β -hydroxybutyrate were unaffected in bST treated group. There were no significant changes in mammary A-V difference, the extraction ratio and the mammary uptake of β -hydroxybutyrate after bST treatment. In comparison between groups, the mammary uptake of β -hydroxybutyrate in animals treated with bST was higher than that of the control animals.

Effect of bST administration on the concentrations of arterial plasma acetate

Table 6 shows the mean values of the concentration of arterial plasma acetate, plasma A-V difference, mammary acetate extraction ratio and mammary acetate uptake. In the control group, the concentration of arterial plasma acetate, A-V difference, extraction ratio and mammary acetate uptake showed no significant differences throughout the study period.

In the treatment group, the concentration of arterial plasma acetate significantly increased ($p < 0.05$) on day 8 and day 12 after bST administration (0.71 ± 0.09 and 0.77 ± 0.07 mmol/l, respectively) in compared to the pretreated value (0.53 ± 0.09 mmol/l). The plasma A-V difference of acetate significantly increased after bST injection on day 1 (0.38 ± 0.08 mmol/l, $P < 0.05$) in compared to that of the pretreatment period (0.30 ± 0.11 mmol/l). There were no changes in mammary

extraction ratio of acetate throughout the experimental period. The mammary acetate uptake significantly increased ($P < 0.05$) on day 1, day 8, day 12 and day 16 after bST treatment.

In comparison between groups, there were significantly higher ($P < 0.05$) in the mammary uptake of acetate in the group treated with bST on day 8 and day 12 of the experiment (943 ± 239 and 829 ± 168 $\mu\text{mole}/\text{min}$, respectively) than those of the control group (443 ± 130 and 435 ± 149 $\mu\text{mole}/\text{min}$, respectively).



Table1: Mammary blood flow (MBF), mammary plasma flow (MPF), plasma IGF-1 concentrations, milk yield, mammary blood flow/milk yield ratio and haematocrit in the control animals and animals treated with bST.

	Pre-treatment	Treatment					Post-treatment
	Day -4	Day 1	Day 4	Day 8	Day 12	Day 16	Day 20
MBF (ml/min):							
Control	1889 ± 53	1908 ± 166	1972 ± 195	1942 ± 119	1955 ± 97	1931 ± 171	1938 ± 178
Treatment	1807 ± 163	2018 ± 277	2748 ± 371 ^{**††}	2715 ± 582 ^{*†}	2464 ± 111 ^{**††}	2278 ± 113 ^{**††}	2160 ± 65 ^{**†}
MPF (ml/min):							
Control	1336 ± 37	1337 ± 116	1406 ± 178	1398 ± 145	1413 ± 116	1398 ± 159	1413 ± 162
Treatment	1291 ± 121	1434 ± 211	1984 ± 281 ^{**††}	1946 ± 397 ^{**†}	1772 ± 125 ^{**††}	1656 ± 115 ^{**††}	1581 ± 60 ^{**†}
IGF-1 (ng/ml)							
Control	87.17 ± 22.20	76.00 ± 18.30	73.50 ± 6.98	68.33 ± 19.11 [*]	47.92 ± 14.11 ^{**}	44.17 ± 12.73 ^{**}	42.25 ± 7.64 ^{**}
Treatment	62.67 ± 18.50	82.67 ± 19.68	116.67 ± 43.10 ^{*†}	144.67 ± 86.58	84.25 ± 40.28	84.00 ± 64.48	51.33 ± 26.17
Milk yield (kg/day):							
Control	5.27 ± 1.44	5.19 ± 1.43	5.39 ± 1.51	5.49 ± 1.48	5.20 ± 1.66	5.36 ± 1.44	5.15 ± 1.53
Treatment	4.89 ± 0.94	5.17 ± 1.25	5.91 ± 1.39	5.98 ± 1.65 [*]	6.13 ± 1.57 [*]	6.37 ± 1.17 ^{**}	5.91 ± 0.78 [*]
MBF/ Milk yield:							
Control	551 ± 161	582 ± 239	560 ± 146	539 ± 134	593 ± 207	559 ± 190	580 ± 172
Treatment	556 ± 160	603 ± 210	710 ± 236 [*]	716 ± 341	622 ± 212	534 ± 127	534 ± 69
Haematocrit (%):							
Control	29.3 ± 2.4	29.8 ± 3.5	28.8 ± 3.7	28.2 ± 4.1	27.8 ± 4.0	27.8 ± 2.4 [*]	27.2 ± 3.7 [*]
Treatment	28.6 ± 1.3	29.0 ± 1.8	27.8 ± 2.0	28.1 ± 3.7	28.2 ± 1.9	27.3 ± 1.8	26.8 ± 2.8 [*]

Values are means ± SD. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (**P<0.01, *P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (††P<0.01, †P<0.05).

Table2: The concentrations of arterial plasma glucose (Glu_a), A-V difference concentration, mammary extraction ratio and mammary glucose uptake in the control animals and animals treated with bST.

	Pre-treatment	Treatment					Post-treatment
	Day -4	Day 1	Day 4	Day 8	Day 12	Day 16	Day 20
Glu_a (mmol/l):							
Control	2.79 ± 0.51	2.94 ± 0.27	2.77 ± 0.35	2.68 ± 0.42	2.80 ± 0.29	2.79 ± 0.32	2.78 ± 0.32
Treatment	2.70 ± 0.41	2.82 ± 0.25	2.56 ± 0.28	2.37 ± 0.15	2.35 ± 0.23 [‡]	2.72 ± 0.44	3.49 ± 0.42 ^{*‡‡}
A-V dif (mmol/l):							
Control							
Treatment	0.59 ± 0.36	0.62 ± 0.21	0.58 ± 0.20	0.67 ± 0.34	0.70 ± 0.14	0.72 ± 0.22	0.58 ± 0.24
Extraction ratio (%):							
Control							
Treatment	23.2 ± 18.3	21.0 ± 6.5	20.7 ± 5.3	24.8 ± 13.1	24.9 ± 4.9	25.6 ± 5.8	21.0 ± 8.9
	28.6 ± 12.9	29.7 ± 7.2	31.7 ± 5.9 ^{‡‡}	30.0 ± 9.8	27.2 ± 11.9	25.2 ± 15.0	17.6 ± 4.2
Glucose uptake (μmole/min):							
Control	796 ± 507	831 ± 306	819 ± 294	944 ± 489	991 ± 254	994 ± 270	813 ± 331
Treatment	951 ± 355	1199 ± 347	1581 ± 269 ^{**‡‡}	1352 ± 377	1149 ± 537	1209 ± 892	980 ± 288

Values are means ± SD. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (**P<0.01, *P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (‡‡P<0.01, ‡P<0.05).

Table3: Milk compositions in the control animals and animals treated with bST.

	Pre-treatment	Treatment					Post-treatment
	Day -4	Day 1	Day 4	Day 8	Day 12	Day 16	Day 20
Milk composition							
Protein (gm%)							
Control	3.82 ± 1.67	3.64 ± 1.51	3.92 ± 1.63	3.87 ± 0.59	3.79 ± 1.56	3.72 ± 0.44	3.50 ± 1.45
Treatment	3.42 ± 0.43	3.46 ± 0.45	3.67 ± 0.73	3.37 ± 0.34	3.38 ± 0.38	3.04 ± 0.47 ^{*‡}	3.35 ± 0.43
Fat (gm%)							
Control	4.22 ± 1.20	3.97 ± 1.01	3.80 ± 0.83	3.75 ± 0.88	4.23 ± 1.99	4.26 ± 1.71	3.85 ± 1.45
Treatment	4.82 ± 1.67	6.57 ± 1.12 ^{‡‡}	4.50 ± 1.27	5.42 ± 2.47	4.03 ± 0.65	5.43 ± 1.69	4.61 ± 1.41
Lactose (gm%)							
Control	3.31 ± 1.44	3.84 ± 0.61	3.85 ± 0.08	4.16 ± 0.31	4.22 ± 0.11	3.98 ± 0.10	4.02 ± 0.16
Treatment	3.81 ± 0.19	3.70 ± 0.06	3.66 ± 0.13 [‡]	4.01 ± 0.4	4.01 ± 0.07 ^{*‡‡}	3.91 ± 0.12	3.89 ± 0.16

Values are means ± SD. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (*P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (‡‡P<0.01, ‡P<0.05).

Table 4: The concentrations of arterial plasma triglyceride (TG_a), A-V difference concentration, mammary extraction ratio and mammary triglyceride uptake in the control animals and animals treated with bST.

	Pre-treatment	Treatment					Post-treatment
	Day -4	Day 1	Day 4	Day 8	Day 12	Day 16	Day 20
TG _a (mmol/l):							
Control	0.57 ± 0.08	0.64 ± 0.05	0.71 ± 0.03 ^{**}	0.60 ± 0.04	0.57 ± 0.04	0.59 ± 0.05	0.57 ± 0.08
Treatment	0.54 ± 0.08	0.55 ± 0.08 [‡]	0.41 ± 0.03 ^{*‡‡}	0.45 ± 0.08 ^{*‡‡}	0.50 ± 0.05 [‡]	0.45 ± 0.06 ^{‡‡}	0.47 ± 0.06 [‡]
A-V dif. (mmol/l):							
Control	0.06 ± 0.03	0.07 ± 0.03	0.07 ± 0.04	0.10 ± 0.05	0.09 ± 0.02	0.08 ± 0.01	0.08 ± 0.05
Treatment	0.06 ± 0.04	0.10 ± 0.07	0.05 ± 0.03	0.08 ± 0.05	0.07 ± 0.05	0.07 ± 0.05	0.11 ± 0.07
Extraction ratio (%):							
Control	11.1 ± 5.1	10.5 ± 4.8	9.8 ± 6.0	16.4 ± 9.0	15.1 ± 4.0	12.9 ± 1.9	13.1 ± 8.4
Treatment	11.0 ± 5.9	18.1 ± 11.4	12.9 ± 7.8	16.5 ± 9.0	13.8 ± 9.3	15.4 ± 9.5	22.5 ± 12.8
TG uptake (μmole/min):							
Control	84 ± 38	90 ± 40	93 ± 50	115 ± 45	115 ± 31	106 ± 24	108 ± 72
Treatment	78 ± 47	150 ± 117	103 ± 63	161 ± 112	124 ± 86	118 ± 73	174 ± 110

Values are means ± SD. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (^{**}P<0.01, ^{*}P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (^{‡‡}P<0.01, [‡]P<0.05).

Table 5: The concentrations of arterial plasma β -hydroxybutyrate (β -HBA_a), A-V difference concentration, mammary extraction ratio and mammary β -hydroxybutyrate uptake in the control animals and animals treated with bST.

	Pre-treatment	Treatment					Post-treatment
	Day -4	Day 1	Day 4	Day 8	Day 12	Day 16	Day 20
β -HBA _a (mmol/l):							
Control	0.93 ± 0.30	0.77 ± 0.35	1.02 ± 0.39	0.90 ± 0.27	0.92 ± 0.34	0.84 ± 0.43	1.15 ± 0.35
Treatment	1.29 ± 0.42	0.91 ± 0.38	1.18 ± 0.37	1.03 ± 0.27	1.26 ± 0.26	1.06 ± 0.27	1.17 ± 0.19
A-V dif.(mmol/l):							
Control	0.57 ± 0.42	0.49 ± 0.31	0.62 ± 0.38	0.50 ± 0.30	0.68 ± 0.35	0.52 ± 0.49	0.68 ± 0.30
Treatment	0.76 ± 0.56	0.36 ± 0.20	0.81 ± 0.37	0.65 ± 0.33	0.75 ± 0.27	0.65 ± 0.30	0.73 ± 0.30
Extraction ratio (%):							
Control	64.9 ± 25.9	61.6 ± 20.9	58.7 ± 21.5	56.2 ± 25.4	75.5 ± 26.0	55.6 ± 19.3	58.9 ± 14.6
Treatment	57.9 ± 30.1	54.7 ± 28.9	65.7 ± 30.4	59.8 ± 20.1	59.5 ± 18.6	58.9 ± 12.9	62.2 ± 21.5
β -HBA uptake ((μ mole/min):							
Control	753 ± 556	632 ± 364	859 ± 570	688 ± 394	935 ± 438	727 ± 676	972 ± 452
Treatment	1020 ± 761	738 ± 577	1620 ± 821	1277 ± 642	1335 ± 479	1074 ± 507	1155 ± 460

Values are means ± SD. (n=6).

Table 6: The concentrations of arterial plasma acetate, A-V difference concentration, mammary extraction ratio and mammary acetate uptake in the control animals and animals treated with bST.

	Pre-treatment	Treatment					Post-treatment
	Day -4	Day 1	Day 4	Day 8	Day 12	Day 16	Day 20
Acetate _a (mmol/l):							
Control	0.51 ± 0.04	0.61 ± 0.09	0.65 ± 0.20	0.61 ± 0.05	0.62 ± 0.17	0.65 ± 0.11	0.51 ± 0.14
Treatment	0.53 ± 0.09	0.55 ± 0.09	0.71 ± 0.14	0.71 ± 0.09*	0.77 ± 0.07*	0.66 ± 0.11	0.65 ± 0.03
A-V dif.(mmol/l):							
Control	0.29 ± 0.07	0.34 ± 0.06	0.34 ± 0.07	0.32 ± 0.07	0.31 ± 0.10	0.33 ± 0.12	0.30 ± 0.06
Treatment	0.30 ± 0.11	0.38 ± 0.08*	0.35 ± 0.09	0.44 ± 0.09	0.48 ± 0.10	0.40 ± 0.12	0.30 ± 0.05
Extraction ratio (%):							
Control	57.3 ± 18.3	57.5 ± 16.2	54.0 ± 7.6	53.3 ± 13.3	50.0 ± 8.5	49.8 ± 10.4	60.6 ± 17.3
Treatment	55.8 ± 13.5	68.1 ± 9.9	61.2 ± 29.4	62.0 ± 7.4	61.7 ± 9.3	59.8 ± 15.4	46.5 ± 5.5
Acetate uptake (μmole/min):							
Control	380 ± 105	480 ± 112	463 ± 147	443 ± 130	435 ± 149	453 ± 184	409 ± 108
Treatment	397 ± 158	551 ± 165*	744 ± 264	943 ± 239* [‡]	829 ± 168* [‡]	682 ± 211*	479 ± 66

Values are mean ± SD. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (*P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, ([‡]P<0.05).

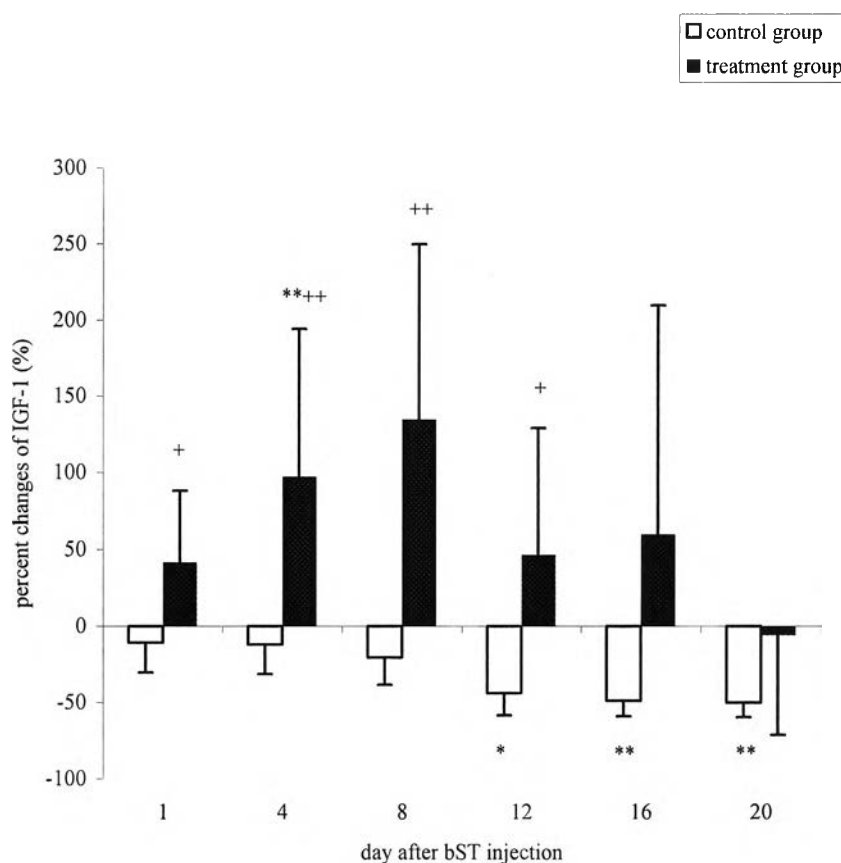


Figure 1. Percentage of changes of plasma IGF-1 level of animals in the control and the group treated with bST.

Values are means \pm sd. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (**P < 0.01, *P < 0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (**P < 0.01, +P < 0.05).

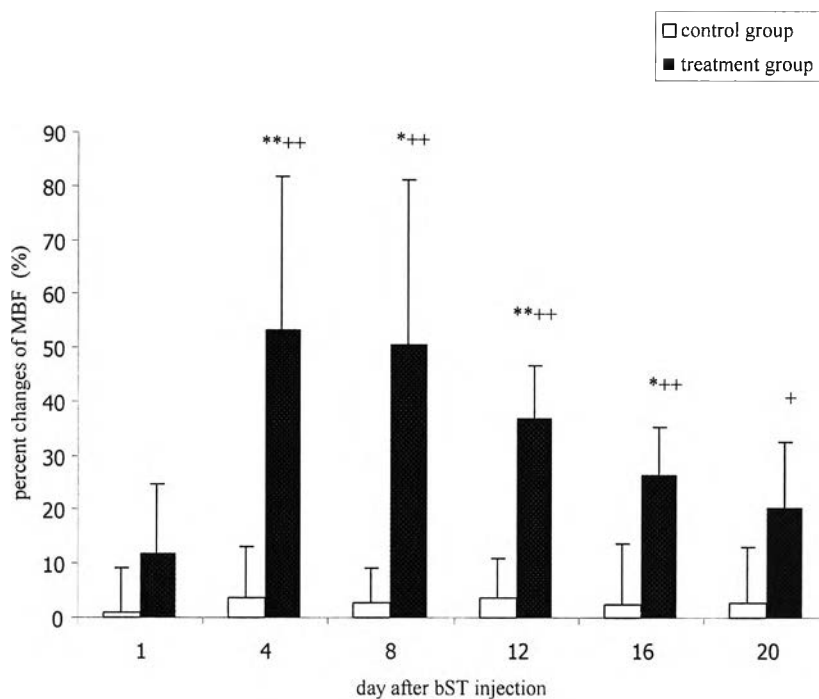


Figure 2. Percentage of changes of mammary blood flow (MBF) of animals in the control and the group treated with bST.

Values are means \pm sd. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (**P<0.01, *P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (++)P<0.01, +P<0.05).

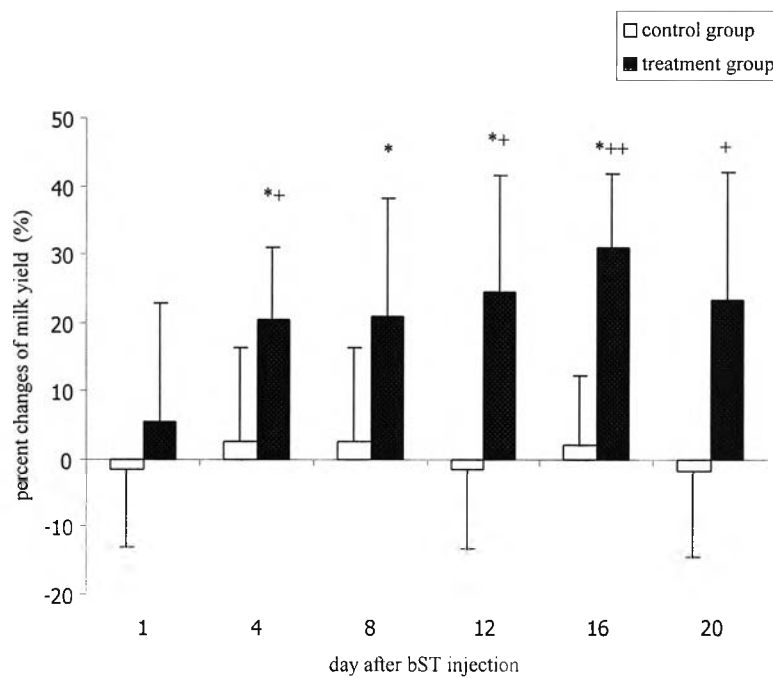


Figure 3. Percentage of changes of milk yield of animals in the control and the group treated with bST.

Values are means \pm sd. (n=6).

P-value by paired t-test with respect to the pretreated period in the same group, (*P<0.05).

P-value by unpaired t-test with respect to the similar period of experiment between control and the group treated with bST, (**P<0.01, +P<0.05).