

## CHAPTER IV

### RESULTS

#### **Effects of bST administration on dietary dry matter intake, water intake and milk yield (table 2)**

The total daily dry matter intake (DMI) was not significantly different between control and experimental groups during the pretreatment period. No significant differences in total DMI as a percent body weight between control animals and animals given bST. Estimated mean values of daily water intake was higher for animals given bST than control animals given placebo. Daily water intake significantly increased ( $P<0.01$ ) in treatment period when compared with pretreatment period of animals given bST group. Daily water intake increased during early lactation period of animals given bST, mainly due to increased milk production. Milk yield was higher for animals given bST than control animal given placebo. Milk yield increased from 13.37 to 16.02 kg/d ( $P<0.05$ ) with early lactation period of animals given bST group. In contrast to animals given bST, milk yield of animals in control group was not significantly different between treatment period and pretreatment period. The peak of milk yield occurred at week 10, thereafter yield declined in both groups throughout the end of experiment (Fig. 1). An evaluation of the dry matter intake and milk yield revealed that during treatment period the mean ratios of total dry matter intake to milk yield of 87.5%HF animals given bST were lower than those of control animals given placebo. The mean ratios of dry matter intake to milk yield decreased significantly ( $P<0.05$ ) in treatment period when compared with pretreatment in animals given bST group.

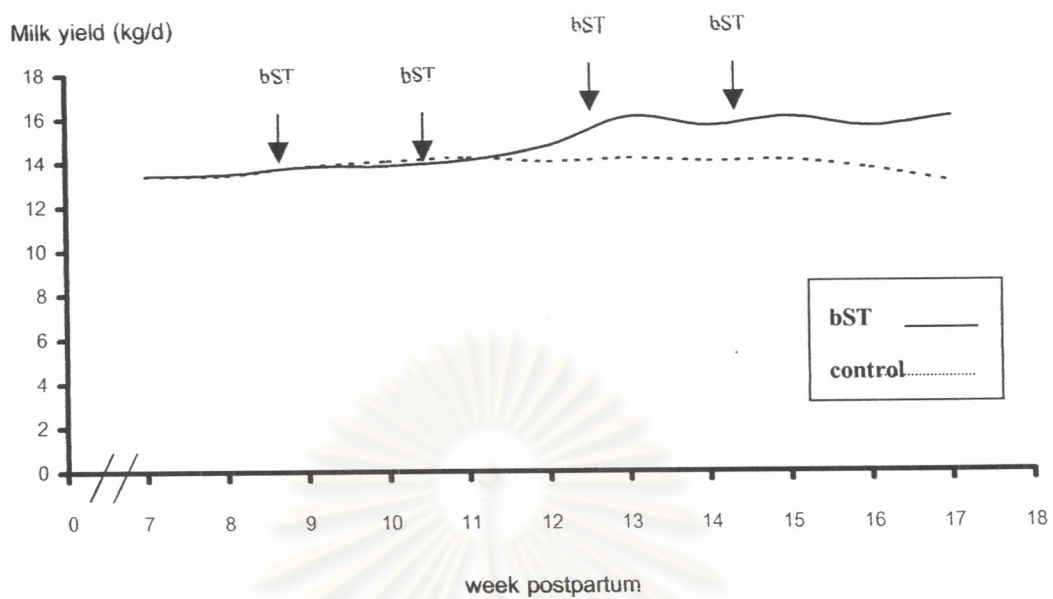
**Table 2:** Dietary dry matter intake, water intake and milk yield in the control animals and animals treated with bST.

		Period of		
		experiments		
		Control group	bST group	Control vs bST group <sup>1</sup>
<b>Dry matter intake (kg/d)</b>				
Concentrate	Pretreatment	7.06 ± 1.27	7.09 ± 0.87	NS
	Treatment	7.93 ± 0.72	8.30 ± 1.68	NS
Roughage	Pretreatment	4.35 ± 1.08	5.21 ± 0.93	NS
	Treatment	3.71 ± 0.82	4.70 ± 1.31	NS
Total DM intake	Pretreatment	11.41 ± 0.66	12.30 ± 0.76	NS
	Treatment	11.64 ± 1.11	13.01 ± 1.67	NS
Total DM intake (kg/100kg)	Pretreatment	3.41 ± 0.38	3.40 ± 0.36	NS
	Treatment	3.26 ± 0.10	3.32 ± 0.27	NS
<b>Water intake (l/d)</b>	Pretreatment	58.66 ± 13.16	65.20 ± 10.57	NS
	Treatment	60.22 ± 12.31	70.89 ± 12.43 <sup>**</sup>	NS
<b>Milk yield (kg/d)</b>	Pretreatment	12.98 ± 1.53	13.37 ± 2.66	NS
	Treatment	13.11 ± 1.85	16.02 ± 3.99 <sup>*</sup>	NS
<b>DM intake/Milk yield</b>	Pretreatment	0.89 ± 0.12	0.96 ± 0.25	NS
	Treatment	0.90 ± 0.12	0.85 ± 0.22 <sup>*</sup>	NS

Values are means ± SD. (n = 5).

P-values by paired t-test: \* P<0.05, \*\* P<0.01, with respect to the pretreated period in the same group.

<sup>1</sup> Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)



**Figure 1.** Milk yield of animals in the control and the group treated with bST

( ↓ : injection of bST or placebo)

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**Effects of bST administration on plasma volume, blood volume, plasma osmolality and packed cell volume (Table 3)**

There were no significant differences of the plasma volume and blood volume as absolute values or as percentages of body weight for either animals given bST or control animals given placebo. The animals given bST group, plasma volume and blood volume as absolute values was significantly increased ( $P < 0.05$ ) in treatment period when compared with pretreatment period. The packed cell volume of both groups were not significantly different higher. During the study period there were no significant differences of body weight and plasma osmolality between groups of 87.5%HF animals given bST and control animals given placebo. The body weight was significantly increased ( $P < 0.05$  and  $P < 0.01$ ) in treatment period when compared with pretreatment period in animals given bST and animals in the control group, respectively.



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**Table 3:** Plasma volume, blood volume and packed cell volume in the control animals and animals treated with bST.

		Period of		
		Control group	bST group	Control vs bST group <sup>1</sup>
		experiments		
<b>Plasma volume</b>				
(l)	Pretreatment	16.00 ± 1.30	16.63 ± 1.40	NS
	Treatment	17.38 ± 1.90	19.38 ± 3.20 <sup>*</sup>	NS
(l/100kg)	Pretreatment	4.74 ± 0.41	4.58 ± 0.24	NS
	Treatment	4.86 ± 0.16	4.94 ± 0.56	NS
<b>Blood volume</b>				
(l)	Pretreatment	22.16 ± 2.00	23.30 ± 2.00	NS
	Treatment	24.64 ± 3.20	26.91 ± 4.70 <sup>*</sup>	NS
(l/100kg)	Pretreatment	6.59 ± 0.53	6.41 ± 0.29	NS
	Treatment	6.88 ± 0.33	6.85 ± 0.76	NS
<b>Hct (%)</b>				
	Pretreatment	28.10 ± 1.50	28.65 ± 0.90	NS
	Treatment	29.25 ± 2.50	27.90 ± 1.40	NS
<b>Plasma osmolality</b>				
	Pretreatment	280 ± 4	274 ± 6	NS
(mOsm/kg)	Treatment	280 ± 5	276 ± 3	NS
<b>Body weight (kg)</b>				
	Pretreatment	336.9 ± 31.06	363.6 ± 27.06	NS
	Treatment	357.1 ± 34.04 <sup>**</sup>	391.2 ± 35.64 <sup>*</sup>	NS

Values are means ± SD. (n = 5).

P-values by paired t-test: <sup>\*</sup> P<0.05, <sup>\*\*</sup> P<0.01, with respect to the pretreated period in the same group.

<sup>1</sup>Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)



**Effects of bST administration on the water turnover rate, biological half-life and total body water (Table 4)**

Water turnover rate as absolute values were not significantly different between control and bST treated animals during the pretreatment period. In the treatment period, water turnover rate as absolute values significantly increased ( $P < 0.05$ ) in animals given bST when compared with the control animals. The animals given bST, water turnover rate as absolute values was significantly increased ( $P < 0.05$ ) when compared with pretreatment period. An average water turnover rate as a percent of body weight and the water turnover rate per body fat free wet weight ( $\text{kg}^{0.82}$ ) was not significantly different between control and experimental groups throughout the study period. There were no changes the tritiated water biological half-life between control animals and animals given bST. The TOH space and total body water vary with the size of animals. The TOH space and total body water as absolute values was not significantly different between control animals and animals given bST in the pretreatment period. The TOH space and total body water as absolute values of bST treated animals was significantly increased ( $P < 0.01$ ) than control animals given placebo in the treatment period. The TOH space and total body water as absolute values in treatment period was higher ( $P < 0.01$ ) than pretreatment period in animals given bST group. Absolute values of total body water and TOH space or total body water as percentage of body weight in treatment period was significant lower than pretreatment period in control animals given placebo. No significant differences in TOH space and total body water as a percentage of body weight between control animals and animals given bST.

**Table 4:** Changes in water turnover rate and total body water in the control animals and animals with bST.

		Period of experiments		
		Control group	bST group	Control vs bST group <sup>1</sup>
<b>Water turnover rate</b>				
(l/d)	Pretreatment	60.00 ± 13.57	70.63 ± 18.53	NS
	Treatment	60.65 ± 10.06	85.20 ± 19.35*	P<0.05
(l/100kg/d)	Pretreatment	17.52 ± 3.3	19.56 ± 5.50	NS
	Treatment	17.03 ± 2.70	22.11 ± 5.90	NS
(ml/kg <sup>0.82</sup> /d)	Pretreatment	499.69 ± 97.71	564.40 ± 156	NS
	Treatment	489.99 ± 75.91	645.50 ± 168	NS
<b>Biological half-life (d)</b>	Pretreatment	3.25 ± 0.6	2.94 ± 0.78	NS
	Treatment	3.03 ± 0.44	2.60 ± 0.71	NS
<b>TOH space</b>				
(l)	Pretreatment	268.7 ± 16.42	283.0 ± 8.7	NS
	Treatment	260.7 ± 14.75*	304.6 ± 12.23**	P<0.01
(l/100kg)	Pretreatment	79.95 ± 3.04	78.13 ± 5.37	NS
	Treatment	73.23 ± 3.09**	78.22 ± 5.91	NS
<b>Total body water</b>				
(l)	Pretreatment	246.6 ± 13.2	259.3 ± 7.5	NS
	Treatment	238.7 ± 11.6**	278.3 ± 11.3**	P<0.01
(l/100kg)	Pretreatment	73.42 ± 3.2	71.57 ± 5.01	NS
	Treatment	67.11 ± 3.4**	71.48 ± 5.49	NS

Values are means ± SD. (n = 5).

P-values by paired t-test: \* P<0.05, \*\* P<0.01, with respect to the pretreated period in the same group.

<sup>1</sup> Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)

**Effects of bST administration on the empty body water, gut water, extracellular fluid and intracellular fluid (Table 5)**

There were no significant differences of the EBW as absolute values or as percentages of body weight between control animals given placebo and animals treated with bST during the pretreatment period. In the treatment period, the EBW as absolute values was higher ( $P<0.05$ ) in animals given bST when compared with control animals. Gut water as absolute values was significantly increased ( $P<0.01$ ) in animals given bST when compared with control animals given placebo in treatment period. Gut water as percentages of body weight in animals given bST was higher ( $P<0.05$ ) than control animals in treatment period. Animals in control group, gut water as percentage of body weight was significant decreased ( $P<0.05$ ) in the treatment period when compared with the pretreatment period. An extracellular fluid volume as absolute values or as percentages of body weight showed no significant differences between animals given bST and control animals given placebo. In comparison between period of experiment, the extra cellular fluid volume in the treatment period was significantly higher ( $P<0.05$ ) than those in the pretreatment period of animals given bST. Intracellular fluid volume was significantly increased ( $P<0.01$ ) in animals given bST when compared with control animals given placebo in the treatment period. There were no significant differences of the intracellular fluid volum as percentages of body weight between animals given bST and control animals given placebo. In comparison between period of experiment, animals in the control group showed significant decrease ( $P<0.01$ ) in intracellular fluid volume as absolute values in treatment period when compared with pretreatment period. No significant differences in intracellular fluid volume as percentage of body weight in both groups in comparison between the treatment period and the pretreatment period.



**Table 5:** Empty body water, gut water, extracellular fluid and intracellular fluid in the control animals and animals treated with bST.

	Period of experiments	Control group			Control vs bST group <sup>1</sup>
		Control group	bST group	Control vs bST group <sup>1</sup>	
<b>Empty body water</b>					
(l)	Pretreatment	145.84 ± 12.3	148.25 ± 11.21	NS	
	Treatment	147.05 ± 7.02	163.81 ± 12.65	P<0.05	
(l/100kg)	Pretreatment	43.34 ± 1.74	40.82 ± 2.41	NS	
	Treatment	41.37 ± 2.75	42.09 ± 4.54	NS	
<b>Gut water</b>					
(l)	Pretreatment	100.76 ± 7.88	111 ± 7.52	NS	
	Treatment	91.69 ± 6.77	114.5 ± 6.50	P<0.01	
(l/100kg)	Pretreatment	30.08 ± 3.15	30.75 ± 4.10	NS	
	Treatment	25.74 ± 1.44*	29.39 ± 2.25	P<0.05	
<b>Extracellular fluid</b>					
(l)	Pretreatment	76.55 ± 7.53	77.74 ± 9.25	NS	
	Treatment	82.92 ± 11.18	88.61 ± 10.95*	NS	
(l/100kg)	Pretreatment	22.87 ± 3.08	21.37 ± 1.79	NS	
	Treatment	23.38 ± 3.96	22.65 ± 1.95	NS	
<b>Intracellular fluid</b>					
(l)	Pretreatment	170 ± 14.96	181.5 ± 9.26	NS	
	Treatment	155.8 ± 16.06**	189.7 ± 4.61	P<0.01	
(l/100kg)	Pretreatment	50.55 ± 2.95	50.20 ± 5.22	NS	
	Treatment	43.73 ± 3.71	48.83 ± 4.87	NS	

Values are means ± SD. (n = 5).

P-values by paired t-test: \* P<0.05, \*\* P<0.01, with respect to the pretreated period in the same group.

<sup>1</sup> Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)

**Effects of bST administration on mammary circulation and the plasma concentration of IGF-1 (Table 6)**

In the treatment period, mammary plasma flow and mammary blood flow were higher for animals given bST than those of control animals given placebo. Mammary plasma flow and mammary blood flow were significantly increased ( $P<0.05$ ) in animals treated bST in the treatment period when compared with the pretreatment period. An increase in mammary blood flow coincided with an increase in milk yield. The ratio of mammary blood flow to milk yield showed no significant differences between control animals and bST treated animals. The plasma IGF-1 concentration was significantly increased ( $P<0.01$ ) in animals treated bST when compared with those of control animals during the treatment period.



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**Table 6:** Changes in mammary circulation and the plasma concentration of IGF-1 in the control animals and animals treated with bST.

	Period of experiments	Control group			bST group		Control vs bST group <sup>1</sup>
		Control group	bST group	Control vs bST group <sup>1</sup>			
<b>Mammary plasma flow (ml/min)</b>	Pretreatment	2438 ± 331	2549 ± 342	NS			
	Treatment	2730 ± 357	3927 ± 1203*	NS			
<b>Mammary blood flow (ml/min)</b>	Pretreatment	3286 ± 461	3548 ± 463	NS			
	Treatment	3817 ± 616	5310 ± 1620*	NS			
<b>Mammary blood flow/ Milk yield</b>	Pretreatment	364 ± 25	397 ± 111	NS			
	Treatment	420 ± 32*	491 ± 152	NS			
<b>IGF-1 (ng/ml)</b>	Pretreatment	40 ± 15	50 ± 29	NS			
	Treatment	48 ± 16	209 ± 42**	P<0.01			

Values are means ± SD. (n = 5).

\* P-values by paired t-test: P<0.05 with respect to the pretreated period in the same group.

<sup>1</sup> Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)

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**Effect of bST administration on the concentrations of arterial plasma glucose, A-V difference concentration, mammary extraction ratio and mammary glucose uptake (Table 7)**

The mean arterial plasma glucose concentration and mammary glucose uptake were not significant different between control animals and bST treated animals throughout the study period. The plasma A-V differences of glucose significantly decreased ( $P<0.05$ ) in animals given bST when compared with control animals in the treatment period. There were no changes in mammary extraction ratio of glucose between control animals and animals given bST. In the treatment period, mammary extraction ratio of glucose significantly decreased ( $P<0.05$ ) when compared with the pretreatment period in animals given bST.



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**Table 7:** The concentrations of arterial plasma glucose ( $\text{Glu}_a$ ), A-V difference concentration, mammary extraction ratio and mammary glucose uptake in the control animals and animals treated with bST.

	Period of experiments	Control vs bST group <sup>1</sup>		
		Control group	bST group	Control vs bST group <sup>1</sup>
<b><math>\text{Glu}_a</math> (mmol/l)</b>	Pretreatment	$3.78 \pm 0.23$	$3.72 \pm 0.14$	NS
	Treatment	$3.83 \pm 0.37$	$3.80 \pm 0.24$	NS
<b>A-V dif (mmol/l)</b>	Pretreatment	$0.93 \pm 0.30$	$0.98 \pm 0.15$	NS
	Treatment	$0.90 \pm 0.11$	$0.71 \pm 0.13^*$	P<0.05
<b>Extraction ratio (%)</b>	Pretreatment	$24.53 \pm 6.94$	$26.35 \pm 3.24$	NS
	Treatment	$23.61 \pm 3.85$	$18.68 \pm 3.96^*$	NS
<b>Glucose uptake (<math>\mu\text{mmol/min}</math>)</b>	Pretreatment	$2322 \pm 960$	$2503 \pm 494$	NS
	Treatment	$2454 \pm 468$	$2858 \pm 1178$	NS

Values are means  $\pm$  SD. (n= 5).

P-values by paired t-test: \* P<0.05, with respect to the pretreated period in the same group.

<sup>1</sup>Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)

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**Effect of bST administration on the concentrations of arterial plasma acetate, A-V difference concentration, mammary extraction ratio and mammary acetate uptake (Table 8)**

There were no significant differences of the concentration of arterial plasma acetate and the plasma A-V difference for either 87.5%HF animals given bST or control animals throughout the study period. The concentration of arterial plasma acetate was significantly increased ( $P<0.05$ ) in treatment period when compared with pretreatment period in animals given bST group. The mammary extraction ratio of acetate and mammary acetate uptake were not significantly different between control and experimental groups during the pretreatment period. In treatment period, the mammary extraction ratio of acetate and mammary acetate uptake significantly increased ( $P<0.05$ ) in animals given bST when compared with control animals given placebo groups.



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**Table 8:** 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.

	Period of experiments	Control vs bST group <sup>1</sup>		
		Control group	bST group	Control vs bST group <sup>1</sup>
<b>Acetate<sub>a</sub> (mmol/l)</b>	Pretreatment	1.1 ± 0.16	1.07 ± 0.11	NS
	Treatment	1.18 ± 0.21	1.24 ± 0.10*	NS
<b>A-V dif. (mmol/l)</b>	Pretreatment	0.48 ± 0.30	0.57 ± 0.15	NS
	Treatment	0.46 ± 0.16	0.62 ± 0.06	NS
<b>Extraction ratio (%)</b>	Pretreatment	41.79 ± 23.68	53.78 ± 15.54	NS
	Treatment	38.32 ± 7.79	50.72 ± 6.65	P<0.05
<b>Acetate uptake (μmmol/min)</b>	Pretreatment	1109 ± 613	1436 ± 376	NS
	Treatment	1292 ± 547	2464 ± 872	P<0.05

Values are means ± SD. (n= 5).

\* P-values by paired t-test: P<0.05, with respect to the pretreated period in the same group.

<sup>1</sup>Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)

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**Effect of bST administration on the concentrations of arterial plasma  $\beta$ -hydroxybutyrate, A-V difference concentration, mammary extraction ratio and mammary  $\beta$ -hydroxybutyrate uptake (Table 9)**

The concentration of arterial plasma  $\beta$ -hydroxybutyrate were unaffected in bST treated group. There were no significant changes in plasma A-V difference and the extraction ratio of  $\beta$ -hydroxybutyrate between control and experimental group throughout the study periods. The mammary uptake of  $\beta$ -hydroxybutyrate did not differ between animals given bST and animals control.

**Table 9:** The concentrations of arterial plasma  $\beta$ -hydroxybutyrate ( $\beta$ -HBA<sub>a</sub>), A-V difference concentration, mammary extraction ratio and mammary  $\beta$ -hydroxybutyrate uptake in the control animals and animal treated with bST.

	Period of experiments	Control group			bST group			Control vs bST group <sup>1</sup>
		Control group	bST group	Control vs bST group <sup>1</sup>				
$\beta$ -HBA <sub>a</sub> (mmol/l)	Pretreatment	1.60 $\pm$ 0.74	1.14 $\pm$ 0.30	NS				
	Treatment	1.78 $\pm$ 0.56	1.25 $\pm$ 0.38	NS				
A-V dif (mmol/l)	Pretreatment	0.69 $\pm$ 0.29	0.46 $\pm$ 0.12	NS				
	Treatment	0.76 $\pm$ 0.24	0.46 $\pm$ 0.22	NS				
Extraction ratio (%)	Pretreatment	44.13 $\pm$ 6.51	41.77 $\pm$ 11.41	NS				
	Treatment	44.49 $\pm$ 11.03	36.76 $\pm$ 11.58	NS				
$\beta$ -HBA uptake ( $\mu$ mmol/min)	Pretreatment	1679 $\pm$ 737	1156 $\pm$ 269	NS				
	Treatment	2116 $\pm$ 835	1986 $\pm$ 1345	NS				

Values are means  $\pm$  SD. (n= 5).

<sup>1</sup>Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)



**Effect of bST administration on the concentrations of arterial plasma triglyceride, A-V difference concentration, mammary extraction ratio and mammary triglyceride uptake (Table 10)**

The mean arterial plasma triglyceride concentration, plasma A-V difference, extraction ratio and the mammary uptake of triglyceride were not significant different between control and experimental group. In comparison between period of experiment, the concentration of arterial plasma triglyceride, plasma A-V difference, extraction ratio and the mammary uptake of triglyceride were not significantly different between pretreatment and treatment period in both group.

**Table 10:** The concentrations of arterial plasma triglyceride (TG<sub>a</sub>), A-V difference concentration, mammary extraction ratio and mammary triglyceride uptake in the control animals and animal treated with bST.

	Period of experiments	Control group			Control vs bST group <sup>1</sup>
		Control group	bST group	Control vs bST group <sup>1</sup>	
<b>TG<sub>a</sub> (mmol/l)</b>	Pretreatment	0.151 ± 0.02	0.161 ± 0.05	NS	
	Treatment	0.134 ± 0.04	0.128 ± 0.01	NS	
<b>A-V dif (mmol/l)</b>	Pretreatment	0.037 ± 0.02	0.065 ± 0.03	NS	
	Treatment	0.058 ± 0.05	0.037 ± 0.02	NS	
<b>Extraction ratio (%)</b>	Pretreatment	24.96 ± 12.15	37.26 ± 15.17	NS	
	Treatment	38.89 ± 21.3	27.31 ± 15.53	NS	
<b>TG uptake (μmmol/min)</b>	Pretreatment	91 ± 43	169 ± 87	NS	
	Treatment	147 ± 114	165 ± 138	NS	

Values are means ± SD. (n= 5).

<sup>1</sup> Statistical analysis of treatment differences. NS = Nonsignificant (P>0.05)

### Effects of bST administration on milk composition (Table 11)

There were no significant differences of the concentration of protein and lactose concentration in milk of control and experimental groups during the study period. Milk fat concentration significantly ( $P < 0.05$ ) increased in 87.5%HF animals given bST when compared with control animal given placebo in treatment period. The animals given bST groups, milk fat concentration was significantly increased ( $P < 0.05$ ) in treatment period when compared with pretreatment period.

**Table 11:** Milk compositions in the control animals and animals treated with bST.

	Period of experiments			
		Control group	bST group	Control vs bST group <sup>1</sup>
<b>Milk composition</b>				
Protein (gm%)	Pretreatment	3.15 ± 0.21	3.16 ± 0.16	NS
	Treatment	3.27 ± 0.15	3.16 ± 0.25	NS
Fat (gm%)	Pretreatment	3.60 ± 0.76	3.90 ± 0.60	NS
	Treatment	3.60 ± 0.25	4.70 ± 0.77 <sup>*</sup>	P < 0.05
Lactose (gm%)	Pretreatment	4.49 ± 1.02	4.90 ± 0.24	NS
	Treatment	4.52 ± 0.55	4.79 ± 0.49	NS

Values are means ± SD. (n= 5).

P-values by paired t-test: \* P < 0.05, with respect to the pretreated period in the same group.

<sup>1</sup>Statistical analysis of treatment differences. NS = Nonsignificant (P > 0.05)